Testing and Reporting Requirements for Four Pin-Base Replacement Lamps for CFLs

under Technical Requirements V5.1

[Effective July 1, 2020]

The DLC accepts SSL QPL applications for four-pin base replacement lamps to include all base types G24q/GX24q lamps, and 2G11 base lamps greater than or equal to twenty inches. At this time, G24q/GX24q and 2G11 UL Type A lamps (designed to operate utilizing the existing CFL ballast), and 2G11 UL Type B (designed to operate utilizing direct line voltage), 2G11 UL Type C (designed to operate utilizing a non-integral driver), and 2G11 UL dual mode (designed to operate utilizing the existing CFL ballast or direct line voltage) are all eligible.

G24q or GX24q UL Type B lamps and UL Type C lamps, as well as products with other bases (including 2-pin products), remain under consideration for future development. Note that due to testing considerations, at this time only products that can 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.

The testing and reporting requirements described below are intended to subject the lamps to conditions found in typical luminaires to assure confidence in performance.

Supporting Documentation Requirements

Applications for four pin-base replacement lamps for CFLs must provide the following supporting documentation in addition to the standard test data required for all applications.

- **Installation Instructions**
  Installation instruction sheets must be submitted with the application to indicate how the lamp will be installed in an existing luminaire in the field. These installation instructions must be the same ones provided to customers and installers in the market.

- **Compatibility Documentation**
  Due to concerns of compatibility of LED lamps with the existing CFL ballasts, the DLC will require that lamps undergo system-level testing on a variety of ballasts to demonstrate compatibility. The DLC requires G24q and GX24q lamps seeking qualification to undergo testing as per the ENERGY STAR requirements for Frequency. Ballast compatibility testing is not currently required for 2G11 4 pin-base lamps. (Please note that the DLC may seek to evolve compatibility testing

requirements as appropriate, based on experience and demonstrated need to assess products in the market.)

Testing Requirements

All DLC testing and reporting requirements that apply to new luminaires shall also apply to any lamp applications, e.g. LM-79, ISTMT, IES file, TM-21 projection, etc. Note that for lumen maintenance testing, the LED manufacturer is responsible for the LM-80 test of the LED package, array, or module. A report resulting from this test must be passed on to the DLC by the applicant, as specified in the application instructions. The report submitted to the DLC should be the most up-to-date report available for the LED package/module/array employed in the lamp.

For testing purposes, the DLC specifies typical reference luminaire housings for lamp products to be tested in, as well as reference ballasts to be included in testing. This is so that testing results provided and used in evaluation of the product are similar to common installed conditions. In providing this list of typical luminaire housings and ballasts, the DLC does not endorse any particular make or model for use in energy efficiency programs. Note that in each recommended housing variation, an option for testing in a "Pre-approved Equivalent" is available for applicants to propose an alternative housing.

In selecting a luminaire or ballast for testing, the applicant must consider the purpose of subjecting the tested lamp to extreme confinement for thermal endurance and electrical factors. For purposes of the Four Pin-Base Replacement Lamps for CFLs category, if a product demonstrates necessary performance in a given pre-approved luminaire and reference ballast, the product will be considered qualified generally.

Pre-Approved Equivalent Luminaires

The DLC does not endorse any particular make or model of reference luminaire. Options listed are intended to illustrate common luminaires of that type. Manufacturers may test in alternative luminaires to those listed, with pre-approval from the DLC. Pre-approved equivalent luminaires must meet the following conditions:

- Alternative luminaires must be commonly used in the intended application category. Documentation may be required to demonstrate luminaires appropriate use if questions arise.
- Alternative luminaires must provide similar thermal environments to those listed below. Particularly, alternative luminaires may not be significantly different in internal volume or construction materials. Please note that pre-approved equivalent requests will only be evaluated against the approved luminaires listed below. Evaluation will not be made against the list of pre-approved equivalents.

To request that a luminaire be considered as a pre-approved equal for testing purposes, please send the spec sheet for the luminaire to applications@designlights.org, along with a spec sheet for the relevant lamp. DLC review staff may need additional details, depending on the request and details available in the spec sheet.

