Solid-State Lighting (SSL) Technical Requirements Version 5.1

Final Version

Released: February 14, 2020

This version of the Technical Requirements document contains corrections and clarifications made to the originally released document, which are displayed as Policy Clarifications and Updates at the end of this document.

This version of SSL V5.1 contains references to the DLC LUNA Technical Requirements, which focus on lighting for responsible light at night. Areas of the requirements are highlighted below where manufacturer test planning can include tests for both SSL and LUNA qualification. Additional details can be found in the LUNA Technical Requirements.

Table of Contents

Introduction

Solid-State Lighting (SSL) Technical Requirements Version 5.1 is the second of two revisions (V5.0 and V5.1) designed to improve the quality and controllability of high performance, energy efficient commercial lighting products by establishing requirements and reporting standards for DLC listed products. V5.0 of the Solid-State Technical Requirements laid the groundwork around efficacy and controllability, and V5.1 continues to capture advances in lighting quality characteristics such as color performance, discomfort glare, and light distribution; and increases the controls functionality of installed energy efficient technology so that maximum energy savings and user benefits are realized.

Quality of light encompasses the characteristics of lighting that impact productivity, performance, comfort, mood, safety, health, wellbeing, and more. V5.1 includes new requirements for spectral quality and light distribution that will improve the quality of light of DLC listed products. The V5.1 lighting controllability requirements support additional energy savings while promoting better quality of light for people living and working in the built environment. V5's phased approach to incorporating quality of light metrics on the QPL will ensure that high-quality products are listed, superior performing products can be differentiated, and additional energy savings are realized.

V5.1 applications will be accepted beginning July 1, 2020. More information can be found in the V5.0 & V5.1 Manufacturer and Industry Guidance, published along with the V5.0 and V5.1 Technical Requirements.

The DLC's LUNA Technical Requirements establish performance criteria for specific categories of outdoor lighting so that lighting decision makers can be confident that their selections save energy AND follow best environmental practices for nighttime lighting. Areas of the requirements are highlighted below where manufacturer test planning can include tests for both SSL and LUNA qualification. Additional details can be found in the LUNA Technical Requirements.

Goals of Version 5.1

New color quality requirements help provide good color rendering with better color consistency over time.

Lighting decision makers can use DLC Premium classification to have more confidence in the glare performance of listed products.

Virtually all listed products are dimmable, providing increased energy savings and improved user satisfaction.

V5.0 Requirements Not Addressed in This Document

This document (V5.1) describes additions to the V5.0 Technical Requirements. Any technical requirements not addressed within this document, including but not limited to warranty, power quality, and safety certification, will not change with V5.1, and existing requirements will apply. Please see the DLC website for complete requirements within the Technical Requirement Tables (TRT).

Manufacturer and Industry Guidance

The DLC has released V5.0 & V5.1 Manufacturer and Industry Guidance along with the policy that provides information on how the V5.1 Technical Requirements are applied to the SSL QPL. Manufacturers who wish to update their product listings or others interested in how V5.1 will be implemented should consult this guidance document for information about:

- Submitting applications to be listed under V5.1
- Required product testing under the V5.1 Technical Requirements
    - An example of typical required testing and reporting for a family of products listed under V5.1 is provided in the guidance
- Transition timelines, grace periods, and updating instructions for products qualified under previous versions of the Technical Requirements
- Application fee changes effective with V5.1 of the Technical Requirements
- Impacts to application processing timeframes

Energy Efficiency Administrators' Program Guidance

With the final release of the V5.1 Technical Requirements, program guidance and other resource materials will be made available to energy efficiency programs to provide explanations of new metrics, benefits to customers and trade allies, and timelines for transitioning to the new requirements.

V5.1 Technical Requirements: Efficacy

Minimum light output and efficacy values have not changed from V5.0, but V5.1 includes the following changes:

- Revised minimum light output requirements for High-Bay Primary Use Designations
- Addition of a new Low-Bay General Application with minimum light output and efficacy requirements, separate from High-Bay
- Removed in-luminaire requirements for Linear Replacement Lamps, per the V5.1 Reference Housings update.
- Test reports to demonstrate compliance with the light output and efficacy requirements must be submitted as Full LM-79/color reports as described in the *V5.1 Additional Reporting Requirements for LM-79, LM-80, and TM-21 Reports* section.

Table 1 shows minimum light output (measured in lumens) and efficacy (measured in lumens per Watt) requirements for DLC Standard and Premium luminaires and retrofit kits. **Table 2** shows minimum output and efficacy requirements (in-luminaire and bare-lamp, as applicable) for linear replacement lamps, four pin-base replacement lamps for CFLs, and mogul screw-base (E39/E40) replacements for HID lamps. Lamps are not eligible for DLC Premium.

Table 1: *V5.1 Efficacy Requirements for Luminaires and Retrofit Kits [DLC Standard and DLC Premium Classifications]*

Category	General Application	Minimum Light Output (lm)	Minimum Efficacy (lm/W)	
			DLC Standard	DLC Premium
Outdoor Luminaires	Low Output	250-5,000	105	120
	Mid Output	5,000-10,000	105	120
	High Output	10,000-30,000	105	120
	Very High Output	≥30,000	105	120
Indoor Luminaires	Interior Directional	≥250	80	95
	Case Lighting	≥50 lm/ft	95	110
	Troffer	≥1,500	110	125
	Linear Ambient	≥375 lm/ft	115	130
	High-Bay	≥10,000	120	135
	Low-Bay	5,000-10,000	115	130
Outdoor Retrofit Kits	Low Output	250-5,000	105	120
	Mid Output	5,000-10,000	105	120
	High Output	≥10,000	105	120
	Very High Output	≥30,000	105	120

Category	General Application	Minimum Light Output (lm)	Minimum Efficacy (lm/W)	
			DLC Standard	DLC Premium
Indoor Retrofit Kits	Troffer	≥1,500	110	125
	Linear Ambient	≥375 lm/ft	115	130
	High-Bay	≥10,000	120	135
	Low-Bay	5,000-10,000	115	130

Table 2: *V5.1 Standard Efficacy Requirements for Lamps [In-Luminaire and Bare-Lamp]**

Category	General Application	Minimum Light Output (lm)		Minimum Efficacy (lm/W)	
		In-Luminaire	Bare-Lamp	In-Luminaire	Bare-Lamp
Linear Replacement Lamps	2’ T8 Lamps	n/a	800	n/a	120
	3’ T8 Lamps		1,200		120
	4’ T8 Lamps		1,600		120
	4’ T5 Lamps		1,600		120
	4’ T5HO Lamps		3,200		120
	8’ T8 Lamps		3,200		120
	U-Bend Lamps		1,400		120
Mogul Screw-Base (E39/E40) Replacements for HID Lamps	Outdoor: Low Output	250-5,000	n/a	105	n/a
	Outdoor: Mid Output	5,000-10,000		105	
	Outdoor: High Output	10,000-30,000		105	
	Outdoor: Very High Output	≥30,000		105	
	High-Bay	≥10,000		120	
	Low-Bay	5,000-10,000		115	
Four Pin-Base Replacement Lamps for CFLs	Vertically-Mounted Lamps	1 lamp: 575	675	75	85
	Horizontally-Mounted Lamps	2 lamps: 800	675	75	85
	2G11 Base Lamps	n/a	1,900	n/a	120

* Lamps are not eligible for DLC Premium classification.

V5.1 Technical Requirements: Quality of Light

Under SSL V5.1, a product's quality of light is evaluated by its spectral quality, light distribution, and discomfort glare.

Spectral Quality Requirements

The Spectral Quality Testing and Reporting Requirements for all SSL products are as shown in **Table 3** for DLC Standard classification and **Table 4** for DLC Premium classification. The "QPL Listing" column describes the information that appears as publicly available on the Qualified Products List, if applicable. The "Method of Evaluation" column describes how the products will be evaluated for qualification, whether by compliance with industry standards, manufacturer claims, or other DLC verification methodology.

Table 3: *Testing and Reporting Requirements for Spectral Quality (DLC Standard)*

Metric and/or Application	V5.1 Standard Requirements	QPL Listing	Method of Measurement/ Evaluation
Chromaticity (CCT & D_{uv})	All products shall exhibit chromaticity consistent with at least one of the basic, flexible, or extended, nominal 7-step quadrangle CCTs from 2200 K – 6500 K	CCT and D_{uv} for parent[1] products from LM-79 test reports listed as Tested Data Nominal CCT for child products listed as Reported Data	ANSI/IES LM-79 *ANSI C78.377-2017*
Color Rendition	*All Indoor products, except high-bay:* **Option 1 - ANSI/IES TM-30-18:** • IES $R_f \geq 70$ • IES $R_g \geq 89$ • $-12\% \leq$ IES $R_{cs,h1} \leq +23\%$ **Option 2 - CIE 13.3-1995:** • R_a (CRI) ≥ 80 • $R_9 \geq 0$ *All Outdoor and high-bay products:* **Option 1 - ANSI/IES TM-30-18:** • IES $R_f \geq 70$ • IES $R_g \geq 89$ • $-18\% \leq$ IES $R_{cs,h1} \leq +23\%$ **Option 2 - CIE 13.3-1995:** • R_a (CRI) ≥ 70 • $R_9 \geq -40$ (high-bay only) • Outdoor must report R_9	All color rendition metrics for parent products from LM-79 test reports listed as Tested Data. All color rendition metrics for child products listed as Reported Data	ANSI/IES LM-79 *ANSI/IES TM-30-18* *CIE 13.3-1995*

[1] Please see the definition of a parent product in the Definitions section of this document.

Metric and/or Application	V5.1 Standard Requirements	QPL Listing	Method of Measurement/ Evaluation
Color Maintenance	*All Indoor products, except high-bay:* Chromaticity shift from ≈1,000-hour measurement to ≈6,000-hour measurement shall be within a linear distance of 0.004 ($\Delta u'v' \leq 0.004$) on the CIE 1976 (u', v') chromaticity diagram	Color maintenance information not listed on the QPL at this time.	ANSI/IES LM-80, and/or IES LM-84-14
	All Outdoor and high-bay products: Chromaticity shift from ≈1,000-hour measurement to ≈6,000-hour measurement shall be within a linear distance of 0.007 ($\Delta u'v' \leq 0.007$) on the CIE 1976 (u', v') chromaticity diagram		

Table 4: *Additional Testing and Reporting Requirements for Spectral Quality (DLC Premium)*

Metric and/or Application	V5.1 Premium Requirements	QPL Listing	Method of Measurement/ Evaluation
Chromaticity (CCT & D_{uv})	*All Indoor products, except high-bay:* Products shall exhibit chromaticity consistent with at least one of the basic, flexible, or extended, nominal 4-step quadrangle CCTs from 2200 K – 6500 K *All other products*: Same as V5.1 Standard	CCT and D_{uv} for parent products listed as Tested Data Nominal CCT for child products listed as Reported Data	ANSI/IES LM-79 *ANSI C78.377-2017*

Test Report and Implementation Requirements: DLC Standard

This section describes the test reports required to qualify products to the DLC SSL QPL under the Standard classification.

