



Testing and Reporting Requirements for Linear Replacement Lamps

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, and its performance in an appropriate reference fixture, representative of the most common application for each fluorescent replacement lamp type.

General Applications

Two-foot, three-foot, and U-bend replacement lamp general applications are restricted to LED lamps intended to replace fluorescent T8. Eight-foot replacement lamps are restricted to lamps intending to replace T8 fluorescent 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 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 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 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.

T8 Eight-Foot Linear Replacement Lamps

LED lamps intended to replace T 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 T 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 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 of different bases are not eligible.

Primary Use Designations

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

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.** Note that due to testing considerations, at this time **only products that operate utilizing specific ballasts types are eligible. Please see Fixture Level Test requirements below.**
- Replacement lamps designed to operate utilizing magnetic ballasts or other types of electronic ballasts not specified are not eligible at this time.

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.

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 an external driver. The lamp holders are then wired to receive only the low-voltage electricity that is supplied by that external driver.

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.** Note that due to testing considerations, at this time **only products that operate utilizing specific ballast types are eligible. Please see testing requirements below.**
- Replacement lamps designed to operate utilizing magnetic ballasts, or other types of electronic ballasts not specified, are not eligible at this time.

For testing purposes, the DLC requires testing of both the bare lamp and lamps installed in a typical fixture housing. These typical fixture housings are intended to provide testing results of the most common applications in which these products are used, including representative thermal conditions of the fixtures in which the lamps would be installed. In specifying these fixture housings, the DLC does not endorse or exclude any particular make or model frame for use in energy efficiency programs.

Supporting Documentation

Applicants shall 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

DLC has updated the Safety Certification Documentation requirements and processes. The documentation required for the lamp under the new policy must be submitted with the corresponding application. Please review the updated Safety Certification Documentation detailed requirements outlined in the V4.3 Primary Technical Requirements page released with this document. Both policies will be officially implemented on March 26th, 2018.

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.
- For the lamp-level testing, 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" sections below.*
- For the fixture-level testing, the system must be installed in the relevant reference housing as it is designed, sold, and intended to be installed in the field.
- All testing will be evaluated and must demonstrate that the products pass the requirements, including both lamp-level and in-fixture testing.
- 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.

*Testing notes sections state the following regarding testing of multi-lamp type C systems. This has been the long-standing approach DLC has taken to these products:

"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. For questions, please contact applications@designlights.org."

Lamp Level Tests

All lamps seeking qualification by the DLC must test the bare lamp according to LM-79.

Table 1: Individual Replacement Lamp Criteria: T8, T5, and T5HO Replacements

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
System Efficacy	≥ 110 lm/W	≥ 110 lm/W	≥ 110 lm/W	≥ 110 lm/W	≥ 110 lm/W	≥ 110 lm/W	≥ 110 lm/W
Initial Light Output	≥ 800 lm	≥ 1,200 lm	≥ 1,600 lm	≥ 1,600 lm	≥ 3,200 lm	≥ 3,200 lm	≥ 1,400 lm
Correlated Color Temp. (CCT)	≤ 5000K	≤ 5000K	≤ 5000K	≤ 5000K	≤ 5000K	≤ 5000K	≤ 5000K
Color Rendering Index (CRI)	≥ 80	≥ 80	≥ 80	≥ 80	≥ 80	≥ 80	≥ 80
Power Factor	≥ 0.90	≥ 0.90	≥ 0.90	≥ 0.90	≥ 0.90	≥ 0.90	≥ 0.90
Total Harmonic Distortion	≤ 20%	≤ 20%	≤ 20%	≤ 20%	≤ 20%	≤ 20%	≤ 20%

Testing Notes

For T8 replacement lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a standard 0.88 ballast factor, electronic instant-start ballast. For T5 and T5HO replacement lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a normal 1.0 ballast factor, electronic programmed-start ballast. Specification sheets for the ballasts 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.

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. For questions, please contact applications@designlights.org.

Fixture Level Tests: Two-Foot Linear Replacement Lamps

Please note that at the time of this release, lamps intended to replace T5-diameter fluorescents are only eligible in the four-foot categories. Only lamps intended to replace T8 fluorescents are currently eligible in the 2-foot categories.

