



LUNA Technical Requirements Version 1.0



Final Version

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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.



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Foreword

About the DLC

The DLC is a non-profit organization improving energy efficiency, lighting quality, and the human experience in the built environment. We collaborate with utilities, energy efficiency programs, manufacturers, lighting designers, building owners, and government entities to create rigorous criteria for lighting performance that keeps up with the pace of technology. Together, we're creating solutions for a better future with better lighting.

The [DLC Solid-State Lighting \(SSL\) Technical Requirements](#) define product performance requirements for commercial and industrial lighting products listed on the [DLC SSL Qualified Products List \(QPL\)](#). This list is used by DLC member programs across the US and Canada to designate SSL products eligible for energy efficiency incentives and rebates. Similarly, the [DLC Networked Lighting Controls \(NLC\) Technical Requirements](#) define requirements for commercial and industrial networked lighting control systems on the [DLC NLC QPL](#); and the [Horticultural Lighting Technical Requirements](#) define requirements for LED lighting on the [DLC Horticultural Lighting QPL](#) for controlled environment agriculture. The energy efficiency programs that use these lists play a pivotal role in the replacement of incumbent lighting technologies with better performing and more energy efficient solutions to help their customers save energy and meet carbon reduction goals.

In addition to energy efficiency programs sponsored by electric utilities and state and provincial governments, the DLC's SSL QPL and Technical Requirements are used by multiple U.S. government facilities' specifications. The General Services Administration's (GSA) [P100 Facilities Standards for the Public Buildings Service](#) requires LED luminaires to be qualified to DLC SSL Premium and the [Department of Defense Unified Facilities Criteria](#) requires that LED roadway luminaires be DLC listed. In addition, the [Federal Energy Management Program \(FEMP\)](#) requires that indoor troffers, linear ambient, and high bay luminaires meet the product qualification criteria listed in Table 4.4. of the DLC SSL V5.0 Technical Requirements.

This LUNA V1.0 document lists supplemental requirements for a classification of qualified outdoor commercial and industrial luminaires that not only meet the SSL V5.1 requirements for energy efficiency and lighting quality, but also have attributes that help limit light pollution, sky glow, and light trespass. LUNA qualified products will help cities and communities meet dark sky policies and ordinances; will help specifiers fulfill the light pollution and trespass requirements in LEED and WELL; and will help projects following the application guidance in the [Joint IDA-IES Model Lighting Ordinance \(MLO\)](#). LUNA is a qualification granted to luminaires that meet both the SSL V5.1 and LUNA requirements. LUNA luminaires will be listed on the SSL V5.1 QPL and will be differentiated by a LUNA designation and product logo. This means that LUNA luminaires will be eligible for efficiency rebates and incentives designed for SSL V5.1 products.



Limits of this Document

LUNA qualified products that meet the technical requirements defined in this document may help limit light pollution, sky glow, and light trespass when used appropriately. However, this document only contains requirements for white-light LED outdoor products within the scope of the LUNA program, which does not include some types of outdoor lighting products. Examples of products outside of the scope of the LUNA program include:

- Non-white-light (e.g., amber) luminaires that may be appropriate for some outdoor applications (such as environmentally sensitive areas and areas or communities near observatories) even though these products are not included in the LUNA requirements and are not currently eligible for listing under SSL V5.1.
- Floodlights, which do not have a LUNA qualification pathway, could yield desirable results when aimed down at the ground, but undesirable results when aimed improperly up at the sky or into windows on an adjacent property.

White-light product categories (such as floodlights), for which appropriate project-specific design and installation is essential to avoid light pollution, are not included in the LUNA requirements, but are eligible for listing under the SSL V5.1 requirements. In addition, BUG criteria are reported under SSL V5.1; therefore, the V5.1 QPL can be searched for BUG values of non-LUNA luminaires if they are of interest to a QPL user. Non-LUNA outdoor products such as these, as well as non-white-light luminaires, may be used to mitigate light pollution by applying appropriate project-specific design, as outlined in the following section “Dark Sky Design Guidance”.

