



## Testing and Reporting Requirements for Linear Replacement Lamps *under Technical Requirements V5.1*

**[Effective July 1, 2020]**

*The DLC defines all tube-style LED products that use the lamp holders (i.e. sockets or tombstones) in the luminaire to mechanically or electrically connect to the fixture housing and electric supply to fall under these testing requirements. Products that do not employ lamp holders will be classified as Retrofit Kits, regardless of form factor. Please see the Product Eligibility page and Technical Requirements for more details on product classification.*

The DLC accepts QPL applications for two-foot, three-foot, four-foot, eight-foot, and U-Bend Linear Replacement Lamps. The testing and reporting requirements described below are intended to evaluate the performance of the lamp itself.

### General Applications

Two-foot, three-foot, eight-foot and U-bend replacement lamp general applications are restricted to LED lamps intended to replace fluorescent T8 lamps. Four-foot replacement lamp general applications are restricted to LED lamps intended to replace fluorescent T8, T5, and T5HO lamps at this time. Product specification sheets must clearly indicate for which specific linear replacement lamp type (i.e. T8, T5, or T5HO) the product is intended, and list the base type and the nominal length in inches.

- **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. Marketing material shall indicate that they are intended to replace T8 fluorescent lamps of the same length. Products of different lengths and bases are not eligible under this general application. Products intended to operate on magnetic ballasts or those with different base types are not eligible.

- **T8 Three-Foot Linear Replacement Lamps**

LED lamps intended to replace T8 fluorescent lamps. These LED lamps shall be 36 inches long and employ a G13 base. Marketing material shall indicate that they are intended to replace T8 fluorescent lamps of the same length. Products of different lengths and bases are not eligible



under this general application. Products intended to operate on magnetic ballasts or those with different base types are not eligible.

- **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. Marketing material shall indicate that they are intended to replace T8 fluorescent lamps of the same length. Products of different lengths and bases are not eligible under this general application. Products intended to operate on magnetic ballasts or those with different base types are not eligible.

- **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. Marketing material shall indicate that they are intended to replace T8 fluorescent lamps of the same length. Products of different lengths and bases are not eligible under this general application. Products intended to operate on magnetic ballasts or those with different base types are not eligible.

- **U-Bend Replacement Lamps**

LED lamps intended to replace T8 fluorescent lamps. These LED lamps shall employ a G13 base. Marketing material shall indicate that they are intended to replace T8 fluorescent lamps of the same shape. Products intended to operate on magnetic ballasts or those with different base types are not eligible.

- **T5 Four-Foot Linear Replacement Lamps**

LED lamps intended to replace T5 fluorescent lamps (note, not T5 High Output or T5HO). These LED lamps shall be 46 inches long and employ a G5 base. Marketing material shall indicate that they are intended to replace T5 fluorescent lamps of the same length. Products of different lengths, bases, or marketed as intended to replace other types of fluorescent lamps are not eligible under this general application.

- **T5HO Four-Foot Linear Replacement Lamps**

LED lamps intended to replace T5HO fluorescent lamps. These LED lamps shall be 46 inches long and employ a G5 base. Marketing material shall indicate that they are intended to replace T5HO fluorescent lamps of the same length. Products of different lengths, bases, or marketed as intended to replace other types of fluorescent lamps are not be eligible under this general application.

## Primary Use Designations

Under the Technical Requirements Table, replacement lamps will fall under one of the following four Primary Use Designations:



### 1. Replacement Lamps (UL Type A):

Two-foot, three-foot, four-foot, eight-foot, and U-bend LED "tubes" designed to replace two-foot, three-foot, four-foot, eight-foot, and U-bend fluorescent lamps, respectively.

- 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.*
- Replacement lamps designed to operate utilizing magnetic ballasts are not eligible.

### 2. Internal Driver/Line Voltage Lamp-Style Retrofit Kits (UL Type B):

Two-foot, three-foot, four-foot, eight-foot, and U-bend LED "tubes" designed to replace two-foot, three-foot, four-foot, eight-foot, and U-bend fluorescent lamps, respectively.