All lamps seeking qualification must be tested inside in a reference troffer. Type A, Type B, and Dual-mode two-foot lamps shall test with three (3) lamps installed in an appropriate reference troffer. 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-, and four-lamp Type C systems are eligible.

The reference troffer may be any of the following, or a pre-approved equivalent:

- 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
- Pre-approved equivalent
 - 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

Pre-approved Equivalents

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 pre-approval 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.

Table 2: In-situ Testing Performance Requirements: Two-Foot Linear T8 Replacement Lamps

In-situ Lamp Criteria for Two-Foot Linear Replacement Lamps	
Luminaire Efficacy	≥ 100 lm/W
Minimum Initial Luminaire Light Output	2 lamps installed = 1,350 lm 3 lamps installed = 2,000 lm 4 lamps installed = 2,700 lm
Spacing Criteria	Spacing Criteria: 0-180° = 1.0 - 2.0 90-270° = 1.0 - 2.0 Zonal Lumen Distribution: 0-60°: ≥ 75%
Lumen Maintenance L ₇₀	50,000 hours

Lumen Maintenance

- LM-80 for the package/module/array (6,000 hours minimum)
- In-situ Temperature Measurement Test (ISTMT) in selected reference luminaire. Type A, Type B, and Dual-mode two-foot lamps shall test with three (3) lamps installed. 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.
- TM-21 Calculator, appropriately filled out (www.energystar.gov/tm21calculator)

Testing Notes

For Replacement Lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a standard 0.88 ballast factor, electronic instant-start ballast. Specification sheets for the ballasts 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.

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 reviewers 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.

Fixture Level Tests: Three-Foot Linear Replacement Lamps

Please note, at the time of this release, lamps intended to replace T5-diameter fluorescents are only eligible in the four-foot categories. Only lamps intended to replace T8 fluorescents are currently eligible in the 3-foot categories.

All lamps seeking qualification must be tested inside in a reference strip fixture. Type A, Type B, and Dual-mode three-foot lamps shall test with two (2) lamps installed in an appropriate reference fixture. 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- Type C systems are eligible.

The reference fixture may be any of the following, or a pre-approved equivalent:

- Lithonia C 2 25 MVOLT GEB10IS
- Lithonia Z 2 25 MVOLT GEB10IS
- Columbia CS3-225-EU
- Columbia CH3-225-EU
- Pre-approved equivalent

Pre-approved Equivalents

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 pre-approval from the DLC. Pre-approved fixtures must meet the following conditions:

- Alternative fixtures must be commonly used in the application category intended to be applied for. 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.

Table 3: In-situ Lamp Criteria for Three-Foot Linear Replacement Lamps

In-situ Lamp Criteria for Three-Foot Linear Replacement Lamps	
Luminaire Efficacy	≥ 100 lm/W
Minimum Initial Luminaire Light Output	2 lamps installed x 2,200 lm 3 lamps installed x 3,200 lm
Spacing Criteria	<p><u>Spacing Criteria:</u> 0-180° = 1.0 - 2.0 90-270° = 1.0 - 2.0</p> <p><u>Zonal Lumen Distribution:</u> 0-60°: ≥ 75%</p>
Lumen Maintenance L ₇₀	50,000 hours

Lumen Maintenance

- LM-80 for the package/module/array (6,000 hours minimum)
- In-situ Temperature Measurement Test (ISTMT) in selected reference luminaire. Type A, Type B, Dual-mode and one-lamp Type-C three-foot lamps shall test with two (2) lamps installed. 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.
- TM-21 Calculator, appropriately filled out (www.energystar.gov/tm21calculator)

Testing Notes

For Replacement Lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a standard 0.88 ballast factor, electronic instant-start ballast. Specification sheets for the ballasts 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.

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 reviewers 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.

Fixture Level Tests: Four-Foot Linear Replacement Lamps

All T8 and T5 replacement lamps seeking qualification must be tested inside a reference troffer. Type A, Type B, and Dual-mode four-foot lamps shall test with two (2) lamps installed in an appropriate reference troffer. 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-, and four-lamp Type C systems are eligible.