Dark Sky Design Guidance

When using product types that are not eligible for LUNA, appropriate project design and implementation is essential to avoid over-lighting and to achieve relatively low sky glow and light trespass. Design and application guidance is available from the Illuminating Engineering Society (IES), which offers many application documents that address light pollution, including the [Joint IDA-IES Model Lighting Ordinance \(MLO\)](#), [ANSI/IES LP-2-20](#), [LP-10-20](#), [LP-11-20](#), and [RP-33-14](#) (content recently moved to [ANSI/IES LP-11-20](#), and soon to BSR/IES RP-43-2x). In particular, [ANSI/IES TM-37-21](#) provides “guidance on means of reducing human contributions to light in the night sky and information on estimating the relative effectiveness of the different options available.” Also, [ANSI/IES RP-8-18](#) describes recommended practices to design lighting for roadways and parking facilities, which will be updated shortly.

The DLC recommends that, when possible, a qualified lighting professional assist in designing and implementing a complete project that minimizes light pollution. Additionally, in all cases, the DLC recommends that stakeholders consider “Five Principles for Responsible Outdoor Lighting” developed by the IES and IDA (International Dark Sky Association), as shown in **Figure 1** below.




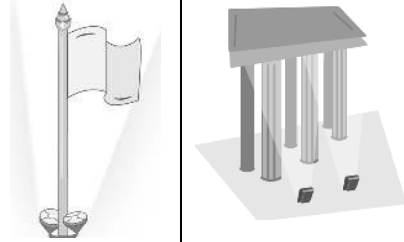


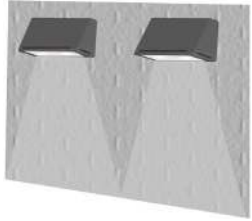
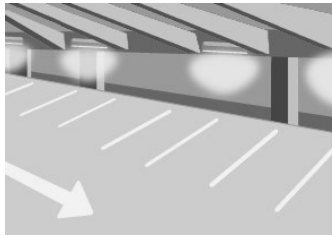

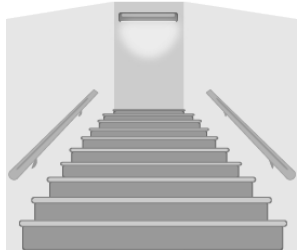

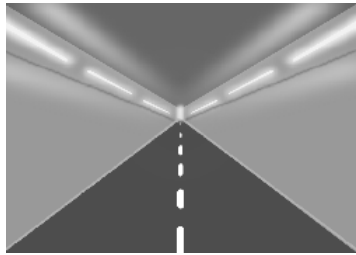
Figure 1: Five Principles for Responsible Outdoor Lighting (© IES/IDA)

Scope of LUNA Requirements

Table 1 provides an overview of products and light source CCT ranges that are in scope and out of scope of the LUNA Version 1.0 requirements. This is not a comprehensive list of products eligible and ineligible for LUNA. **Table 2** provides a complete list by Primary Use Designation (PUD) of eligible products. Floodlights, replacement lamps, and retrofit kits are not included in LUNA because these products require especially careful project design and installation to mitigate light pollution, and project-level application design is beyond the scope of a list of qualified products. Luminaires for parking garages, stairwell/passageway, and tunnels are not included because uplight is typically blocked and contained by the supporting structures and tunnels. White light is included because standardized metrics are readily available; non-white light is out of scope in this release because standardized metrics are in development.

Readers curious about the complete list of SSL Primary Use Designations (PUDs) included in the DLC SSL V5.1 Technical Requirements can find the list on the DLC website [here](#).

Table 1: Outdoor luminaires and LED source types included and not included in LUNA

Included in LUNA V1.0		Not Included in LUNA V1.0	
Pole/Arm-Mounted Area and Roadway Luminaires		Floodlights	
Pole/Arm-Mounted Decorative Luminaires		Replacement Lamps and Retrofit Kits	
Full-Cutoff Wall-Mounted Area Luminaires		Parking Garage	
Canopy		Stairwell	
Bollards		Tunnel	
White Light	CCT 2200K – 3000K	Non-white Light	Phosphor-converted amber, narrowband emitters such as amber, CCT below 2200K, etc.

LUNA Qualification in Policies and Regulations

Any policies, regulations, or owner's project requirements (OPR) referring to requirements for LUNA qualified products should consider including language such as the following:

“DLC LUNA qualified luminaires shall be used for all outdoor lighting projects requiring white light with CCT between 2200K and 3000K. When LUNA luminaires are not appropriate for a particular application, luminaires qualified under DLC SSL V5.1 shall be used. Non-DLC qualified luminaires may be used when the lighting designer deems it necessary to meet project design objectives. In all circumstances, best efforts must be made to use products that are efficient and controllable; limit uplight, light trespass, and glare; and provide the appropriate spectrum for the application. IES guidelines and recommended practices shall always be followed. All lighting product decisions shall be made by a qualified lighting professional and shall be approved by the owner or the owner's representative.”