Color Rendition and Chromaticity (CCT & D_{uv}): DLC Standard

The DLC has several pathways for demonstrating color rendition and chromaticity compliance, depending on the level of product-variation complexity. In the pathways described below, "option" (color rendition or CCT) is used to describe a specific, nominal performance variation in a given set, for a product or product family. Regardless of which pathway is used to demonstrate color rendition and chromaticity compliance, all chromaticity coordinates shall fall within at least one of the basic, flexible, or extended nominal 7-step quadrangle CCTs from 2200 K – 6500 K as defined by ANSI C78.377-2017.

Additionally, all color rendition options shall meet or exceed either the IES TM-30-18 color rendition requirements (Option 1) or the CIE 13.3.-1995 color rendition requirements (Option 2) and both sets of color rendition measures shall be measured and reported.

- **For product families that offer one color rendition option and one or more CCT option(s):**
  - A full LM-79/color report, per the Additional Reporting Requirements, shall be provided at the lowest and highest CCT options offered.
- **For product families that offer one or more color rendition option(s) and one CCT option:**
  - A full LM-79/color report, per the Additional Reporting Requirements, shall be provided at the minimum color rendition option for the CCT option offered.
- **For product families that offer one or more color rendition option(s) and one or more CCT option(s):**
  - A full LM-79/color report, per the Additional Reporting Requirements, shall be provided for the lowest and highest CCT options offered, at the minimum color rendition option.
- The DLC also requires that testing be conducted on the worst-case efficacy variation, which is likely the combination of lowest CCT and highest color rendition. If the overall minimum color rendition option was not captured in any LM-79/color report above, this configuration must be tested.

> To minimize additional testing required for LUNA qualification, tests on products with CCTs of 3000K or lower must be conducted on the highest light output configuration. For LUNA qualification, testing is conducted on the highest light output product that meets the LUNA Technical Requirements, e.g., CCT must be between 2200K-3000K.

- In all cases, testing requirements correspond to Technical Requirements levels, in addition to product options. For example, if a family includes multiple color rendition options, some of which are eligible for an allowance, and some of which are not, testing would be required at the worst-case (efficacy) color rendition option *that meets the allowance requirement*, for the subgroup of products which want to be granted the allowance, and the minimum color rendition *overall* for the remainder of the group.

Color Maintenance: DLC Standard

The DLC has two pathways for demonstrating color maintenance compliance.

- **Color Maintenance Option 1:**
  - An LM-80 report for each LED package/module/array used within the product shall be provided and shall include chromaticity data for at least ≈1000-hour and ≈6000-hour time intervals. If the LM-80 report uses uneven test intervals, the closest measurement points below the 1000-hour measurement point (<1000 hours) and beyond the 6000-hour measurement point (>6000 hours) will be referenced for evaluation of color maintenance. Additionally, color maintenance will be evaluated against the appropriate LM-80's 55°C data set, or the lowest temperature data set provided that is greater than 55°C, if there isn't a 55°C data set available. An appropriate LM-80 data set will be tested at a drive current at or above the drive current utilized for the TM-21 calculations on submitted product(s).
- **Color Maintenance Option 2:**
  - Luminaire-level performance data that follow LM-84 test procedures for the product shall be provided and shall include chromaticity data for at least ≈1000-hour and ≈6000-hour time intervals.
  - Due to the length of this type of testing, it is recommended that the submitter contact the DLC at applications@designlights.org to ensure the testing plan will align with DLC Testing and Reporting Requirements before beginning any testing using the LM-84 method.
- In the case that average chromaticity coordinate data at the ≈1000-hour and ≈6000-hour measurement points are not provided and only chromaticity shift (Δu'v') data is available, the DLC will assume the worst-case shift between these two measurement points. To clarify, the DLC will assume the ≈1000-hour and ≈6000-hour measurement points represent color shifts in opposite directions and will add the two reported chromaticity shift values to ensure that the worst-case shift meets the appropriate color maintenance requirement.

Test Report and Implementation Requirements: DLC Premium

This section describes the test reports required to qualify families of products to the DLC SSL QPL under the Premium classification. In the pathways described below, "option" (color rendition or CCT) is used to describe a specific, nominal performance variation in a given set, for a product or product family.

Color Rendition and Chromaticity (CCT & D_{uv}): DLC Premium

- In addition to the test report and implementation requirements for DLC Standard qualification, a full LM-79/color report, per the Additional Reporting Requirements, for the maximum color rendition option at the lowest CCT option, shall be provided.
    - For example, if a product family consists of two color rendition options (e.g. CRI Ra=80, R9=0 and CRI Ra=90, R9=50) and four CCT options (e.g. 2700 K, 3500 K, 4000 K, and 5000 K), and *all* variations are to be qualified to DLC Premium, a minimum of three LM-79 test reports shall be provided. That is, one test for the highest CCT at the minimum color rendition option, one test for the lowest CCT at the minimum color rendition option, and one test at the lowest CCT for the higher color rendition option.
- Consistent with the Standard classification requirement, tested color rendition options shall meet either (Option 1) the IES TM-30-18 color rendition requirements or (Option 2) the CIE 13.3-1995 color rendition requirements, as described in Table 2, and *both* sets of color rendition measures shall be measured and reported.
- All variations of CCT offered shall fall within at least one of the basic, flexible, or extended nominal 4-step quadrangles (for all indoor products, except high-bay), or 7-step quadrangles (for all outdoor and high-bay products) from 2200 K - 6500 K as defined by ANSI C78.377-2017.
- The DLC also requires that testing be conducted on the worst-case efficacy variation, which is likely the combination of lowest CCT and highest color rendition.
- In all cases, testing requirements correspond to Technical Requirements levels, in addition to product options. For example, if a family includes multiple color rendition options, some of which are eligible for an allowance, and some of which are not, testing would be required at the worst-case (efficacy) color rendition option *that meets the allowance requirement*, for the subgroup of products which want to be granted the allowance, and the minimum color rendition *overall* for the remainder of the group.

Interactions with other DLC Policies: Color-Tunable Products and Field-Adjustable Light Output (FALO) Products

For color-tunable (white-tunable and warm-dimming) products and/or dimmable and field-adjustable light output (FALO) products, additional clarifications on meeting the V5.1 spectral quality requirements are provided below.

- For color-tunable products, testing and reporting requirements for chromaticity (CCT & D_{uv}), color rendition, and color maintenance are applicable, unless specifically excluded per the Color-Tunable Testing and Reporting Requirements. For parent products in a family grouping application, the chromaticity (CCT & D_{uv}) and color rendition at the CCT setting required by the Color-Tunable Testing and Reporting Requirements will be listed on the QPL under the Tested Data section. White-tunable products will be listed on the QPL at the least efficacious setting, with the corresponding product performance characteristics. Warm-dimming products will be

listed on the QPL at the full output setting, with the product performance characteristics. For child products, reporting of CCT and color rendition is required at the worst-case efficacy setting for white-tunable products and at the full output setting for warm-dimming products, and all information will be listed as Reported Data. D_{uv} will not be reported or listed for child products.

- Color maintenance will be evaluated for each unique LED within a product that uses separate LM-80 data.
- White-tunable products that intend to qualify shall test and report at the CCT settings designated per the Color-Tunable Testing and Reporting Requirements, i.e. at the minimum, maximum, and mid-point CCT settings.
- White-tunable products are not required to meet the chromaticity requirements in V5.1.

Color-tunable products are eligible for LUNA qualification if products' CCT range is limited to within the LUNA Technical Requirements, i.e., 2200K – 3000K. Limiting the color tunable range can be achieved through physical or electronic means such that the product is not intended to be tuned beyond 2200K – 3000K by the end user.

- For dimmable/FALO products, testing and reporting requirements for chromaticity (CCT & D_{uv}), color rendition, and color maintenance are applicable and are evaluated at the maximum light output setting. For parent products in a family grouping application, chromaticity (CCT & D_{uv}) and color rendition will be listed on the QPL under the Tested Data section. For child products, reporting of CCT and all color rendition measures is required, and all information will be listed as Reported Data.
- Dimmable/FALO products will not be evaluated for chromaticity (CCT & D_{uv}), color rendition, or color maintenance at dimmed output settings.

Light Distribution and Discomfort Glare Requirements

The light distribution and discomfort glare testing and reporting requirements for all SSL products are described as follows.

Zonal Lumen Distribution and Spacing Criteria

SSL products, except for products in the Linear Replacement Lamps category, shall meet the zonal lumen distribution (ZLD) and spacing criteria (SC) requirements as listed in Table 5 in the full V5.0 Technical Requirements Tables.

Beam Angle

SSL products in the linear replacement lamps and 2G11 base replacement lamps categories shall report their beam angle in the reported values on the application form and demonstrate a beam angle of 140˚ or greater. The beam angle for linear replacement lamps is defined as 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 as illustrated in **Figure 1**.

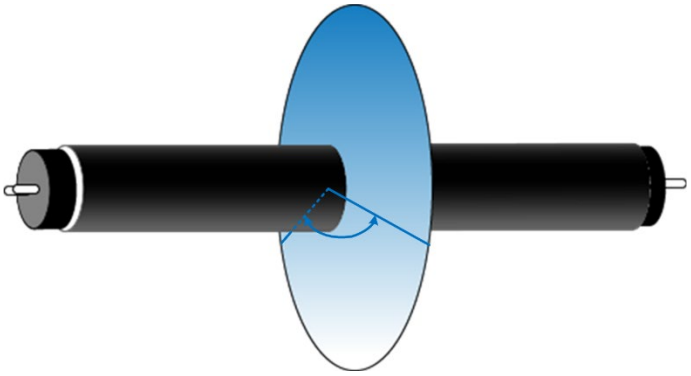

Figure 1: *Linear Replacement Lamp Beam Angle Definition*

BUG (Backlight, Uplight, and Glare) Ratings

SSL products in the Outdoor Luminaire category shall report the 6-character BUG ratings. Applicability to future Specialty Primary Use Designations will be determined on a case-by-case basis. The following Outdoor Low, Mid, High or Very High Output Primary Use Designations are exempt from V5.1 BUG rating reporting requirements:

- Landscape/Accent Flood and Spot Luminaires
- Architectural Flood and Spot Luminaires
- Specialty: Wall Grazing/Slicing
- Specialty: Hazardous Flood and Spot Luminaires
- Specialty: Soffit Lighting
- Specialty: Sports Flood
- Specialty: Natatorium Lighting
- Specialty: Tunnel Lighting

The nomenclature of a BUG Ratings is similar to the example: **B2 U0 G2**. BUG ratings are determined based on the method described in IES TM-15-11 Luminaire Classification System for Outdoor Luminaires and the Addendum A for IES TM-15-11: Backlight, Uplight, and Glare (BUG) Ratings. All products in the Outdoor Luminaire category shall input their BUG ratings on the Reported Performance Table tab of the application form. BUG ratings can be filtered under the Distribution & Glare menu of the QPL. The BUG ratings entered on the Reported Performance Table tab of the application form may be generated either from the photometric data in the LM-79 test report or by manufacturer's own calculation method based on the tested data as long as the procedures in IES TM-15-11 and the Addendum A for IES TM-15-11 are

followed. In addition, for a single product application and for the parent products[2] in a family grouping application, tested BUG ratings will be generated by the DLC reviewer using the photometric data from the submitted LM-79/distribution report (.ies file) and listed under the Tested Data section of the QPL.