The reference troffer may be any of the following, or a pre-approved equivalent:

- Lithonia 2GT8 lensed 2x4 (T8 replacements)
- Lithonia SP5 lensed 2x4 (T5 replacements)
- Lithonia 2PM3N 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)
- Pre-approved equivalent
 - 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
 - Columbia Lighting JT824
 - Visioneering Corp. ERCTB 2x4

- US Energy Sciences YTR-04-7
- Philips Day-Brite 2SPG232-FS01-UNV-1/2EB

All T5HO replacement lamps seeking qualification must be tested inside a reference high bay. Type A, Type B, and Dual-mode four-foot lamps shall test with four (4) lamps installed in an appropriate reference high bay. 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; three-, four-, and six-lamp Type C systems are eligible.

The reference troffer may be any of the following, or a pre-approved equivalent:

- Lithonia IBZT5 4 high bay
- Columbia Lighting LHA4-4 (T5HO version)
- Pre-approved equivalent

Pre-approved Equivalents

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 pre-approval from the DLC. Pre-approved fixtures must meet the following conditions:

- Alternative fixtures must be commonly used in the application category intended to be applied for. 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.

Table 4: In-situ Testing Requirements: Four-Foot Linear T8, T5, and T5HO Replacement Lamps

In-situ Lamp Criteria		
	Four-Foot Linear T8 and T5 Replacement Lamps	Four-Foot Linear T5HO Replacement Lamps
Luminaire Efficacy	≥ 100 lm/W	≥ 105 lm/W
Minimum Initial Luminaire Light Output	2 lamps installed = 3,000 lm 3 lamps installed = 4,500 lm 4 lamps installed = 6,000 lm	3 lamps installed = 7,500 lm 4 lamps installed = 10,000 lm 6 lamps installed = 15,000 lm
Spacing Criteria	<p><u>Spacing Criteria:</u> 0-180° = 1.0 - 2.0 90-270° = 1.0 - 2.0</p> <p><u>Zonal Lumen Distribution:</u> 0-60°: ≥ 75%</p>	<p><u>Zonal Lumen Distribution:</u> 20-50°: ≥ 30%</p>
Lumen Maintenance L70	50,000 hours	50,000 hours

Lumen Maintenance

- LM-80 for the package/module/array (6,000 hours minimum)
- In-situ Temperature Measurement Test (ISTMT) in selected reference luminaire. Type A, Type B, Dual-mode and one-lamp Type-C four-foot lamps shall test with two (2) lamps installed. 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.
- TM-21 Calculator, appropriately filled out (www.energystar.gov/tm21calculator)

Testing Notes

For T8 replacement lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a standard 0.88 ballast factor, electronic instant-start ballast. Specification sheets for the ballasts 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.

For T5 and T5HO replacement lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a normal 1.0 ballast factor, electronic programmed-start ballast. Specification sheets for the ballasts 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.

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 nominal length in inches.

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 reviewers 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.

Fixture Level Tests: Eight-Foot Linear Replacement Lamps

All eight-foot T8 replacement lamps seeking qualification must be tested inside a reference strip fixture using an appropriate integrating sphere. Additionally, using a goniophotometer, a four-foot linear replacement lamp with identical construction as half of the eight-foot linear replacement lamp must be tested inside a reference strip fixture. Representative "identical" four-foot linear lamps must be a sellable product, with a distinct model ordering number, that is marketed and produced by the same manufacturer. "Identical" linear lamps, while having the base type G13 as outlined in four foot lamp requirements, are defined as having the same type and quantity of driver(s), driving the LEDs at the same current, and having the same number of LEDs and PCBs as half of the eight-foot lamp. The representative lamp must also be of identical construction having identical cross-sections, the same tube material and thickness, and same heatsink material and extrusion. The goniophotometer testing results from the four-foot strip fixture shall be extrapolated to represent the eight-foot strip fixture by multiplying the candela of the four-foot goniophotometer output by a scale factor. That factor shall be derived through dividing the tested lumen output of the eight-foot strip fixture by the tested lumen output of the four-foot strip fixture, as obtained from the integrating sphere.

The results must meet the in-situ testing requirements in Table 5. Applicants must provide results from the eight-foot testing in the integrating sphere, the four-foot testing in the integrating sphere, and the four-foot testing in the goniophotometer. Product specification sheets for both the four-foot and eight-foot products must be submitted with the application. Applicant must also provide workflow demonstrating the calculation of the scale factor and identifying, within the photometric report, the candela values derived via calculation. In addition, a photo of the eight-foot and four-foot LED layout side-by-side, as well as a cross section diagram of construction for both products must be submitted.