Introduction

The DLC LUNA Technical Requirements are designed to mitigate negative impacts of outdoor lighting at night. By establishing requirements and reporting standards on light distribution, spectral characteristics, and controllability, LUNA will identify energy efficient luminaires that minimize light pollution, provide appropriate visibility for people, and limit negative impacts to the environment.

These goals are consistent with the IES/IDA Five Principles of Responsible Outdoor Lighting, shown in **Figure 1** above. The goals are generally compatible with the following guidance from [ANSI/IES TM-37-21](#) to reduce sky glow. [TM-37-21](#) recommends that lighting designs:

1. Eliminate unnecessary lighting (most important).
2. Eliminate uplight.
3. Reduce lumen output, both by reducing the initial lumen package and by dimming.
4. Control spectral content, while considering energy use and color rendering ability, and
5. Set appropriate expectations, by considering each light source's relative contributions in the application.

Goals of LUNA

The DLC LUNA requirements are intended to mitigate negative impacts of outdoor lighting at night by establishing luminaire performance specifications with the following goals:

- **Minimize lighting energy use.** In addition to meeting the efficacy thresholds of the DLC's SSL V5.1 Technical Requirements, LUNA qualified products must meet additional dimming, control, and shielding requirements to ensure efficient use of lighting energy. These thresholds will help efficiency programs meet or exceed their energy savings goals and end users reduce operational costs.
- **Minimize light pollution.** The LUNA program introduces requirements for light distribution, correlated color temperature (CCT), and dimming controls that ensure less light is scattered into the atmosphere, resulting in reduction of light trespass and sky glow, and darker skies for stargazers, astronomers, and wildlife.
- **Provide appropriate visibility for people.** The LUNA program incorporates all SSL V5.1 spectral quality requirements, BUG reporting requirements, and additional spectral power distribution and intensity distribution reporting requirements, enabling lighting installations to meet recommended practices and voluntary guidelines for dark-sky best practices.

The DLC LUNA Qualification and Logo

Products with the LUNA qualification (referred to as LUNA products) will be listed on the DLC Solid-State Lighting Qualified Products List. LUNA products can be classified as either DLC Standard or DLC Premium, and will be eligible to use the DLC LUNA logo, which will be provided for use to identify qualified LUNA



products. As with other DLC logos, all stakeholders must use the DLC logos and trademarks consistently and in compliance with [published guidelines](#) in all communication and marketing materials.



Eligibility

Only outdoor luminaires that fall into the Primary Use Designations (PUDs) listed in **Table 2** are eligible for LUNA qualification under Version 1.0. At this time, replacement lamps and retrofit kits are not eligible for LUNA because the lighting distributions for these products are highly dependent on application and installation. Specialty designation hazardous luminaires are eligible for LUNA qualification as noted in the table below, and are exempt from the dimming requirements. All product options within a LUNA qualified model number must meet the LUNA requirements. Model numbers with options that do not meet the LUNA requirements are not eligible for LUNA qualification.

Aimable luminaires, whether floodlights or area lighting with tiltable mounting brackets, may increase sky glow, discomfort glare, and light trespass, which are undesirable lighting qualities from both a light pollution perspective and for typical use cases. Therefore, floodlights are ineligible for LUNA qualification, and roadway and area lighting products with mounting brackets that allow tilt angles of more than +/- 10 degrees are ineligible for LUNA qualification. Tilt of 10 degrees or less will allow these luminaire types to be aligned parallel with the roadway surface.

Table 2: DLC SSL Primary Use Designations (PUDs) eligible for LUNA Version 1.0 qualification

Primary Use Letter	Primary Use Designations Eligible for LUNA Qualification
A	Outdoor Pole/Arm-Mounted Area and Roadway Luminaires
B	Outdoor Pole/Arm-Mounted Decorative Luminaires
C	Outdoor Full-Cutoff Wall-Mounted Area Luminaires
E	Bollards
G	Fuel Pump Canopy Luminaires
n/a	Specialty: Hazardous Area Lighting
	Specialty: Hazardous Outdoor Pole/Arm-Mounted Area and Roadway Luminaires
	Specialty: Hazardous Wall Mounted Luminaire
	Specialty: Canopy Lighting
	Specialty: Directional Fuel Pump Canopy Luminaires
	Specialty: Transportation