BUG ratings have been adopted and are referenced by many national, state and/or local ordinances, regulations, standards and policies. Listing of BUG ratings on the QPL is intended to provide information that can be used to determine compliance with these regulations. Determination of BUG ratings in IES TM-15-11 is currently under review by IES for revision, and the DLC will update the policy to align with the updated standard upon its release.

The LUNA Technical Requirements have a maximum threshold for U Ratings dependent on primary use designation. For example, the maximum U Rating for most qualifying LUNA outdoor Primary Use Designations is U1.

LUNA-qualifying products may only include mounting options that will not allow tilt angles beyond +/- 10 degrees, in order to align the luminaire parallel with the roadway surface. Products with mounting options or accessories that do not meet this requirement (e.g., slipfitters and knuckle mounts) must be excluded from the model number.

Discomfort Glare Performance Metric for Indoor Products

Discomfort glare performance requirements in SSL V5.1 are not applicable to Outdoor products, and the requirements are not applicable to Standard classification Indoor products unless an efficacy allowance is being pursued for enhanced glare control. The requirements only apply to products seeking DLC Premium classification and/or to products seeking efficacy allowances for Premium or Standard classification that meet the more stringent UGR thresholds in **Table 11**. The Unified Glare Rating (UGR) defined in CIE 117-1995 is a metric for evaluating discomfort glare performance of certain products in the indoor category. UGR for a luminaire in a set of reference conditions can be determined using the procedure described in CIE 190-2010. UGR has been widely used in Europe and other regions.

Test Report and Implementation Requirements: DLC Standard

The light distribution testing and reporting requirements for all SSL products are shown in **Table 5** for the DLC Standard classification. The “QPL Listing” column describes the information that appears as publicly available on the Qualified Products List, if applicable. The “Method of Evaluation” column describes how the products will be evaluated for qualification, whether by compliance with industry standards, manufacturer claims, or other DLC verification methodology.

Table 5: *V5.1 Testing and Reporting Requirements for Light Distribution (DLC Standard)*

Metric and/or Data Set	V5.1 Requirements			Method of Evaluation
	Threshold	Reported	QPL Listing	
Zonal Lumen Distributions (ZLD) & Spacing Criteria (SC) *All products except linear replacement lamps*	Per the Technical Requirements Table	No ZLD and SC reporting required	ZLD and SC information will not be published on the QPL	ANSI/IES LM-79 per the Additional Reporting Guidelines, and values produced by photometric analysis from tested .ies files
Beam Angle *Linear replacement lamps and 2G11 lamps only*	≥140˚	Bare-lamp beam angle for each product	Beam angles are reported by the applicants and listed under the Reported Data section. Beam angles for parent products[2] will be verified by the DLC using the test reports and listed under the Tested Data section.	ANSI/IES LM-79 per the Additional Reporting Guidelines
Backlight, Uplight, and Glare (BUG) *Outdoor luminaires only*	None	BUG ratings for each product	BUG ratings for child products are reported by the applicants and listed under the Reported Data section. BUG ratings for parent products[2] will be generated by the DLC using tested photometric data and listed under the Tested Data section.	BUG ratings generated per IES TM-15-11 and Addendum A for IES TM-15-11 using luminaire photometric data

The lighting distribution test reports required to qualify products to the DLC SSL QPL under the Standard classification are described as follows.

- A full LM-79/distribution report per the Additional Reporting Guidelines shall be provided for each unique distribution pattern within the family without consideration of lumen package and the effect of color properties[3], tested at the maximum (non-dimmed) light output and the .ies file based on the LM-79 test data.

> To minimize additional testing required for LUNA qualification, tests on products with CCTs of 3000K (or lower if 3000K is not included) must be conducted on the highest light output configuration. For LUNA qualification, testing is conducted on the highest light output product at the highest LUNA-qualifying CCT.

[2] Please reference parent product definition in the definitions section of this document.
[3] The color properties, such as CCT and color rendition, of the product within the product family used for the LM-79/distribution test may be of the applicant's choice and the tested configuration may be the same configuration used to meet other Technical Requirements if applicable.

- Zonal lumen distribution (ZLD), spacing criteria (SC), beam angle (linear replacement and 2G11 base lamps only), and BUG ratings (outdoor products only) of a single product application or parent products[2] in a family grouping application will be verified using the .ies files associated with the full LM-79/distribution test reports.
- For all child products in a family grouping application where LM-79 test reports are not required, reported data, including beam angle (linear replacement and 2G11 base lamps only) and BUG ratings (outdoor products only), shall be reported in the Reported Performance Table tab on the application form.
- DLC reviewers will use Photometric Toolbox (Lighting Analysts, Inc., version 2.7 or newer) to verify ZLD, SC, and BUG ratings (outdoor products only) using the submitted tested .ies file.

Test Report and Implementation Requirements: DLC Premium

For SSL products seeking Premium classification, the testing and reporting requirements related to light distribution and discomfort glare are listed below in **Table 6**. (See the DLC Premium section and **Table 10** for the complete requirements).

Table 6: *Additional Testing and Reporting Requirements for Discomfort Glare (DLC Premium)*

Metric	V5.1 Premium Requirements	QPL Listing	Method of Evaluation
Discomfort Glare	*Troffer (Luminaire and Integrated Retrofit Kits only):* **Corrected UGR < 22.0** (Note: Linear-Style Retrofit Kits for 2x2, 1x4, and 2x4 Luminaires are not eligible for Premium qualification under V5.1.)	UGR values not published on the QPL	Corrected UGR values generated per CIE 190-2010 at the reference condition below. Room dimension: X = 4H, Y = 8H Spacing to height ratio (S/H): 1 Reflectances: 70/50/20%
	Linear Ambient (Luminaire and Retrofit Kits): **Corrected UGR < 22.0**		
	Low-Bay (Luminaire and Retrofit Kits): **Corrected UGR < 25.0**		
	High-Bay (Luminaire and Retrofit Kits): **Corrected UGR < 28.0**		
	All other products: **n/a**		

Note: DLC reviewers will use Photometric Toolbox (Lighting Analysts, Inc., version 2.7 or newer) to verify UGR using the submitted tested .ies file.

The lighting distribution and discomfort glare test reports required to qualify products under the Premium classification are described as follows:

- **For eligible products that need to meet the UGR requirements:**

- A full LM-79/distribution report per the Additional Reporting Guidelines for the products that have the highest total lumen output for each optical variation within the family without consideration of the effect of color properties[3], tested at the maximum (non-dimmed) light output and the .ies file based on the LM-79 test data.
- Indication on the application form which UGR bin the product's Corrected UGR value falls in. The options for the UGR bins on the application form are 10.0-12.9, 13.0-15.9, 16.0-18.9, 19.0-21.9, 22.0-24.9, and 25.0-27.9. If the product has a UGR less than 10.0, it will fall in the 10.0-12.9 bin.

- **For other eligible products:**
  - A full LM-79/distribution report per the Additional Reporting Guidelines for each optical variation within the family without consideration of lumen package and the effect of color properties[2], tested at the maximum (non-dimmed) light output and the .ies file based on the LM-79 test data.
- For a single product application or the parent products[2] in a family grouping application, ZLD, SC, UGR, and BUG ratings (outdoor products only) will be verified using the .ies files associated with the full LM-79/distribution test report.
- For all child products in a family grouping application where LM-79/distribution reports are not required, reported data, including BUG ratings (outdoor products only), shall be reported in the reported values on the application form.
- DLC reviewers will use Photometric Toolbox (Lighting Analysts, Inc., version 2.7 or newer) to verify ZLD, SC, UGR (Premium and Efficacy Allowance pursuance) and BUG ratings (outdoor products only) using the submitted tested .ies file.

Interactions with Other DLC Policies: Field-Adjustable Light Distribution (FALD)

For field-adjustable light distribution (FALD) products, additional clarifications on meeting the light distribution and discomfort glare requirements are provided below.

- Testing and reporting requirements for zonal lumen distributions (ZLD) and spacing criteria (SC) are applicable to FALD products. DLC reviewers will verify the ZLD requirements per the ZLD and SC measurements at the light distribution setting designated by the manufacturer per the FALD Testing and Reporting Requirements.
- Testing and reporting requirements for BUG ratings are applicable to FALD products in the Outdoor Luminaire category, except for the exempted PUDs (see the BUG Ratings section).
  - For parent products in a family grouping application, BUG ratings at the light distribution setting designated by the manufacturer for meeting the ZLD requirements (per the FALD Testing and Reporting Requirements) will be listed on the QPL under the Tested Data section.
  - For child products, reporting of BUG ratings is exempted, and no BUG ratings will be listed as Reported Data on the QPL.

While FALD products are not eligible to qualify for LUNA, products that restrict tilt to ≤10 degrees are **not** required to list as FALD and **are** eligible for LUNA qualification. Products within the specific Primary Use Designations that are "aimable" but restrict tilt to ≤10 degrees to "level" the intensity distribution with the pavement are **not** required to list as FALD.

- Testing and reporting requirements for UGR are applicable to FALD products in the applicable categories seeking Premium classification. The UGR values shall meet the threshold at the light distribution setting designated, per the FALD Testing and Reporting Requirements, for meeting the ZLD requirements of the PUD, for which the product is seeking qualification.
- Testing and reporting requirements for UGR are not applicable to FALD products seeking efficacy allowances. FALD products are not eligible for efficacy allowances related to discomfort glare control under V5.1.

V5.1 Technical Requirements: Controllability

Controllability Requirements

The V5.1 controllability testing and reporting requirements for all SSL products are as shown in **Table 7**. Please see **Table 8** for integral control sensor and capability descriptions and **Table 9** for control communication descriptions. The "QPL Listing" column describes the information that appears as publicly available on the Qualified Products List, if applicable. The "Method of Evaluation" column describes how the products will be evaluated for qualification, whether by compliance with industry standards, manufacturer claims, or other DLC verification methodology.

Table 7: *V5.1 Controllability Testing and Reporting Requirements*

Metric	V5.1 Requirements	QPL Listing	Method of Evaluation[4]
Dimming	*Indoor luminaires and retrofit kits (excluding case lighting and Specialty primary uses intended for hazardous location):* **Continuous dimming capability required**	*1.* Dimming capability *(continuous, stepped, none)* 2. Range of continuous dimming (if applicable) *(Above 10%, Less than or equal to 10%)*	Product specification sheet shall clearly identify dimming capability[5]
	Outdoor luminaires, retrofit kits, and mogul screw-base replacement lamps for outdoor applications (excluding landscape accent/flood, specialty sports flood, specialty tunnel, and Specialty primary uses designated for hazardous locations): **Continuous or stepped dimming capability required**		
	Lamps, unless noted above: **Continuous dimming capability required**		
	All other products: **Required reporting of dimming capability**		
Integral Controls	All products are required to report on integral control sensors and capabilities	1. Integral control sensors* 2. Integral control capabilities ** 3. LLLC model name (if applicable)	Product specification sheet or supplemental literature shall clearly identify the types of integral controls available

[4] Controllability capabilities are based on manufacturer claims; performance is not verified by DLC.

[5] Use of an acceptable term referring to the control communication type noted **Table 9** is an acceptable method to identify dimming capability. Specification sheets do not explicitly need to state "dim", "dimmable", or "dimming".