Pre-Approved Equivalent Ballasts

The DLC does not endorse any particular make or model of reference CFL ballast. Options listed are intended to illustrate common reference ballasts for CFLs in the field. Manufacturers may test on alternative ballasts to those listed, with pre-approval from the DLC. Pre-approved equivalent ballasts must meet the following conditions:

- Alternative ballasts must be commonly used in operate CFLs in the intended field use. Documentation may be required to demonstrate ballast appropriate use if questions arise.
- Alternative ballasts must provide similar electrical conditions to those listed below. Particularly, alternative ballasts may not be significantly different in intended CFL operating wattage, ballast factor, efficiency, or power quality under similar loading conditions. Note: pre-approved equivalent requests will only be evaluated against the approved ballasts listed below. Evaluation will not be made against the list of pre-approved equivalents.

To request that a ballast be considered as a pre-approved equal for testing purposes, please send the specification sheet for the ballast to applications@designlights.org, along with a specification sheet for the relevant lamp. DLC review staff may need additional details, depending on the request and details available in the specification sheet.

Luminaire-Level Tests

For G24q products, LM-79 tests shall be conducted in a fully functional reference luminaire, and on an appropriate reference ballast, with the lamp properly installed per manufacturer's instructions. **Lamps need to conduct complete photometric testing in (i.e. supply an LM-79, IES file from testing in) only** *one* **of the luminaires approved below, and on only one of the reference ballasts specified.**

G24q/GX24q Base Lamps

Lamp-Level Tests

Qualified G24q/GX24q base lamps are considered qualified as the lamp itself. Due to this qualification approach for these products, the DLC will list on the QPL lamp-level performance information. Therefore, lamps seeking qualification must test the bare lamp-ballast system according to LM-79.

Table 1: Individual Replacement Lamp Criteria: G24q/GX24q Base Type Lamps

Individual Lamp Criteria (Bare Lamps)	
System Efficacy	≥ 75 lm/W
Initial Light Output	≥ 675 lm
Correlated Color Temperature (CCT)	≤ 5000K
Color Rendering Index (CRI)	≥ 80
Power Factor	≥ 0.90

Total Harmonic Distortion	≤ 20%
Warranty	≥ 5 Years

G24q/GX24q base lamps must also be UL Type A (intended to operate on the existing CFL ballast only). Products must be tested on an appropriate one- or two-lamp reference ballast.

Horizontally-mounted Lamp Reference Ballasts:

- Philips ICF-2S18-HI-LD
- Philips ICF-2S26-HI-LD
- OSRAM/Sylvania QTP1/2x18CF/UNV
- OSRAM/Sylvania QTP2x26CF/UNV
- Triad C218UNVBE
- Triad C218UNVME
- Triad C2642UNVBE
- Triad C2642UNVME
- GE GEC218-MVPS-3W
- GE GEC226-MVPS-3W
- Keystone KTEB-226-UV-PS-DW
- Or Pre-Approved Equivalent

Vertically-mounted Lamp Reference Ballasts:

- Philips ICF-2S18-HI-LD
- Philips ICF-2S26-HI-LD
- OSRAM/Sylvania QTP1/2x18CF/UNV
- OSRAM/Sylvania QTP2x26CF/UNV
- Triad C218UNVBE
- Triad C218UNVME
- Triad C2642UNVBE
- Triad C2642UNVME
- GE GEC218-MVPS-3W
- GE GEC226-MVPS-3W
- Keystone KTEB-226-UV-PS-DW
- Or Pre-Approved Equivalent

Note: If the reference ballast used in testing is designed to operate multiple lamps, it 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 system, one lamp should be measured for light output, while the system as intended (with two identical lamps on the ballast) should be measured for electrical input. The wattage into the ballast can then be divided by two, and that wattage divided into the lamp lumens to determine efficacy. For questions, please contact applications@designlights.org.

In-Situ Temperature Measurement Testing

Lamps with G24q/GX24q bases must undergo *In-Situ Temperature Measurement Testing* (ISTMT) in the most restrictive thermal environment the product is rated for, per its safety certifications (UL/CSA 1993). TM-21 projections will use this thermal measurement in conjunction with the provided LM-80 data to evaluate lumen maintenance and compliance with L_{70} requirements listed in Table 2.