Type A, Type B, and dual mode eight-foot lamps shall test with two (2) lamps installed in an appropriate reference strip. 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-, and two-lamp Type C systems are eligible.

The eight-foot reference strip may be any of the following, or a pre-approved equivalent:

- Lithonia C 2 96T8 MVOLT GEB10IS
- Columbia CS8-296T8-EU
- Texas Fluorescent C 259 MV
- Pre-approved equivalent

The four-foot reference strip may be any of the following, or a pre-approved equivalent:

- Lithonia C 2 32 MV
- Columbia CS4-232-EU
- Texas Fluorescent C 232 8 MV
- Pre-approved equivalent

Pre-approved Equivalents

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 pre-approval from the DLC. Pre-approved fixtures must meet the following conditions:

- Alternative fixtures must be commonly used in the application category intended to be applied for. 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.

Table 5: In-situ Testing Requirements: Eight-Foot Linear T8 Replacement Lamps

In-situ Lamp Criteria for Eight-Foot Linear T8 Replacement Lamps	
Luminaire Efficacy	≥ 100 lm/W
Minimum Initial Luminaire Light Output	2 lamps installed = 6,000 lm
Spacing Criteria	<p style="text-align: center;"><u>Spacing Criteria:</u> 0-180° = 1.0 - 2.0 90-270° = 1.0 - 2.0</p> <p style="text-align: center;"><u>Zonal Lumen Distribution:</u> 0-60°: ≥ 75%</p>
Lumen Maintenance L70	50,000 hours

Lumen Maintenance

- LM-80 for the package/module/array (6,000 hours minimum)
- In-situ Temperature Measurement Test (ISTMT) in selected reference luminaire. Type A, Type B, Dual-mode and one-lamp Type-C eight-foot lamps shall test with two (2) lamps installed. 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.
- TM-21 Calculator, appropriately filled out (www.energystar.gov/tm21calculator)

Testing Notes

For T8 replacement lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a standard 0.88 ballast factor, electronic instant-start ballast. Ballasts for each lamp length, including representative “identical” lamps, shall be determined for testing based on the appropriate ballast for installation with that lamp length. Specification sheets for the ballasts 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.

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 reviewers 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.

Fixture Level Tests: U-bend Replacement Lamps

All lamps seeking qualification must be tested inside in a reference troffer. Type A, Type B, and dual mode U-bend lamps shall test with two (2) lamps installed in an appropriate reference troffer. 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.

The reference troffer may be any of the following, or a pre-approved equivalent:

- Lithonia 2GT8 lensed 2x2
- Lithonia 2SP8 lensed 2x2
- Lithonia 2PM3 9 cell 2x2 parabolic
- Columbia Lighting lensed 4PS22
- Columbia Lighting P222 9 cell parabolic
- Pre-approved equivalent
 - 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

Pre-approved Equivalents

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 pre-approval from the DLC. Pre-approved fixtures must meet the following conditions:

- Alternative fixtures must be commonly used in the application category intended to be applied for. 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.

Table 6: In-situ Testing Requirements: U-bend Linear Replacement Lamps

In-situ Lamp Criteria for U-bend Linear Replacement Lamps	
Luminaire Efficacy	≥ 100 lm/W
Minimum Initial Luminaire Light Output	2 lamps installed: 2,500 lm 3 lamps installed: 3,750 lm
Spacing Criteria	<p><u>Spacing Criteria:</u> 0-180° = 1.0 - 2.0 90-270° = 1.0 - 2.0</p> <p><u>Zonal Lumen Distribution:</u> 0-60°: ≥ 75%</p>
Lumen Maintenance L ₇₀	50,000 hours

Lumen Maintenance

- LM-80 for the package/module/array (6,000 hours minimum)
- In-situ Temperature Measurement Test (ISTMT) in selected reference luminaire. Type A, Type B, Dual-mode and one-lamp Type-C U-shaped lamps shall test with two (2) lamps installed. 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.
- TM-21 Calculator, appropriately filled out (www.energystar.gov/tm21calculator)

Testing Notes

For Replacement Lamps designed to operate utilizing existing fluorescent ballasts, testing must be conducted using a standard 0.88 ballast factor, electronic instant-start T8 ballast. Specification sheets for the ballasts used during testing must be provided with the application and the ballast make and model number must be noted in the test report.