Metric	V5.1 Requirements	QPL Listing	Method of Evaluation[4]
Control Communication	All products listed as dimmable are required to report the available wired and/or wireless control communication protocol(s)	1. Wired Communication Protocols† 2. Wireless Communication Protocols††	Product specification sheet or supplemental literature shall clearly identify the communication type and dimming protocol (if applicable)

* Integral control sensors include: Occupancy, Daylight, Multifunction, Traffic, Photocell, Integral Sensor Receptacle, None.
** Integral control capabilities include: High end Trim, LLLC, Energy Monitoring, Networked Replacement Lamp, None. Multiple selections are permitted.
† Wired options include: 0-10V, DALI, DMX, Phase-cut, Other Wired, None.
†† Wireless options include: ZigBee, Bluetooth, Wi-Fi, Other Wireless, None. Multiple selections are permitted.

Dimming

The dimming requirements in V5.1 enhance the controllability of qualified lighting products across all categories in order to increase potential energy savings while improving quality of light, comfort, and wellbeing for end users of the occupied spaces. The policies will ensure that products listed on the QPL have the capability to be dimmed, and are marketed by manufacturers as such, should the customer wish to take advantage of dimming. QPL products designated as dimmable may require the installation of additional components and/or building infrastructure to enable dimming. The DLC does not set requirements regarding how qualified dimmable products are installed and/or used in the field.

- All products shall report the dimming capability. Dimming capabilities are defined in the section Definitions: Controllability.
- Indoor luminaires and retrofit kits shall be capable of continuous dimming, with the following exceptions:
    - All Primary Use designations within the Case Lighting general application
    - Any Specialty Primary Use designation intended for a hazardous location[6]
- Outdoor luminaires and retrofit kits shall be capable of continuous or stepped dimming, excluding the following:
    - Landscape/Accent Flood and Spot Luminaires
    - Specialty: Sports Flood
    - Specialty: Tunnel Lighting
    - Any Specialty Primary Use designation intended for a hazardous location[6]

[6] Dimming requirements on future Specialty designations will be determined at the time the designation is requested and/or granted.

LUNA-qualifying products must have continuous dimming capability to ≤20% of max output power.

- Lamps shall be capable of continuous dimming. For mogul screw-base (E30/E40) replacements for HID lamps qualified within an Outdoor General Application, stepped dimming is permissible.
- Dimming capability shall be documented on the manufacturer's published product specification sheet.
- All products pursuing the DLC Premium classification shall be capable of continuous dimming. Lamps and Specialty Primary Use Designations are not eligible for DLC Premium regardless of dimming capability.
- The DLC does *not* issue requirements around utilization of a specific dimming control protocols (0-10V, DALI, etc.) for the dimming capability requirement. *The act of dimming itself is the focus of this requirement.*

Special Considerations for Dimmable Lamps

As stated in **Table 7**, 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.

Integral Controls

- Reporting of integral control sensors and capabilities is required for all products.

- Integral control sensors and capabilities are defined in **Table 8**. These integral control features will not be evaluated against any standards and will be treated as manufacturer-reported assertions validated with references on the product specification sheet or supplemental literature.
- Multiple selections of integral control sensors and capabilities are permitted.
- Product model numbers may include wild-card characters to represent various integral control options, as was permissible under SSL V4.4.

LUNA-qualifying products have additional choices for integral control capabilities, e.g., part night dim. Refer to the LUNA Technical Requirements for the specific language needed on specification sheets or supplemental materials to claim the LUNA-specific capabilities and control options.

Control Communication

- Reporting of the control communication type (wired, wireless, none) and the dimming protocol (if applicable) for all products is required.
- Control communication types are defined in **Table 9**. These control communication types will not be evaluated against any standards and will be treated as manufacturer-reported assertions validated with references on the product specification sheet or supplemental literature.
- Multiple selections of communication protocols are permitted.
- Product model numbers may include wild-card characters to represent various control communication options.

LUNA-qualifying products have additional and more specific choices for control communications, e.g., DALI-2. Refer to the LUNA Technical Requirements for the specific language needed on specification sheets or supplemental materials to claim the LUNA-specific capabilities and control options.

Test Report and Implementation Requirements

- Given the rapidly evolving technical capabilities included in the controllability requirements, the DLC review staff will not evaluate any controllability claims against actual performance. Reviewers of product applications will rely on manufacturer claims represented directly on the product specification sheet or supplemental controls documentation (where applicable). Documentation shall have explicit declaration of a capability, along with any ordering

information (i.e., model number or ordering code variants) that are associated with the specific capability or attribute.

- The DLC will monitor its stakeholders' experience with QPL controllability information and intends to use surveillance testing procedures to address any concerns about controllability performance claims not matching QPL or market available data.

Table 8: *Integral Control Sensor and Capability Descriptions*

Integral Control Feature		Definition	Acceptable Terms on the Product Spec Sheet or Supplemental Literature
SENSORS	Occupancy	A control device that detects occupant presence and automatically turns luminaires and/or other equipment on and, after a preset delay during which no presence is detected, turns them off. Also called a motion detector.	Occupancy, Vacancy, Motion, Exterior Motion
	Daylight	Sensors that can automatically affect the operation of lighting or other equipment based on the amount of daylight and/or ambient light that is present in a space, area.	Daylight, Daylight Harvesting, Daylight Dimming, Daylight Response, Photosensor, Ambient Light
	Multifunction	A combination sensor that has two or more relevant sensor capabilities listed in **Table 8**. Examples include occupancy + daylight, occupancy + photocell, or traffic + photocell.	Multifunction, Dual/Combination, or any two or more acceptable terms from **Table 8** for the relevant sensors shown as a singular option.
	Traffic	A sensor that can automatically affect the operation of lighting or other equipment based upon detecting the presence or absence of moving vehicles in an area.	Traffic, Adaptive Traffic
	Photocell	A sensor that can automatically affect the operation of lighting or other equipment based on the amount of daylight and/or ambient light that is present in an exterior environment.	Photocell, Daylight, Photo, PCR, Dusk-to-Dawn
	Integral Sensor Receptacle	An integrated receptacle that can accept a variety of sensors, communication hardware, and/or other control devices for indoor or outdoor lighting equipment.	Sensor Receptacle/Socket, Photocell Receptacle/Socket, ANSI C136.41 Receptacle/Socket, NEMA 5-pin Receptacle/Socket, NEMA 7-pin Receptacle/Socket, Zhaga Book 18 Receptacle/Socket, Port

Integral Control Feature		Definition	Acceptable Terms on the Product Spec Sheet or Supplemental Literature
CAPABILITIES	High End Trim	The capability to set the maximum light output to a less-than-maximum state of an individual luminaire/lamp at the time of installation or commissioning. High end trim must be field reconfigurable.	High end trim, task tuning, tuning
	LLLC	The capability to have a networked occupancy sensor, ambient light sensor, and high end trim installed for each luminaire/kit/lamp, and directly integrated or embedded into the form factor during the manufacturing process.	Integrated/embedded networked lighting control, Luminaire Level Lighting Control (LLLC). The LLLC system name shall be shown on the product spec sheet or supporting literature and the system must be listed on the NLC QPL with the LLLC capability claimed.
	Energy Monitoring	The capability of a system to report the energy consumption of a luminaire/lamp. This capability may support performance-based efficiency rebates, real-time energy dashboards, and predictive maintenance.	Power/Energy Monitoring, Power/Energy Metering, Power/Energy Measurement, Power/Energy Reading.
	Networked Replacement Lamp	A linear, mogul screw-base, or four pin-base replacement lamp that includes all the following controllability features built into the lamp: continuous dimming; wireless communication; high end trim; and individual addressability. Some networked replacement lamps may also incorporate integrated sensors such as occupancy/vacancy sensing.	Networked, Smart, Intelligent, Connected, Advanced, NLC

Table 9: *Control Communication Descriptions*

Control Communication Type		Definition	Acceptable Terms on the Product Spec Sheet or Supplemental Literature
WIRED	0-10V	Wired analog low-voltage control that varies DC voltage between 0 and 10 volts (or 1 and 10 volts) to produce varying light output.	0-10V, 1-10V
	DALI	A standard lighting control protocol where each luminaire is assigned a unique address and responds to data signals distributed through a common communication line.	DALI, DALI-2, D4i, Digital Addressable Lighting Interface

Control Communication Type		Definition	Acceptable Terms on the Product Spec Sheet or Supplemental Literature
	DMX	Lighting control protocol initially created for use in theatrical applications but is in common use in architectural lighting applications where color changing or tuning effects are desired. It describes a method of digital data transmission between a controller and a dimmer or relay panel, or to DMX512-compatible luminaires. Wiring is Class 2 and is required to be a daisy-chain configuration.	DMX, DMX512, Digital Multiplex
	Phase-cut	Modification, or cutting, of the leading or trailing edge of the AC mains sinusoidal waveform to produce varying light output.	Phase-cut, phase, forward phase, leading edge, reverse phase, trailing edge, TRIAC, magnetic low-voltage (MLV), electronic low-voltage (ELV)
	Other Wired	Other wired communication protocol as specified by the manufacturer.	N/A
WIRELESS	ZigBee	Low-power wireless protocol. It uses an IP address for devices, has a parallel full-duplex communication, and uses short- to medium-range RF to communicate.	ZigBee, ZigBee HA, ZigBee 3.0
	Bluetooth	Wireless digital communication protocol developed and maintained by the Bluetooth Special Interest Group (SIG). Uses short-range RF to communicate with other nearby Bluetooth-enabled devices.	Bluetooth, Bluetooth Low Energy, BLE, BLE Mesh
	Wi-Fi	A wireless protocol similar to the protocols that computers use and is a very robust wireless option. It also functions similarly to PoE in that it assigns IP addresses to each device and luminaire and is dependent on the user interface for granularity of dimming range.	Wi-Fi, Wireless Internet
	Other Wireless	Other wireless communication protocol as specified by the manufacturer.	N/A

V5.1 Technical Requirements: DLC Premium

DLC Premium under V5.1 is a higher-performance classification for luminaires and retrofit kits. The Premium classification is intended to differentiate products that achieve higher energy savings *while* delivering light quality and controllability performance that exceed DLC Standard requirements. Products submitted to the DLC Premium classification must meet more stringent efficacy, quality of light, and controllability requirements as outlined in **Table 10.** The "QPL Listing" column describes the information that appears as publicly available on the Qualified Products List, if applicable. "The Method of Evaluation" column describes how the products will be evaluated for qualification, whether by compliance with industry standards, manufacturer claims, or other DLC verification methodology.

Only luminaires and retrofit kits are eligible for qualification under DLC Premium. The following product types are not eligible to qualify for the DLC Premium classification:

- Replacement lamps
- Linear-Style Retrofit Kits for 2x2, 1x4, and 2x4 Luminaires
- Products with a Primary Use designated as "Specialty"

DLC Premium products are eligible for LUNA qualification. See the DLC Standard section for testing and reporting recommendations for qualifying products to the LUNA Technical Requirements.