Please note, this means if the product is certified to operate in a completely enclosed luminaire, ISTMT testing must be conducted in the appropriate reference enclosed UL 1993 / CSA C22.2 No. 1993-17 apparatus, using one of the pre-approved ballasts above or an ANSI reference ballast as specified by NEMA/ANSI C82.3 and operated with voltage, current and power as defined in NEMA/ANSI C78.901, for the fluorescent lamp that the lamp is intended to replace. The ballast used shall be clearly marked on the test report (either the ballast model number or “ANSI reference ballast”). Accreditation

requirements necessary for labs to conduct ISTMT testing may be found in the Testing Laboratory Requirements.

G24q/GX24q base lamps seeking qualification must be tested in a reference downlight, based on the intended orientation of the lamp. Horizontally-mounted products must be tested two-lamps to a downlight, in an appropriate two-lamp reference downlight. Vertically-mounted products must be tested one-lamp to a downlight, in an appropriate one-lamp reference downlight. The reference troffer and ballast must be included in the test report.

Note: Products intended to mount horizontally must be axially rotatable (aimable).

Horizontally-mounted Lamp Reference Downlights:

- Lithonia 6HF 2/18DTT MVOLT
- Lithonia 6HF 2/26DTT MVOLT
- Prescolite LF6CFH 218 EB LCFH WT
- Prescolite LF6CFH 226 EB LCFH WT
- Or Pre-Approved Equivalent

Vertically-mounted Lamp Reference Downlights:

- Lithonia 6VF 18DTT/TRT MVOLT
- Lithonia 6VF 26-42TRT MVOLT
- Prescolite LF6CFV 32 EB LCFHV WT
- Or Pre-Approved Equivalent

G24q/GX24q base lamps must also be UL Type A (intended to operate on the existing CFL ballast only). Products must be tested on an appropriate one- or two-lamp reference ballast.

Horizontally-mounted Lamp Reference Ballasts:

- Philips ICF-2S18-HI-LD
- Philips ICF-2S26-HI-LD
- OSRAM/Sylvania QTP1/2x18CF/UNV
- OSRAM/Sylvania QTP2x26CF/UNV
- Triad C218UNVBE
- Triad C218UNVME
- Triad C2642UNVBE
- Triad C2642UNVME
- GE GEC218-MVPS-3W
- GE GEC226-MVPS-3W
- Keystone KTEB-226-UV-PS-DW
- Or Pre-Approved Equivalent

Vertically-mounted Lamp Reference Ballasts:

- Philips ICF-2S18-HI-LD
- Philips ICF-2S26-HI-LD
- OSRAM/Sylvania QTP1/2x18CF/UNV
- OSRAM/Sylvania QTP2x26CF/UNV
- Triad C218UNVBE
- Triad C218UNVME
- Triad C2642UNVBE
- Triad C2642UNVME
- GE GEC218-MVPS-3W
- GE GEC226-MVPS-3W
- Keystone KTEB-226-UV-PS-DW
- Or Pre-Approved Equivalent

Table 2: In-situ Testing Requirements: G24q/GX24q Base Lamps

In-situ Lamp Criteria for Four Pin-Base Replacement Lamps for CFLs with G24q/GX24q Base Types	
Luminaire Efficacy	≥ 65 lm/W
Minimum Initial Luminaire Light Output	**Vertically-mounted products:** ≥ 575 lm **Horizontally-mounted products:** ≥ 800 lm
Light Distribution	**Zonal Lumen Distribution:** 0-60°: ≥ 75%
Lumen Maintenance L_{70}	50,000 hours

Compatibility Tests

Due to concerns of compatibility of LED lamps with the existing CFL ballasts, the DLC will require that lamps undergo system-level testing on a variety of ballasts to demonstrate compatibility. *Please note that the DLC may seek to evolve compatibility testing requirements as appropriate, based on experience and demonstrated need to assess products in the market.* The DLC requires all lamps seeking qualification to undergo testing as per the ENERGY STAR requirements for Frequency. These requirements are found Section 11.3 of the ENERGY STAR Lamps V2.0 Specification, and are reproduced below for reference.