- Products in this category employ lamp holders to connect to the fixture being retrofitted, but do not operate utilizing the existing fluorescent ballast. These products require rewiring of the existing fixture to bypass the ballast and send line voltage directly to the lamp holders.

### 3. External Driver Lamp-Style Retrofit Kits (UL Type C):

Two-foot, three-foot, four-foot, eight-foot, and U-bend LED "tubes" designed to replace two-foot, three-foot, four-foot, eight-foot, and U-bend fluorescent lamps, respectively.

- Products in this category employ lamp holders to connect to the fixture being retrofitted, do not operate utilizing the existing fluorescent ballast, and require rewiring of the existing fixture to replace the ballast with a driver internal to the fixture but external to the lamp. The lamp holders are then wired to receive only the low-voltage electricity that is supplied by that driver.

### 4. Dual Mode Internal Driver (UL Type A and Type B):

Two-foot, three-foot, four-foot, eight-foot, and U-bend LED "tubes" designed to replace two-foot, three-foot, four-foot, eight-foot, and U-bend fluorescent lamps, respectively.

- Products in this category *operate utilizing the existing fluorescent ballast and also have the ability to operate utilizing line voltage if the fixture is rewired to bypass the ballast. These products connect to the fixture using standard pin-base connections to the lamp holders.*
- Replacement lamps designed to operate utilizing magnetic ballasts are not eligible.

## Supporting Documentation

Applicants must provide the following supporting documentation in addition to the test data described below.

- **Installation Instructions**
  - Installation instruction sheets must be submitted with the application to indicate how the replacement lamp will be installed in an existing fixture in the field. This must be provided in addition to all necessary documentation required for other product categories. Lamps that require specialized components for installation to perform to the above criteria are not eligible for qualification. Lamps that employ rotatable end-caps are eligible but must clearly indicate this feature in the product spec sheet.
  
- **Safety Certification Documentation**
  - All products are required to submit a compliance certificate from an approved safety certification organization relevant in the United States or Canada. This compliance document shall bear the manufacturers name and will be proof that the products listed have been investigated by the safety organization and found to be in compliance with the standards listed on the certificate. The name of this document varies by safety organization, however, is commonly referred to as a Certificate of Compliance or Authorization to Mark.
  - During the application process, manufacturers will be required to digitally sign an agreement confirming that the safety documentation they are providing with the application covers ALL models they wish to be listed on the QPL and that the products being sold will bear the proper markings from the safety organization.
  - Note: If, after qualification, the safety documentation gets updated so that any model number(s) listed on the QPL are no longer covered by the original safety certificate, it is the responsibility of the manufacturer to submit the revised documentation so that the DLC records can be updated accordingly. Failure to do so may result in the product and any associated family members or private labels of the product being delisted.

## Special Considerations for Linear Replacement Type-C Lamp Systems with Non-Identical Lamps

Multi-lamp Type-C lamp systems are, in general, expected to have multiple lamps of the exact same type. For multi-lamp Type-C systems where the lamps within the system are not identical, the following restrictions and testing rules apply:

- Lamps within the Type-C system may only differ for purposes of allowing enhanced communications or control features. Lamps with explicitly different performance, such as nominally different color temperatures or light outputs, are not eligible to be listed in a Type-C system.

- Lamp-level testing must show consistency between the two lamps in terms of light output, efficacy, and wattage within  $\pm 10\%$ . Products must also be of the same nominal CCT and CRI.
- Multi-lamp Type-C systems where the lamps within the system are not identical may only be submitted under Family Grouping applications. These products will not be eligible as “Single Product” applications.
- Each of the distinct lamps in the system must have their own lamp-level testing.
  - The appropriate number of multiple lamps *of the same type* should be loaded onto the driver, and lamp-level lamp testing conducted according to the “Testing Notes” section below.
- All testing will be evaluated and must demonstrate that the products pass the requirements.
- QPL listings in the “Model Number” field must be of one of the following forms:
  - If each lamp and the associated driver in the system has a distinct product identifier (model number or other unique identifier), the distinct product identifiers will be noted in the model number field with the lamp quantity (“N”) for each lamp model in the system as: (Lamp A, Lamp B,... Lamp N)(Driver)
    - In a system with more than two lamps, model numbers will be represented as follows:
      - *Lamp A (one), Lamp B (“N”), (Driver)*
      - For example, a 4-lamp system will be represented as “*Lamp A (one), Lamp B (three), (Driver)*”
  - Alternatively, if the system is sold as one unified system under a single distinct product identifier, that identifier will be listed in the Model Number field: (System Ordering Code)
  - Test data and reported data on the QPL listing will reflect the worst-case efficacy lamp. A note placed in the Notes field will clarify that the data represents lamp-level data for the worst-case lamp in the system.