Table 10: *V5.1 DLC Premium Testing and Reporting Requirements*

Metric	V5.1 Premium Requirements*	QPL Listing	Method of Evaluation
Efficacy	**+15 lumens per watt** over V5.1 Standard efficacy requirements	Same as V5.1 Standard	Same as V5.1 Standard
Chromaticity (CCT & D_{uv})	*All Indoor products, except High-Bay*: Products shall exhibit chromaticity consistent with at least one of the basic, flexible, or extended, nominal **4-step quadrangle** CCTs from 2200K-6500K *All other products*: Same as V5.1 Standard	Same as V5.1 Standard	Same as V5.1 Standard
Discomfort Glare	*Troffer (Luminaire and Integrated Retrofit Kits only):* **Corrected UGR < 22.0** (Note: Linear-Style Retrofit Kits for 2x2, 1x4, and 2x4 Luminaires are not eligible for Premium qualification under V5.1.)	UGR values not published on the QPL	Corrected UGR values generated per CIE 190-2010 at the reference condition below.

Metric	V5.1 Premium Requirements*	QPL Listing	Method of Evaluation
	Linear Ambient (Luminaire and Retrofit Kits): **Corrected UGR < 22.0**		Room dimension: X = 4H, Y = 8H Spacing to height ratio (S/H): 1 Reflectances: 70/50/20%
	Low-Bay (Luminaire and Retrofit Kits): **Corrected UGR < 25.0**		
	High-Bay (Luminaire and Retrofit Kits): **Corrected UGR < 28.0**		
	All other products: **n/a**		
Controllability	All products shall be **capable of continuous dimming**. Stepped dimming is not acceptable for Premium qualification. (note: integral control reporting is no longer a Premium requirement since it is required of all qualified products).	Same as V5.1 Standard	Same as V5.1 Standard
Lumen Maintenance	$L_{90} \geq 36{,}000$ hours (Note new LM-80 / TM-21 guidance. See Additional Reporting Guidelines: IES TM-21-11 and its Addendum B)	Lumen Maintenance values not published on the QPL	TM-21 projections in the same manner as the V5.1 Standard L_{70} requirements
Driver In-Situ Temperature Measurement Testing (ISTMT)	Measured temperature at the TMP_{ps} is less than or equal to the allowable operating temperature for which the driver is designed to last ≥50,000 hours specified by the power supply manufacturer when tested in-situ under steady-state operating conditions, with case temperature measured at the designated TMP. (No change from V5.0)	Driver ISTMT values not published on the QPL	1. Laboratory test report indicating the measured temperature from the TMP_{ps}; 2. A picture of the TMP_{ps} location; 3. Driver manufacturer documentation indicating the maximum case temperature for which the driver is under designed to last ≥50,000 hours.

* For any metric not listed in **Table 10**, V5.1 Standard requirements apply.

Test Report and Implementation Requirements: DLC Premium

If a manufacturer seeks qualification of its product(s) to the DLC Premium classification, it shall provide all the necessary testing to demonstrate that the product(s) meet the Premium classification's requirements in addition to meeting all base V5.1 Standard requirements. Topic-specific details are described below.

Color Rendition and Chromaticity (CCT & D_{uv}): DLC Premium

In the pathways described below, "option" (color rendition or CCT) is used to describe a specific, nominal performance variation in a given set, for a product or product family.

- In addition to the test report and implementation requirements for DLC Standard qualification, a full LM-79/color report, per the Additional Reporting Requirements, for the maximum color rendition option at the lowest CCT option, shall be provided.
- For example, if a product family consists of two color rendition options (e.g. CRI Ra=80, R9=0 and CRI Ra=90, R9=50) and four CCT options (e.g. 2700 K, 3500 K, 4000 K, and 5000 K), and *all* variations are to be qualified to DLC Premium, a minimum of three LM-79 test reports shall be provided. That is, one test for the highest CCT at the minimum color rendition option, one test for the lowest CCT at the minimum color rendition option, and one test at the lowest CCT for the higher color rendition option.
- Consistent with the Standard classification requirement, tested color rendition options shall meet either (Option 1) the IES TM-30-18 color rendition requirements or (Option 2) the CIE 13.3-1995 color rendition requirements, as described in Table 2, and *both* sets of color rendition measures shall be measured and reported.
- All variations of CCT offered shall fall within at least one of the basic, flexible, or extended nominal, 4-step quadrangles (for all indoor products, except high-bay), or 7-step quadrangles (for all outdoor and high-bay products) from 2200 K to 6500 K as defined by ANSI C78.377-2017.
- The DLC also requires that testing be conducted on the worst-case efficacy variation, which is likely the combination of lowest CCT and highest color rendition.
- In all cases, testing requirements correspond to technical requirements levels, in addition to product options. For example, if a family includes multiple color rendition options, some of which are eligible for an allowance, and some of which are not, testing would be required at the worst-case (efficacy) color rendition option *that meets the allowance requirement*, for the subgroup of products which want to be granted the allowance, and the minimum color rendition *overall* for the remainder of the group.

Discomfort Glare: DLC Premium

The Premium discomfort glare requirements are only applicable to products within the eligible luminaire and retrofit General Applications, namely, Troffers, Linear Ambient, Low-Bay and High-Bay. (Note: Linear-Style Retrofit Kits for 2x2, 1x4, and 2x4 Luminaires are not eligible for Premium qualification under V5.1). Applications shall include the following additional materials:

- A full LM-79/distribution report per the Additional Reporting Requirements for the products that have the highest total lumen output for each optical variation within the family without

consideration of the effect of color properties[7], tested at the maximum (non-dimmed) light output and the .ies file based on the LM-79 test data.

- Indication on the application form which UGR bin the product's Corrected UGR value falls in. The options for the UGR bins on the application form are 10.0-12.9, 13.0-15.9, 16.0-18.9, 19.0-21.9, 22.0-24.9, and 25.0-27.9. If the product has a UGR less than 10.0, it will fall in the 10.0-12.9 bin.

Qualification for Premium is verified by the application reviewer using the Corrected UGR table in Photometric Toolbox (Lighting Analysts, Inc., version 2.7 or newer) generated from the submitted tested .ies file. If the values in the UGR table for the glare evaluation reference condition (room dimension: X = 4H, Y = 8H; spacing to height ratio: 1; reflectances: 70/50/20%) meet the requirements in **Table 10**, both viewed endwise and crosswise, the product, or family of products in the case of family grouping applications, qualifies for the DLC Premium classification.

Interactions with other DLC Policies

For Field Adjustable Light Distribution (FALD) products seeking Premium classification, the UGR value shall meet the threshold at the light distribution setting designated, per the FALD policy, for meeting the ZLD requirements of the PUD, for which the product is seeking qualification.

[7] The color properties, such as CCT and CRI, of the product within the product family used for the LM-79/distribution test may be of the applicant's choice.

V5.1 Technical Requirements: Efficacy Allowances

As with previous revisions of the DLC Technical Requirements, the V5.1 revision includes increases in efficacy thresholds. Additionally, V5.1 more intentionally considers the trade-offs between efficacy and quality of light. The DLC recognizes that quality must go hand-in-hand with efficacy if long-term energy savings are to be realized. The DLC also recognizes the risk that some products may achieve higher efficacy at the expense of quality, which can leave customers unsatisfied and/or can negatively impact human health or wellbeing. The DLC is incorporating quality requirements to ensure that the QPL includes a balance of products that provide good quality of light, while at the same time saving energy through high efficacy and controllability.

The DLC efficacy requirements are not intended to drive market development or customer choice away from features that contribute to the overall quality of light or the quality of the lighting for a particular space. As such, the DLC will grant allowances to efficacy requirements, applicable to both tested and reported performance values, to off-set potential efficacy tradeoffs due to these enhanced quality features.

A summary of allowances included in Version 5.1 can be seen in **Table 11**. Allowances are cumulative up to a maximum allowance of 15%. For example, a 2700K product that exhibits superior color rendition may utilize a maximum allowance of 10%, whereas a 2700K, low glare product that exhibits superior color rendition may utilize a maximum allowance of 15%, to be applied to the efficacy requirement for the Category and General Application under which the product is qualified. Additionally, a product may take advantage of an efficacy allowance in conjunction with the luminaire efficacy tolerance, as stated in **Table 12**.

LUNA-qualifying products are eligible for an additional efficacy allowance for shielded products and bollards. LUNA allowances can be combined with applicable SSL V5.1 allowances, such as low CCT.

Table 11: *V5.1 Allowances to Efficacy*

Feature	General Application	Performance Metric	Allowance under V5.1
Low CCT	All	≤ 2700K	-5%
High Color Rendition	Indoor, excluding high-bay	**Option 1 - ANSI/IES TM-30-18:** • IES R_f ≥ 75 • IES R_g ≥ 92 • -7% ≤ IES $R_{cs,h1}$ ≤ +19% **Option 2 - CIE 13.3-1995:** • R_a (CRI) ≥ 90 and R_9 ≥ 50	-5%
		ANSI/IES TM-30-18: • IES R_f ≥ 78 • IES R_g ≥ 95 • -1% ≤ IES $R_{cs,h1}$ ≤ +15%	-10%
	Outdoor and high-bay	**Option 1 - ANSI/IES TM-30-18:** • IES R_f ≥ 70 • IES R_g ≥ 89 • -12% ≤ IES $R_{cs,h1}$ ≤ +23% **Option 2 - CIE 13.3-1995:** • R_a (CRI) ≥ 80 and R_9 ≥ 0	-5%
Enhanced Discomfort Glare Control	Troffer (Luminaires and Integrated Retrofit Kits only)	**Corrected UGR < 16.0** at the glare evaluation reference condition of • Room dimension: X = 4H, Y = 8H • Spacing to height ratio (S/H): 1 • Reflectances: 70/50/20% (Note: Linear-Style Retrofit Kits for 2x2, 1x4, and 2x4 Luminaires are not eligible for efficacy allowances under V5.1.)	-10%
	Linear Ambient (Luminaires and Retrofit Kits)	**Corrected UGR < 16.0** at the glare evaluation reference condition of • Room dimension: X = 4H, Y = 8H • Spacing to height ratio (S/H): 1 • Reflectances: 70/50/20%	-10%
	Low-Bay (Luminaires and Retrofit Kits)	**Corrected UGR < 19.0** at the glare evaluation reference condition of • Room dimension: X = 4H, Y = 8H • Spacing to height ratio (S/H): 1 • Reflectances: 70/50/20%	-10%
	High-Bay (Luminaires and Retrofit Kits)	**Corrected UGR < 22.0** at the glare evaluation reference condition of • Room dimension: X = 4H, Y = 8H • Spacing to height ratio (S/H): 1 • Reflectances: 70/50/20%	-10%

Efficacy Allowances: Spectral Quality

To enable a qualification pathway for luminaires designed for applications that demand higher level color rendition and to recognize the tradeoff between efficacy and color rendition, efficacy allowances are provided for products with improved color rendition that meet all other QPL criteria. Recognizing the tradeoff between CCT and efficacy, efficacy allowances are also provided for products with CCT ≤2700K.

To qualify for efficacy allowances, applications shall include the following additional materials:

- A full LM-79/color report, per the Additional Reporting Requirements, for the worst-case (efficacy) color rendition option and the minimum color rendition overall of the group that intends to qualify for an efficacy allowance.
    - All color rendition options shall meet the color rendition requirements detailed in **Table 11**, and *both* sets of color rendition measures (IES TM-30-18 and CIE 13.3) shall be measured and reported.
- All variations of CCT offered shall meet DLC Standard or Premium chromaticity requirements.
- The DLC also requires that testing be conducted on the worst-case efficacy variation, which is likely the combination of lowest CCT and highest color rendition.
- In all cases, testing requirements correspond to Technical Requirements levels, in addition to product options. For example, if a family includes multiple color rendition options, some of which are eligible for an allowance, and some of which are not, testing would be required at the worst-case (efficacy) color rendition option *that meets the allowance requirement*, for the subgroup of products which want to be granted the allowance, and the minimum color rendition *overall* for the remainder of the group.