Table 3: Compatibility Testing Requirements: G24q/GX24q Base Type Lamps

Requirement	Methods of Measurement and/or Reference Document	Testing Guidance
Lamp light output shall have a frequency of ≥120 Hz	**Method of Measurement:** None **Reference Document:** IEEE Std 1789™- 2015	Sample Size: One unit per model Light output waveform shall be measured with a photodetector with a rise time of 10 microseconds or less, transimpedance amplifier and oscilloscope. Employed equipment models and method of measurement shall be documented. Temporal response, amplification and filtering characteristics of the system shall be suitably designed to capture the photometric waveform. Digitized photometric waveform data and an image of the relative photometric amplitude waveform shall be recorded. Measured data shall be recorded to a digital file with an interval between each measurement no greater than 0.00005 sec (50 microseconds) corresponding to an equipment measurement rate of no less than 20 kHz, and capture at least 1 second of data.

The lamp must be tested and results documented according to Table 3 above on each of the following ballasts:

- Philips ICF-2S18-HI-LD
- Philips ICF-2S26-HI-LD
- OSRAM/Sylvania QTP1/2x18CF/UNV
- OSRAM/Sylvania QTP2x26CF/UNV
- Triad C218UNVBE or Triad C218UNVME
- Triad C2642UNVBE or Triad C2642UNVME
- Fulham NPY-120-226-CFL
- Robertson RED1L10-120

Pre-approved equivalent requests will *not* be accepted for compatibility testing purposes.

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.

Testing Notes

Results of testing must be included in application materials submitted to DLC for evaluation. Products must pass criteria for all ballasts to qualify for listing on the QPL.

Testing must be conducted at a laboratory that is recognized by the ENERGY STAR program to conduct testing on LED replacement lamps (as listed in the ENERGY STAR directory.

Testing must be conducted at each end of the acceptable voltage range of the ballast.

All compatible ballasts must be clearly indicated on product marketing and installation literature. This documentation must be provided with the application for review.

2G11 Base Lamps

Lamp-Level Tests

Qualified 2G11 base lamps are considered qualified as the lamp itself. Due to this qualification approach for these products, the DLC will list on the QPL lamp-level performance information.

Therefore, lamps seeking qualification must test the bare lamp-ballast system according to LM-79.

Table 5: Individual Replacement Lamp Criteria: 2G11 Base Type Lamps

Individual Lamp Criteria (Bare Lamps)	
System Efficacy	≥ 120 lm/W
Initial Light Output	≥ 1,900 lm
Nominal Length	≥ 20”
Beam Angle	≥ 140°

Note that spectral quality, electrical performance, and any other parameter not described here must be in accordance with general requirements of V5.1

Products must be tested on an appropriate one- or two-lamp reference ballast:

- Philips ICN-1TTP40-SC
- Philips ICN-2TTP40-SC
- GE GEC140MAX-A
- GE GEC240MAX-A
- Osram QHE1X40DL/UNV/ISNSC
- Osram QHE2X40DL/UNV/ISNSC
- Or Pre-Approved Equivalent

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 and shall conform to the Additional Reporting Requirements for LM-79, LM-80, and TM-21 Reports, without consideration of lumen package and the effect of color properties, and associated IES file, for purposes of evaluating the beam angle. For the DLC’s purposes, the definition of beam angle for linear replacement lamps will be 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.

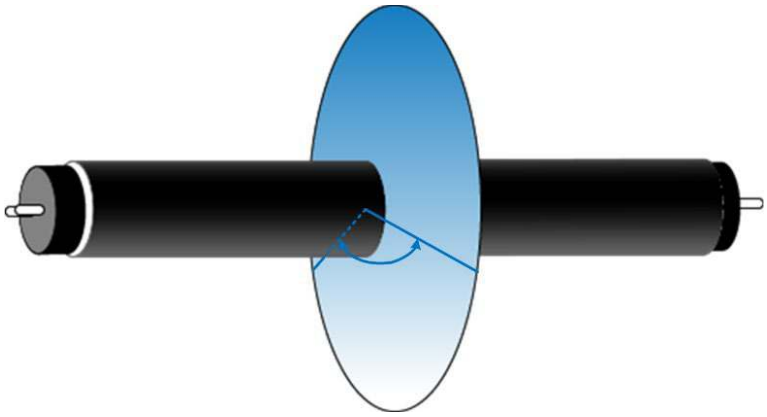

Figure 1: *Linear Replacement Lamp Beam Angle Definition*

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) in the most restrictive thermal environment the product is rated for, per its safety certifications (e.g. UL/CSA 1993). That is, ISTMT's 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. TM-21 projections will use this thermal measurement in conjunction with the provided LM-80 data to evaluate lumen maintenance and compliance with L70 requirements.