## Lamp-Level Tests

All lamps seeking qualification by the DLC must test the bare lamp according to LM-79. DLC defines bare lamp as *the performance characteristics of a replacement lamp when operated outside of a luminaire or retrofit kit, including the effects of an external ballast (for Type A and Dual Mode lamps) or driver (for Type C lamps).*

Table 1: Performance Criteria for Linear Replacement Lamps

Individual Lamp Criteria							
	Two-foot lamps, T8 replacements	Three-foot lamps, T8 replacements	Four-foot lamps, T8 replacements	Four-foot lamps, T5 replacements	Four-foot lamps, T5HO replacements	Eight-foot lamps, T8 replacements	U-bend lamps, T8 replacements
Bare Lamp Efficacy	≥ 120 lm/W	≥ 120 lm/W	≥ 120 lm/W	≥ 120 lm/W	≥ 120 lm/W	≥ 120 lm/W	≥ 120 lm/W
Initial Bare Lamp Light Output	≥ 800 lm	≥ 1,200 lm	≥ 1,600 lm	≥ 1,600 lm	≥ 3,200 lm	≥ 3,200 lm	≥ 1,400 lm
Beam Angle	≥ 140°	≥ 140°	≥ 140°	≥ 140°	≥ 140°	≥ 140°	≥ 140°

Notes: [1] Bare lamp efficacy and bare lamp light output must include the effects of an external ballast or driver; [2] spectral quality, electrical performance, and any other parameter not described here must be in accordance with general requirements of V5.1

### Testing Notes

For Type A and Dual Mode Type A/B linear replacement lamps designed to operate on an existing fluorescent ballast, the efficacy, lumen output, and wattage performance must represent the combined lamp + ballast system. LM-79 testing shall be conducted using a ballast consistent with **Table 2**. Specification sheets for the ballast used during testing must be provided with the application and the ballast make and model number must be noted in the test report. Ballasts used in testing must be certified to the applicable safety standards and must comply with applicable ANSI standards.

Table 2: Type A and Dual Mode Reference Ballast Criteria

Type A and Dual Mode Reference Ballast Criteria	
General Applications	Reference Ballast for Type A and Dual Mode Type A/B
T8 Linear Replacement Lamps	T8 electronic instant-start ballast with 0.88 ballast factor
T5/T5HO Linear Replacement Lamps	T5/T5HO electronic programmed-start ballast with 1.0 ballast factor

For Type-B and Type-C products (i.e. lamp-style retrofit kits, which connect mechanically and/or electrically to the fixture via standard lamp holders, but which require an electrical modification to the existing fixture), “lamp”-level testing is also required.

If the system is designed to operate multiple lamps utilizing an external driver, the driver should be loaded as it would be in the field, with appropriate steps taken to calculate the efficacy of the single lamp. For example, for a two-lamp kit, one lamp should be measured for light output, while the system as intended (with two identical lamps on the driver) should be measured for electrical input. The wattage into the driver can then be divided by two, and that wattage divided into the lamp lumens to determine system efficacy.

Appropriate steps to measure the electrical and photometric properties of the lamp system, under most circumstances, would be to load the driver or ballast appropriately, then isolate a single lamp in the apparatus being used for photometric measurements. In a sphere, for example, this could be accomplished by placing one lamp from the system inside the sphere, while the other one is outside the sphere.