Efficacy Allowances: Enhanced Discomfort Glare Control

Recognizing that luminaires and retrofit kits for applications demanding low glare are often designed at the expense of efficacy, allowances are provided for products with low glare design that meet all other QPL criteria. The allowances are currently only provided for the following products:

- Luminaires and integrated retrofit kits within the Troffer General Applications
- Luminaires and retrofit kits within the Linear Ambient General Applications
- Luminaires and retrofit kits within the Low-Bay General Applications
- Luminaires and retrofit kits within the High-Bay General Applications

To qualify for the efficacy allowances, applications shall include the following additional materials:

- A full LM-79/distribution report per the Additional Reporting Requirements for the products that have the highest total lumen output for each optical variation within the family without

consideration of the effect of color properties[8], tested at the maximum (non-dimmed) light output and the .ies file based on the LM-79 test data.

- Indication on the application form which UGR bin the product's Corrected UGR value falls in. The options for UGR bins on the application form are 10.0-12.9, 13.0-15.9, 16.0-18.9, and 19.0-21.9. If the product has a UGR less than 10.0, it will fall in the 10.0-12.9 bin.

The product's qualification for efficacy allowances is verified by the application reviewer using the Corrected UGR table generated in Photometric Toolbox (Lighting Analysts, Inc. version 2.7 or newer) from the submitted tested .ies file. If the values in the UGR table for the glare evaluation reference condition (room dimension: X = 4H, Y = 8H; spacing to height ratio: 1; reflectances: 70/50/20%) meet the requirements in **Table 11** both viewed endwise and crosswise, the product qualifies for the allowances. In the case of a family grouping application, all products of the same optical variations as the submitted luminaires within the family automatically qualify for the allowances.

Interactions with other DLC Policies: Field-Adjustable Light Distribution

Field-adjustable light distribution (FALD) products are not eligible for efficacy allowances related to discomfort glare, and therefore the testing and reporting requirements for UGR are not applicable to FALD products.

[8] The color properties, such as CCT and CRI, of the product within the product family used for the LM-79/distribution test may be of the applicant's choice and the tested configuration may be the same configuration used to meet other Technical Requirements if applicable.

V5.1 Technical Requirements: Tolerances

The DLC accepts measurement tolerances to most metrics listed in the Technical Requirements. For zonal lumen tolerances specific to each Primary Use Designation, please refer to Table 11 of the V5.1 Technical Requirements Tables on the DLC website.

Table 12: *Tolerances under Version 5.1*

Performance Metric	V5.1 Tolerance
Light Output	±10%
Luminaire Efficacy	-3%
Allowable CCT	Defined by ANSI C78.377-2017†
Color Rendition	CIE Ra (CRI): -1 Point CIE R9: -1 Point IES Rf: -1 Point IES Rg: -1 Point IES $R_{cs,h1}$: +/- 1%
Color Maintenance	$\Delta u'v'$: + 0.0004 points Data must be consistent with the LM-80 testing and reporting guidelines.
UGR	None[9]
Power Factor	-3%
Total Harmonic Distortion	+5%
Beam Angle (linear replacement lamps and 2G11 lamps only)	-5°

† ANSI C78.377-2017 also referred to for Duv, $\Delta u'v'$, and (x,y) chromaticity coordinates tolerances for indoor categories.

For performance metrics that are a nominal value, a tolerance is a percentage of the required value. For example, for a minimum efficacy requirement of 110 lm/W with a -3% tolerance, the functional requirement is 106.7 lm/W (i.e., 110 x 97% = 106.7).

Tolerances are intended to account for all testing variation, rounding, and significant digits. The requirement values and tolerances will be interpreted by DLC review staff as exact requirements. While test labs will be expected to follow the requirements of their accreditation and relevant test standards, DLC staff will not employ additional rounding to interpret values below the absolute thresholds as passing. For example, if a luminaire is required to have an efficacy of 110 lm/W, then with then efficacy tolerance of -3%, any value for efficacy less than 106.70000… will be interpreted as a failing value. It is an applicant's responsibility to check all data presented in an application before submission to ensure compliance with the DLC requirements.

[9] There is no additional tolerance for UGR threshold values.

V5.1 Technical Requirements: Reference Housings

Under the V5.1 Technical Requirements, DLC requirements for General Applications that previously required testing in reference housings have changed, as described below.

Linear Replacement Lamps & 2G11-base Replacement Lamps for CFLs

All linear replacement lamps and 2G11-base replacement lamps for CFLs have historically had to provide test information on the lamps themselves and other test information obtained from testing the lamps installed in a reference luminaire housing. Under the V5.1 Technical Requirements, the DLC has removed the reference housing testing requirements for these product types and replaced them with alternative requirements as described below.

Test Report and Implementation Requirements for Linear Replacement Lamps and 2G11-base Replacement Lamps for CFLs

The testing and reporting requirements for linear replacement lamps and 2G11-base replacement lamps for CFLs under V5.1 are shown in **Table 13**. Additional performance requirements for these products are otherwise as described in applicable Technical Requirements above (for color, controllability, etc.).

Table 13: *Light Output and Efficacy Requirements for Linear Replacement Lamps*

General Application	Initial Light Output (lm)	Bare-lamp Efficacy (lm/W)[10]	Bare-lamp Beam Angle
Two-foot Lamps, T8 Replacements	≥ 800	≥ 120	≥ 140° as defined in **Figure 1**
Three-foot Lamps, T8 Replacements	≥ 1,200		
Four-Foot Lamps, T8 Replacements	≥ 1,600		
Four-Foot Lamps, T5 Replacements	≥ 1,600		
Four-Foot Lamps, T5HO Replacements	≥ 3,200		
Eight-Foot Lamps, T8 Replacements	≥ 3,200		
U-bend Lamps, T8 Replacements	≥ 1,400		
2G11 Replacement Lamps	≥ 1,900		

In addition to full LM-79/color reports for worst-case light output, worst-case efficacy, and appropriate color properties per rules applicable to all products, submitters shall 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

[10] Ballast factor is included in Bare-lamp efficacy requirements for replacement lamps.

beam angle. Full LM-79/color reports and full LM-79/distribution reports must conform to Additional Reporting Guidelines section in Technical Requirements V5.1. 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, as shown in **Figure 1**.

Additionally, all linear replacement lamps (including child products) shall report their beam angle in the Reported Performance Table on the application form.

All product categories above shall conduct *in-situ temperature measurement testing* (ISTMT) 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 shall 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 that 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 L_{70} requirements.

Linear Replacement Lamp Primary Use Designation Changes

Due to the removal of the reference housing testing requirement, Type-C linear replacement lamps with a system configuration of 1-lamp-to-1-external driver will be listed in a new Primary Use Designation titled "1-Lamp External Driver (UL Type C) Lamps". Additionally, Type-C T5HO linear replacement lamps with a system configuration of 2-lamp-to-1-external driver will be listed in a new Primary Use Designation titled "2-Lamp External Driver (UL Type C) Lamps" (that is, this Primary Use will be newly applicable to the T5HO Four-Foot Linear Replacement Lamp General Application). These changes can be seen in Technical Requirements Tables V5.1.

Other Categories (Retrofit Kits, Mogul Screw-Base (E39/E40) Replacements for HID Lamps, and G24q-base Replacement Lamps for CFLs)

For retrofit kits, mogul screw-base (E39/E40) replacements for HID lamps, and G24q-base replacement lamps for CFLs, the DLC will continue using reference housing testing as a necessary evaluation of the performance of these products in a typical end use. To address availability concerns, both the approved housing provisions and the "Option B" pathway for luminaire-specific retrofit kits remains in place. Additionally, the DLC periodically reviews public sources to check that the housings listed on the DLC Approved Housing webpage appear to be available on the market. In cases where they do not appear to be available, the DLC will seek alternative housings and add them to the acceptable reference housing list. The DLC does not endorse any particular manufacturer associated with particular reference housings listed as part of these policy provisions.

Performance requirements for these products remain otherwise as described in other sections of this Technical Requirements document (for light output, efficacy, color, etc.).

V5.1 Additional Reporting Requirements for LM-79, LM-80, and TM-21 Reports

The DLC has introduced new requirements as part of V5.1 that require complete information to be included in LM-79 test reports (information that may not have been required in the past). Additionally, there are new compliance requirements related to TM-21 and its Addendum B to address concerns around projected lumen maintenance claims and current DLC provisions. This section specifies additional reporting requirements for all submitted LM-79, LM-80, and TM-21 reports. Test reports that do not comply will not be accepted.

IES LM-79 (-08 and -19 versions)

SSL products or family groupings shall be tested according to the guidelines in specified ANSI/IES Lighting Measurement (LM) documents. Test reports generated by a test lab that complies with the DLC LM-79 Testing Requirements will be accepted only if all optical and electrical performance are tested and documented as described below. LM-79-08, and -19 versions will both be accepted. All tests shall be conducted at the full output or non-dimmed state.

All submitted photometric test reports must comply with the full LM-79/color report or full LM-79/distribution report definitions below. Configurations tested to produce full LM-79/color reports and full LM-79/distribution reports will be listed as parent products on the QPL with the tested performance data based on the QPL listing information in each applicable section. If a full LM-79/color report and full LM-79/distribution report are provided on the same configuration, the tested performance listed on the QPL will be the worst performing data set.

Test reports that require color performance information (generally expected to be from testing in an integrating sphere, though gonio-spectroradiometer testing is also acceptable) do not require distribution performance information. These color-specific test reports are generally referred to within this V5.1 policy as **"full LM-79/color reports"** and shall include, but are not limited to, the following:

- Electrical characteristics (Wattage, Input Voltage, THD, and PF)
- Total luminous flux
- Efficacy
- Chromaticity ((x,y) and (u',v'))
- CCT and D_{uv}
- ANSI/IES TM-30-18 Full Report (per Annex D, Figure D-3)
- CIE 13.3-1995 complete Color Rendering Index Detail
- Accompanying ANSI/IES TM-27 .spdx files document (IES TM-27-14) with spectral power distribution data from 380-780 nm in ≤5nm increments
    - The product model number shall be present and match in both the TM-27 and LM-79 documents.

All information listed above, except the accompanying ANSI/IES TM-27 .spdx files document, shall be included in a single LM-79 test report. Separate ANSI/IES TM-30-18 reports will not be accepted.

Test reports that require distribution performance information (generally expected to be from testing with a goniophotometer) do not require color performance information. These distribution-specific test reports are generally referred to within this V5.1 policy as **"full LM-79/distribution reports"** and shall include, but are not limited to, the following:

- Electrical characteristics (Wattage and input voltage)
- Luminous intensity distribution (Candela array)
- .ies file (ANSI/IES LM-63-02(R2008)) meeting the following requirements:
    - Test report number, test lab, issue date, manufacturer, and luminaire catalog number are correctly and pertinently indicated using the keywords [TEST], [TESTLAB], [ISSUEDATE], [MANUFAC], and [LUMCAT], respectively.
    - The multiplier field shall only be 1.0, i.e., the candela values shall be from an actual goniophotometer test, and scaled values are not permitted.
    - The luminous intensity data shall be presented using Type C photometry format, except for products in the Primary Use Designations of Flood and Spot Luminaires, which may use the Type B photometry format.
    - The luminous dimensions shall appropriately reflect the luminous opening of the luminaire. See next section, "Additional Guidance on Luminous Dimensions," for additional detailed guidelines. In no circumstances shall the luminous dimensions be zero or exceed the luminaire's physical dimensions, and DLC reviewers will verify the luminous dimensions in the .ies file against the luminaire physical dimensions that are provided either in the specification sheet, LM-79 test report, or as separate application submission materials.
    - The angular resolution for the luminous intensity distribution data shall comply with the scanning resolution specified in LM-79 (Section 9.3.3 in LM-79-08 and Section 7.3.3 in LM-79-19) and be fine enough to accurately characterize the product's intensity distribution. For products with a wide-angle, smooth intensity distribution, the luminous intensity distribution data shall be in a resolution of 5 degrees or less in the vertical plane and 22.5 degrees or less in horizontal planes. A smaller vertical angular increment must be used for products whose luminous intensity changes rapidly as a function of angle.

For LUNA qualification, product image(s) of the tested product showing the optics and shields, if applicable, must be included in the PDF distribution report. (This must be a full LM-79/distribution report in PDF format for the products that have the highest total lumen output for each optical variation across the LUNA family members with the highest qualifying CCT (e.g., 3000K), tested at the maximum (non-dimmed) light output.

Test reports containing only a partial set of LM-79 metrics (for example, an integrating sphere test report without luminous flux reported), will not be accepted for application review purposes. For clarity, even if a test is needed for purposes of verifying chromaticity, it must be a full LM-79/color report as described herein, with all required metrics reported.

- Indoor luminaires with uplight and downlight distributions may be tested such that the uplight and downlight components are measured separately in the goniophotometer, if the goniophotometer mounting structure occludes the uplight or downlight distribution during testing. In the case of separate measurements:
    - The distributions shall then be combined to produce the full LM-79/distribution report, including the .ies file. The data from this .ies file will not be displayed on the QPL.
    - An [OTHER] keyword shall be added to the .ies file header as follows:
        - [OTHER] This photometric file contains combined distribution data from separate measurements.

The DLC reserves the right to require additional information about the separate measurements, and manufacturers should be prepared to provide documentation that addresses concerns that arise.

Additional Guidance on Luminous Dimensions

Per ANSI/IES LM-63-02 (R2008), "[The luminous dimensions] refer to the luminous (that is, light emitting) opening of the luminaire, not its physical dimensions. They are meant to approximate the luminous opening (either as a luminous area or luminous volume) for lighting calculations. … It is assumed that there is only one luminous opening in each IESNA LM-63-2002 data file." Modern SSL luminaires may have more than one luminous opening, and regardless of the number of luminous openings, the width, length and height fields in the .ies file must use one of the luminous shapes available in IES LM-63 to describe the smallest geometry that completely encompasses all of the light emitting surfaces of the product.

For example, for a troffer with a luminous basket, the length, width and height of the entire luminaire must be represented as a rectangle with luminous sides or a rectangle, per Annex D in IES LM-63-02 (R2008). **Figure 2** through **Figure 5** show examples of luminous shapes for luminaires in each General Application.

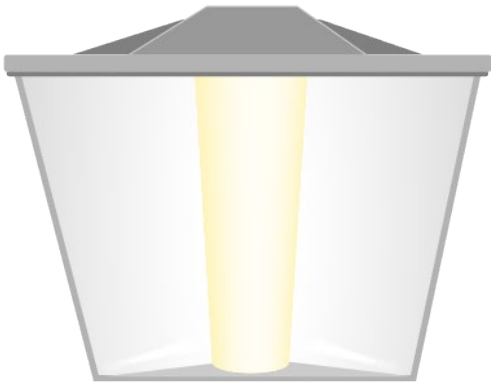

Figure 2: *Isometric view of a troffer with luminous basket and non-luminous panels on each side. The luminous shape would have the width, length and height of the rectangle or rectangle with luminous sides encompassing entire luminaire.*

Figure 3: *Isometric view of a troffer with a luminous basket and luminous panels on each side. The luminous shape would be represented by a rectangle or rectangle with luminous sides encompassing entire luminaire.*

Figure 4: *Isometric view of a linear ambient product with a luminous panel at the bottom. The luminous shape would be represented by a rectangle the size of the luminous panel only. If the sides were luminous, a rectangle with luminous sides would be used.*

Figure 5: *Isometric view of a high bay product with LEDs on the underside. The luminous shape would be represented by a 2D luminous circle, with length and width elements represented as negative values of the respective diameter (see LM-63 for details). If the luminous surfaces were on the sides as well, a vertical cylinder or rectangle with luminous sides would be used instead.*

Additional Reporting Guidelines: Photometric Software in Application Review

During the application review process, DLC reviewers will use Photometric Toolbox (Lighting Analysts, Inc, version 2.7 or newer) to calculate ZLD, SC, BUG ratings (for Outdoor Luminaires only) and UGR threshold values (for Premium and Efficacy Allowance pursuance in appropriate categories) from the tested .ies files.

IES TM-21-11 and its Addendum B and the transition to ANSI/IES TM-21-21 and the ANSI/IES TM-21 calculator

SSL products or family groupings shall project long term lumen maintenance according to the guidelines in specified ANSI/IES TM-21-11 documents and current addenda OR ANSI/IES TM-21-21. Long term lumen maintenance projections will be accepted only if fully compliant with TM-21-11 and its Addendum B OR ANSI/IES TM-21-21. This includes, but is not limited to, the following:

- Luminous flux data collection and selection (section 4.3 and 4.4)
- Data used for the curve-fit (section 5.2.3)
- Temperature data interpolation (section 6.0)
- Limit for Extrapolation (section 6.5) Or Limit for Projecting Flex Maintenance (section 5.2.7)

The DLC is making an exception to allow uneven interval reporting for TM-21 projections drawing from an LM-80 report initiated prior to March 31, 2015, one year after the introduction of even intervals in Addendum A to TM-21. Otherwise, TM-21 projections not fully compliant with Addendum B revisions or ANSI/IES TM-21-21 will not be accepted. A complete and accurate copy of the December 31, 2023 version of the ENERGY STAR TM-21 calculator OR a complete and accurate copy of the ANSI/IES TM-21 Calculator report in both PDF and JSON format is required for submission, and will suffice in meeting the above requirements, unless uneven interval reporting is used for TM-21 projections. In cases where uneven intervals are used, the February 08, 2016 version of the ENERGY STAR TM-21 calculator shall be used. In no case will the DLC allow uneven intervals of <250 hours.

Additionally, under V5.1, the DLC will require LM-80 sets to be sufficient for projecting to the require lumen-maintenance hours via TM-21 rules alone in order to demonstrate compliance with the L_{70} lumen maintenance requirement. Products with LM-80 sets insufficient to do so will be ineligible for qualification. To clarify, projections shall not extend beyond 6 times the test duration for 20 or more samples (5.5 times for 10 to 19 samples).

- For example, LM-80 sets used to project to 50,000 hours are required to demonstrate a test duration of ≥ 8,333.33 hours for 20 or more samples.

Definitions

Unless otherwise noted, the terms in this policy directly reference the definitions from the Illuminating Engineering Society (IES) *ANSI/IES LS-1-22: Nomenclature and Definitions for Illuminating Engineering*[11], and, where applicable, the International Commission on Illumination (CIE) *CIE S 017/E:2011 ILV: International Lighting Vocabulary*[12], with key deviations noted below.

Definitions: General

Explanations below reference specific terms used by the DLC in the application process or policy documents.

- **Technical Requirements Tables (TRT):** The Technical Requirements Tables are a complete set of minimum technical specifications that products must meet to be qualified on the DLC QPL. TRTs can be found on the DLC website.[13]
- **Parent Product:** Products for which test data including lumen output, efficacy, UGR (if applicable), BUG rating (if applicable) is listed on the QPL. Note that these products have both tested and reported data.
- **Child Product:** Products for which test data is not listed on the QPL.
- **Bare Lamp**: DLC uses the term Bare Lamp to represent the performance of replacement lamp when operated outside of a luminaire or retrofit kit, including a ballast for Type A or driver for Type C.

Definitions: Spectral Quality

Explanations below reference the DLC's understanding of definitions as used by the industry.

- **Spectral Power Distribution (SPD):** Describes the power emanating from a light source as a function of wavelength. The information can be presented graphically or as a numerical table.
- **Color Rendition (of Objects):** Effect of an illuminant on the color appearance of objects by conscious or subconscious comparison with their color appearance under a reference illuminant.
- **Color of Light**
  - **Chromaticity:** The aspects specified by the chromaticity coordinates of the color. It describes the color of the emitted light, independent of its intensity.
  - ***D*uv:** A signed measure of the distance from the blackbody locus in the CIE 1960 (u, v) color space. A positive D_{uv} indicates that the chromaticity of the light is above the

[11] ANSI/IES LS-1-22: Nomenclature and Definitions for Illuminating Engineering
[12] CIE S 017/E:2011 ILV International Lighting Vocabulary
[13] https://www.designlights.org/solid-state-lighting/qualification-requirements/technical-requirements/

blackbody locus (on the green side). A negative D_{uv} means the chromaticity is below the blackbody locus (on the blue/pink/purple side).

- **Correlated Color Temperature (CCT):** The thermodynamic temperature of a blackbody whose chromaticity most nearly resembles that of the light source. Expressed in kelvin (K).
- **Color Maintenance:** A product's ability to maintain a specific chromaticity over time. This is the spectral corollary to luminous flux maintenance, which describes depreciation in luminous flux over time.

Definitions: Light Distribution and Discomfort Glare

- **Discomfort Glare**[14] is glare that produces discomfort. It does not necessarily interfere with visual performance or visibility.

  Other definitions of discomfort glare include:

  - Discomfort glare is a sensation of annoyance or pain caused by high luminance in the field of view. Four factors are known to participate in the perception of discomfort glare: Luminance of the glare source, Size of the glare source, Position of the source in the field of view, Luminance of the background (10th edition of the IES Handbook, Chapter 4.10.1.)

- **Unified Glare Rating (UGR)** is a measure of the discomfort produced by a lighting system along a psychometric scale of discomfort.[15]
  - The Unified Glare Rating formula is a discomfort glare likelihood assessment method developed, published, and recommended by the CIE in 1995. The UGR formula produces a glare rating which is a psychophysical parameter estimating the discomfort in response to glare in a visual environment containing light sources. The practical UGR range is from 10 to 30 with most lighting systems producing values in that range. A high value indicates likelihood of significant discomfort glare, while a low value indicates little likelihood of discomfort glare.[16]
  - The development of UGR predated the application of LEDs in general lighting, and studies have reported that the original UGR formula tends to underestimate the discomfort sensation provoked by the highly non-uniform source luminance from some LED luminaires. A correction term to the original UGR formula was consequently formalized in a CIE report in 2019 taking into consideration the effects of non-uniform glare sources.[17] Due to the recency of this new development, UGR in the remainder of this policy refers to the 1995 UGR formula, and the DLC will consider adopting UGR with the correction term in future updates when standards are available.