Goniophotometric testing of bare lamps is also required for verification of beam angle. Understanding that it may be challenging to properly isolate a single lamp from a multi-lamp system in a goniophotometer, the DLC will accept testing that conforms to the LM-79 standard and operates the lamp directly on DC power, eliminating the external driver or ballast from the system. The only results of this test that will be used in the application review will be the candela array for calculations of beam angle. All other measurements will not be used in the application review.

If testing using this method:

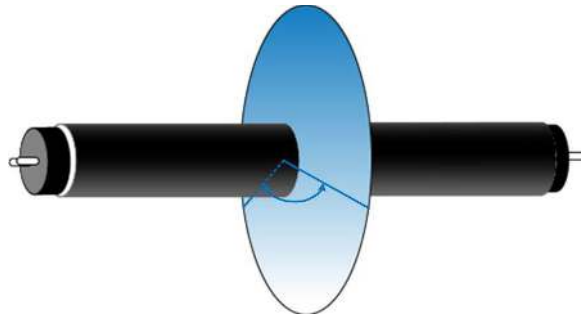
- The power supplied by the lab power supply to the lamp should match that which the lamp would receive from the ballast or external driver.
- A separate full LM-79/color report (as described in the [V5.1 Additional Reporting Requirements for LM-79, LM-80, and TM-21 Reports](#) section of the V5.1 Technical Requirements) from an integrating sphere must be provided on the lamp under test.
- The goniophotometric test report shall explicitly and clearly state the test conditions (i.e. without driver/ballast),

For questions, please contact [applications@designlights.org](mailto:applications@designlights.org).

## Photometric Distribution Testing

In addition to LM-79/color reports for worst-case light output, worst-case efficacy, and appropriate color properties per rules applicable to all products, submitters are required to provide a full LM-79/distribution (goniophotometer) test for each optical variation (including lens variations) of a lamp product without consideration of lumen package and the effect of color properties, tested at the maximum (non-dimmed) light output and the .ies file based on the LM-79 test data, for the purposes of evaluating the beam angle. Full LM-79/distribution reports must conform to the [V5.1 Additional Reporting Requirements for LM-79, LM-80, and TM-21 Reports](#). For the DLC's purposes, the definition of beam angle for linear replacement lamps is as follows:

- **Beam Angle** – the angle between the two opposite directions in which the average intensity is 50% of the center beam intensity as measured in the azimuthal plane perpendicular to and at the center of the linear replacement lamp axis.



**Figure 1:** Linear Replacement Lamp Beam Angle Definition

Additionally, all linear replacement lamp products (including child products) will be required to report their beam angle in the scaled/reported values on the application form.

### In-Situ Temperature Measurement Testing (ISTMT)

All categories above are required to conduct *in-situ temperature measurement testing* (ISTMT) via one of the two methods below. TM-21 projections will use this thermal measurement in conjunction with the provided LM-80 data to evaluate lumen maintenance and compliance with L<sub>70</sub> requirements.

**Method 1:** ISTMT is to be conducted in the most restrictive thermal environment for which the product is rated, per its safety certifications (e.g. UL/CSA 1993). That is, ISTMTs for DLC submission are required to be in the same thermal environment and use the same apparatus as is used by the safety organizations for evaluation thermal performance in safety testing. ISTMTs will be reviewed to ensure the safety standard is referenced and the apparatus used is specifically noted/described in the test report.

**Method 2:** ISTMT to be conducted in a selected reference luminaire. Reference luminaires for replacement lamps can be found in **Table 3**.

*Table 3: Reference luminaires for replacement lamp ISTMT Testing*

Lamp Type	Reference Luminaire
Two-Foot Linear Replacement Lamps	Lithonia 2GT8 lensed 2x2
	Lithonia 2SP8 lensed 2x2
	Lithonia 2PM3 9 cell 2x2 parabolic
	Columbia Lighting lensed 2x2 4PS22
	Columbia Lighting P222 9 cell 2x2 parabolic
	A.L.P. EL-2x2-20-*(#= # of lamps)
	Texas Fluorescents 131-A-2-32U-E120
	Monmouth Lighting Corp RF24
	Simkar Corporation TY Lensed Troffer 2x2
	Juno Lighting Group S2x2BL
	LSI LA/FLA 2x2
	Columbia Lighting JT822
	Visioneering Corp. ERCTB 2x2
US Energy Sciences YTR-02-5	
Three-Foot Linear Replacement Lamps	Lithonia C 2 25 MVOLT GEB10IS