[14] ANSI/IES LS-1-22 5.9.11.5.
[15] ANSI/IES LS-1-22 Definitions and Nomenclature 5.9.11.5.8
[16] CIE 117-1995 Discomfort Glare in Interior Lighting
[17] CIE 232-2019 Discomfort Caused by Glare from Luminaires with a Non-Uniform Source Luminance

- **Uncorrected UGR Table**[18] refers to a set of UGR values of the luminaire tested based on pre-set room definitions and a luminous flux of 1000 lumens, as defined in CIE 190-2010. The data are provided for 19 standard room shapes with 5 different combinations of room surface reflectance. For application of the uncorrected UGR table, the values must be corrected to the actual luminous flux in the luminaire.
- **Corrected UGR Table** refers to a set of UGR values presented in the same format as the uncorrected UGR table with the same pre-set room definitions but corrected using the total luminous flux of the luminaire.
- **BUG Rating**[19] is the IES Luminaire Classification System (LCS) that defines the distribution of light from a luminaire within three primary solid angles: forward light, backlight and uplight. These are further divided into ten secondary solid angles as described in IES TM-15-11. The BUG rating is then determined using Addendum A for IES TM-15-11 according to a luminaire's lumen output within the secondary solid angle zones as defined in the document.
- **(Bare Lamp) 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.

Definitions: Controllability

This policy references three areas of controllability: dimming (stepped and continuous), integral controls, and control communication.

- **Dimmable**: a product that (a) includes a dimmable driver and/or is capable of being dimmed by an external control signal, and (b) is identified as dimmable on the product specification sheet.
- **Continuous Dimming**: Per NEMA LSD-64: *a lighting control strategy that varies the light output of a lighting system over a continuous range from full light output to a minimum light output without flickering in imperceptible steps. To achieve the perception of smooth transitions, one hundred or more steps are required.* Continuous dimming shall be capable of reducing the light output to at least 20% of full light output.
- **Stepped Dimming**: Per NEMA LSD-64: *a lighting control strategy that varies the light output of a lighting system in one or more predetermined steps of greater than one percent of full output. The changes between levels are generally perceptible.* Stepped dimming shall be capable of reducing the light output to at least 70% of full light output.
- **Integral Controls**: The capability to have sensing and/or control of light output directly integrated or embedded into the lamp or luminaire and available as an option within the lamp or luminaire product model number.

[18] CIE 190-2010 Calculation and Presentation of Unified Glare Rating Tables for Indoor Lighting Luminaires
[19] IES TM-15-11 Luminaire Classification System for Outdoor Luminaires and Addendum A for IES TM-15-11: Backlight, Uplight, and Glare (BUG) Ratings

- **Control Communication**: The method and capability of a lighting system to receive and implement commanded changes to the operation, dimmed state, color setting, timing, etc.

Policy Clarifications and Updates

As the DLC processes applications for V5.1 and interacts with stakeholders, we encounter opportunities for minor corrections, terminology clarifications, and policy interpretations. In order to be as transparent as possible, the V5.1 Policy documents will be updated as needed, and the changes will be tracked in the table below and on the DLC website. **Table 14** shows the corrections or clarifications and where they can be found in the document.

Table 14: *Corrections and clarifications published as needed*

Date updated	Subject	Change Type	Description	Affected Page(s)
01/23/25	TM-21	Link update	In response to ENERGY STAR retiring its TM-21 calculator, the DLC intends to transition away from all pathways requiring ENERGY STAR TM-21 calculators to requiring use of the ANSI/IES TM-21 calculator. ENERGY STAR pathways are acceptable throughout V5.1.	42
11/19/24	Approved Housings	Policy Change	Approved Housings and Pre-Approved Equivalents list on the website was combined into “Approved Housings”	37
6/11/2024	Definitions	Correction	Corrected references to ANSI/IES RP-16-17 to ANSI/IES LS-1-22	44, 45
5/13/2024	LUNA clarifications, TM-21 requirements, DLC Glossary language alignments	Clarifications, Policy Change	Addition of references to the LUNA program. Addition of language to allow use of the IES TM-21 calculator for submissions. Minor language adjustments to align with the DLC glossary, corrected an incorrectly ordered instance in the change log.	11, 13, 24, 25, 27, 37, 38, 42, 45
11/30/2022	Approved Housings	Correction	The link to the approved housings page was incorrect. Correct link was swapped in.	35
10/19/2022	LM-79 Distribution Reports	Policy Change	Describes a method by which the uplight and downlight components of indoor luminaires may be measured separately in a goniophotometer and combined into a single LM-79 report.	37, 38
4/15/2022	Integral Control Sensor Options	Policy Change	Adds “Ambient Light” as an acceptable term for daylight sensors.	23
2/23/2022	Special Considerations for Dimmable Lamps	Policy Change	Adds a requirement for Type A T8 8’ lamps claiming to be dimmable via a wired protocol. Due to a lack of dimmable ballasts for T8 8’ lamps, The DLC will not accept T8 8’ lamps that claim wired dimming capability via direct input from the ballast.	20, 21
2/8/2022	Special Considerations for Dimmable Lamps	Policy Change	Shortens the name of the communication protocol classification for Type B dimmable	21

Date updated	Subject	Change Type	Description	Affected Page(s)
			lamps using an external device to receive a wired control signal.	
11/19/2021	Integral Control Sensors	Clarification	Generalizes the Multifunction Sensor category to include functions other than Occupancy + Daylight.	19
10/15/2021	Color Maintenance Testing	Clarification	Adds description of the appropriate drive current to be used for the LM-80 data set.	10
9/20/2021	Color Rendering Notation	Clarification	Changes the notation of R_a to include (CRI) for clarity.	7, 8, 28, 29, 32
9/20/2021	Beam Angle Tolerance	Clarification	Clarifies the PUDs applicable to the beam angle tolerance requirement.	14, 32
6/23/2021	Multifunction integral controls	Clarification	Broadens the types of controls that can be categorized as multifunction.	22
6/23/2021	Phase cut control communication	Clarification	Revises Power Line/Phase-Cut communication types to only include products that specifically use phase-cut. Products communicating via Power Line are listed as “Wired Other.”	24
5/5/2021	Filtering for BUG on the QPL	Clarification	More information on how to find BUG Ratings on the QPL.	14
5/5/2021	Acceptable terms for dimming	Clarification	To meeting dimmability requirements Specification sheets do not explicitly need to state "dim", "dimmable", or "dimming"; using terms from **Table 9** is acceptable.	18
5/5/2021	Examples of calculating UGR	Clarification	Clarified how to calculate UGR for basket type troffers.	38
5/5/2021	Special Considerations for Dimmable Lamps	Clarification	Clarifies how UL Type B lamps using an external device to dim will be complete application form.	20
5/5/2021	Color Rendition Tolerances	Clarification	More clearly lists out tolerances to color rendition.	31
3/17/2021	Special Considerations for Dimmable Lamps	Policy Change	Because lamps are most often used in retrofit applications, there are special considerations needed to ensure end users can dim lamps as desired. The policy change requires more of Type B lamps that claim to be dimmable with wired protocols.	20, 21
1/22/2021	Linking SPDX information to LM-19	Clarification	In order to link TM-27 and LM-79 documents, the following language has been added: “The product model number shall be present and match in both the TM-27 and LM-79 documents”.	36
1/22/2021	IES Rcs,h1 tolerance	Correction	IES Rcs,h1 tolerance corrected from "-1%" to "+/- 1%".	33

Date updated	Subject	Change Type	Description	Affected Page(s)
1/22/2021	Products required to meet Beam Angle	Correction	2G11 base replacement lamps must also meet Beam Angle requirements, along with linear replacement lamps.	13, 15, 16, 34
11/13/2020	Products with UGR < 10	Clarification	Original version did not indicate what bin to use when a product has UGR values lower than the listed range: if a product has a UGR less than 10.0, it will fall in the 10.0-12.9 bin.	17, 26, 30
10/15/2020	Acceptable Integral Control Terms	Clarification	Broadens acceptable terms on the Product Spec Sheet or Supplemental Literature.	21
10/15/2020	Definition of Multi-function integral controls	Clarification	Multifunction integral controls are an interior control capability.	21
10/15/2020	Color testing if minimum color rendition was not captured	Clarification	The DLC requires that color testing be conducted on the worst-case CCT, CRI, and efficacy variations, which is likely the combination of lowest CCT and highest color rendition. If the overall minimum color rendition option was not captured in any LM-79/color report above, this configuration must be tested.	9
10/15/2020	Efficacy allowances for FALD products	Clarification	While FALD products are not eligible for efficacy allowances related to discomfort glare, they are eligible for other allowances.	32
9/1/2020	Electrical testing in full LM-79/ distribution reports	Policy Change	Some goniophotometers do not have the ability to measure/report total harmonic distortion (THD). As such, THD as well as Power Factor will not be tested as part of the full LM-79/distribution reports.	36, 37
8/20/2020	Outdoor R_9 Requirements	Policy change	The R_9 requirement for outdoor products has been changed from a required threshold to a reporting requirement only. High-bay products must still meet $R_9 \geq -40$.	8
7/30/2020	Color Maintenance reporting requirements	Guidance added	LM-80 reports may not include absolute D_{uv} information for each reporting interval, but only the change in D_{uv} from 0 hours. Guidance has been added to the policy document and Manufacturer Guidance that describes how to report maintenance in the case that average chromaticity coordinate data at the ≈ 1000-hour and ≈ 6000-hour measurement points are not provided and only chromaticity shift (Δu'v') data is available.	10
6/17/2020	White-tunable testing requirements	Clarification	Clarified requirements around testing and reporting at various CCT settings for all white-tunable products; not just DLC Premium.	11

Date updated	Subject	Change Type	Description	Affected Page(s)
6/17/2020	Range of continuous dimming capability	Clarification	Original versions of the V5 policy documents were not clear about designating the range of continuous dimming capability, in which the options were "Above 10%, Below 10%." This version of the document clarifies the options as "*Above 10%, Less than or equal to 10%.*"	17
6/17/2020	Expanded rationale regarding dimming requirements	Clarification	The V5.0/V5.1 dimming policy enhances controllability and ensures that products listed on the QPL have the capability to be dimmed and are marketed as such. The DLC does not set requirements regarding how qualified dimmable products are installed and/or used in the field.	18
6/17/2020	"Bare lamp" terminology	Clarification	Language has been added to clarify that the term "bare lamp" represents the performance of replacement lamps when operated outside of a luminaire or retrofit kit, including a ballast for Type A or driver for Type C. The Linear Replacement Lamps policy has also been updated to reflect this change.	41
6/17/2020	Full LM-79/color report and full LM-79/distribution report instructions	Clarification	Clarifications have been added around submitting photometric test reports to comply with the full LM-79/color report or full LM-79/distribution report definitions.	36, 37
6/17/2020	Scaled vs. reported tab terminology	Correction	The SSL application form has a tab called the "Reported Performance Table." The original version of the V5.1 policy document referenced the "Scaled Performance Table." The correct terminology is "Reported Performance Table."	Through-out