Lamp Type	Reference Luminaire
	Lithonia Z 2 25 MVOLT GEB10IS
	Columbia CS3-225-EU
	Columbia CH3-225-EU
Four-Foot Linear Replacement Lamps (except T5HO replacement lamps seeking qualification inside a reference high-bay)	Lithonia 2GT8 lensed 2x4 (T8 replacements)
	Lithonia SP5 lensed 2x4 (T5 replacements)
	Lithonia 2PM2N 12 cell 2x4 parabolic (T8 or T5 version, as appropriate)
	Columbia Lighting lensed 4PS24 (T8 or T5 version, as appropriate)
	Columbia Lighting P224 12 cell parabolic (T8 or T5 version, as appropriate)
	A.L.P. EL-2x4-23-*( * = # of lamps)
	Lithonia 2SP8 G 2 32 A12 XXXX XX XXXX
	Texas Fluorescents 131-A-4-32-E120
	Columbia Lighting 4PS24
	Monmouth Lighting Corp DCP 22
	Simkar Corporation TY Lensed Troffer 2x4
	Juno Lighting Group S2x4BL
	LSI GA 2x4
	Columbus Lighting JT824
	Visioneer Corp. ERCTB 2x4
US Energy Sciences YTR-04-07	
Philips Day-Brite 2SPG232-FS01-UNV-1/2EB	
T5HO Replacement lamps seeking qualified inside a reference high bay	Lithonia IBZT5 4 high bay
	Columbia Lighting LHA4-4 (T5HO version)
Eight-Foot Linear Replacement Lamps	Lithonia C 2 96T8 MVOLT GEB10IS
	Columbia CS8-296T8-EU
	Texas Fluorescent C 259 MV
Four-Foot Linear Replacement Lamps representative of Eight-Foot Linear Replacement Lamps	Lithonia C 2 32 MV
	Columbia CS4-232-EU
	Texas Fluorescent C 232 8 MV
U-bend Replacement Lamps	Lithonia 2GT8 lensed 2x2
	Lithonia 2SP8 lensed 2x2
	Lithonia 2PM3 9 cell 2x2 parabolic
	Columbia Lighting lensed 4PS22
	Columbia Lighting P222 9 cell parabolic
	A.L.P. EL-2x2-20-*( * = # of lamps)
	Texas Fluorescents 131-A-2-32U-E120
	Monmouth Lighting Corp RF24
	Simkar Corporation TY Lensed Troffer 2x2
	Juno Lighting Group S2x2BL
	LSI LA/FLA 2x2
	Columbia Lighting JT822
	Visioneer Corp. ERCTB 2x2
US Energy Sciences YTR-02-5	

The DLC does not endorse or exclude any particular make or model of reference fixture. Options listed are intended to illustrate common fixtures of the appropriate type. Manufacturers may test in alternative fixtures to those listed, with preapproval from the DLC. Pre-approved fixtures must meet the following conditions:

- Alternative fixtures must be commonly used in the application category intended for which they are to be applied. Documentation may be required to demonstrate fixtures appropriate use if questions arise.
- Alternative fixtures must provide similar thermal environments to those listed. Particularly, alternative fixtures may not be significantly different in internal volume or construction materials.

Type A, Type B, and Dual-mode lamps shall test with three (3) lamps installed for Two-Foot Linear Replacement Lamps.

Type A, Type B, Dual-mode, and one-lamp Type C shall test with two (2) lamps installed for Three-Foot, Four-Foot, and Eight-Foot Linear Replacement Lamps and two (2) lamps for U-shaped lamps.

Type C lamps shall test with the appropriate number of lamps as are intended to be operated on the external driver included in that Type C system; one-, two-, three-, four-, and six-lamp Type C systems are eligible.

For replacement lamps designed to operate utilizing existing fluorescent ballasts testing must be conducted according to **Table 2** above.

Replacement Lamps that utilize rotatable end caps should be tested in the orientation specified as the default in the manufacturer's installation instructions. If the installation instructions do not specify an orientation, the lamps should be oriented "straight down" (this is commonly the "zero degree" setting). DLC will review the installation instructions provided with the application to verify the appropriate testing orientation and compare this against documentation in the LM-79 report and IES file. Rotatable end cap linear replacement lamp listings will include information on the testing orientation in the Notes field of the QPL.

For the fixture level testing of linear replacement Type-C Lamp systems with non-identical lamps, the system must be installed in the relevant reference housing as it is designed, sold, and intended to be installed in the field.

## Controllability

Per V5.1, all lamps qualified for indoor applications must be continuously dimmable and lamps qualified for outdoor applications must be either stepped or continuously dimmable. Because lamps are most often used in retrofit applications, there are special considerations needed to ensure end users can dim lamps as desired. The following considerations apply to each UL Type of linear replacement lamps, mogul-screw base lamps, and pin-based replacement lamps, as appropriate:

- UL Type A
  - Type A lamps, with the exceptions noted below, capable of wired dimming solely via input from the existing ballast should note the dimmable capability and range, leave the “Wired Communication Protocol” column blank, and enter “Dimmable depending on ballast capability” in the “Other Wired Protocol” column, as wired control signals are received by the ballast and not the lamp itself. All other fields should be filled in as applicable.
    - Due to the lack of dimmable ballasts available in the marketplace for eight-foot T8 fluorescent lamps, Type A lamps in the T8 eight-foot general application that claim wired dimming capability utilizing the direct input from the ballast to achieve dimming will be rejected. Therefore, these lamp types that claim to be dimmable via a wired protocol must provide a wiring diagram in the product specification sheet, installation instructions, or separate document showing the electrical circuit of the lamp connecting to mains power via the ballast, including the location of the input signal from an external control source to the lamp.
    - Any Type A lamps which do not solely utilize the ballast input to achieve dimming capability through a wired protocol (i.e. the dimming control wires connect directly to the lamp), must report the specific wired communication protocol and provide a wiring diagram.
      - For the two exceptions above, if an external device is used between the dimming control user interface and Type A lamp, then these lamps will be classified as “Wired Communication Protocol: Other Wired Communication Protocol: Input Signal from External Control Source” and should indicate this on the application form in column AI as: “Other Wired Communication Protocol: Input signal from external control source”. The wiring diagram noted above will be evaluated by reviewers to determine if an external device is required to achieve the specific communication protocol.
- UL Type B
  - In addition to reporting dimming capability, dimming range, presence of integral controls, and communication protocol, Type B lamps that claim to be dimmable via a wired protocol with 0-10V, DALI, and DMX must provide a wiring diagram in the product specification sheet, installation instructions, or separate document showing the electrical circuit of the lamp connecting to mains power, including the location of the input signal from an external control source to the lamp or lamp holder for 0-10V, DALI or DMX control.
  - Type B lamps listed for operations with 0-10V, DALI, or DMX communication control must be able to achieve this dimming capability without an external signal converter and the low voltage control wires must connect directly to the lamp or lamp holders.
    - If an external device is used to receive the 0-10V, DALI, or DMX control signal, then these lamps will be classified as “Wired Communication Protocol: Other Wired Communication Protocol” and should indicate this on the application form in column AI as: “Other Wired Communication Protocol: Input signal from external control source”. The wiring diagram noted above will be evaluated by reviewers to determine if an external device is required to achieve the specific communication protocol.
- UL Type A/B Dual Mode
  - Type A/B must be dimmable in both modes of operation and stated as such on the product specification sheet.

- Everything from UL Type A above applies to UL Type A/B Dual Mode. All products will have a note on the QPL that says: “When operated as Type A, dimmable depending on ballast capability”
- Similarly, Dual Mode Lamps must supply documentation as noted in the Type B section above and will be listed on the QPL as described for Type B lamps. If the Type B lamp accomplishes dimming with an external accessory, it will include a note that is specific to Type B operation.
- UL Type C
  - Type C lamps must meet all V5.1 Controllability requirements with no further considerations.