Definitions

The following terms are used by the DLC in the LUNA requirements documents and/or application process documentation:

- **Continuous dimming:** 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. (NEMA LSD-64-2019)
- **Light pollution:** The combination of all the adverse or obtrusive effects of electric light that produces artificial sky glow, including:
 - Unnecessary, unwanted, or wasted light
 - Light that damages or degrades the nighttime environment
 - Light that negatively impacts humans and other species ([ANSI/IES LP-11-20](#))
- **Light trespass:** The encroachment of light, typically across property boundaries, causing annoyance, loss of privacy, or another nuisance. Also called spill light or obtrusive light. ([ANSI/IES LS-1-20](#))
- **Rayleigh scatter:** The dispersion of electromagnetic radiation by particles much smaller than the wavelength of the radiation. The amount of scatter varies inversely as the fourth power of the wavelength, resulting in short wavelengths being scattered far more than longer wavelengths. ([ANSI/IES LS-1-20](#))
- **Receptacle ([ANSI C136.41-2013](#)):** Defines the mechanical and electrical interface between an outdoor LED luminaire and a photocell, typically mounted on top of the luminaire. The dimensions of the receptacle are roughly 1.5” high x 2.5” diameter.

- **NEMA 5-pin:** The 5-position receptacle has three line-voltage power contacts plus two dimming/signal contacts.
- **NEMA 7-pin:** The 7-position receptacle has three line-voltage power contacts plus four dimming/signal contacts. The 7-pin configuration supports field upgrades of the control capabilities of LED luminaires by adding or changing wirelessly networked controllers with sensing and communication abilities.
- **Receptacle ([ANSI C136.58-2019 \(Zhaga Book 18\)](#)):** Defines the mechanical and electrical interface between an outdoor LED luminaire and modules for sensing and communication. The data interface is defined by the digital [D4i/ANSI C137.4](#) standard. The specification supports field upgrades of the control capabilities of LED fixtures by adding or changing 24V modules that provide sensing and communication abilities. The dimensions are roughly 1.1” high x 1.5” diameter.
- **Shield:** Shields are used to minimize light trespass onto adjacent areas. A shield is an internal or external opaque structure that obstructs the backward, forward, or side light distribution in a specific solid angle produced by the shield angle and azimuth. A house-side-shield (HSS) prevents some amount of high angle light from spilling backward behind the luminaire. A front-side-shield (FSS) prevents some amount of high angle light from being emitted towards the street-side. A cul-de-sac-shield (CSS) prevents some amount of high angle light from spilling backwards and sideways. Other shield types may be offered by manufacturers – such as left-side-shields (LSS) and right-side-shields (RSS) – that do not qualify for efficacy allowances.
- **Shield type subgroup:** Shields typically reduce luminaire efficacy due to light absorption, so they may be eligible for an efficacy allowance based on distribution performance. Shield type subgroups eligible for LUNA efficacy allowances are house-side shields (HSS), cul-de-sac shields (CSS), and front-side shields (FSS), provided that the zonal lumen differences between the shielded and unshielded version meet the requirements noted in the allowance section. Shield type subgroups cannot be combined. A HSS subgroup, for example, can only contain products with house-side shields, not cul-de-sac shields or front-side shields. Other shield types can be used to meet the requirement that a roadway/area/decorative product must have a shield option/accessory; however, they are not eligible for a shielding efficacy allowance.
- **Sky glow:** The brightening of the night sky that results from the scattering and reflection of light from the constituents of the atmosphere (gaseous molecules and aerosols), in the direction of the observer. It has two components: natural sky glow and artificial sky glow. ([IES LS-1-20](#))

Relationship between DLC SSL V5.1 Technical Requirements and LUNA Technical Requirements

To attain DLC LUNA qualification, products must meet the [SSL V5.1 Technical Requirements](#) as a baseline, in addition to the LUNA Technical Requirements outlined in this document. Efficacy allowances are provided for cases where efficacy is compromised due to using shielding in a luminaire. In other

words, LUNA creates allowances for efficacy where efficacy is compromised due to enhanced dark sky attributes, such as shielding used to minimize light trespass or uplight.

The requirements for SSL V5.1 outdoor luminaires are summarized for the reader’s convenience in **Table 3**, below. The complete SSL V5.1 Technical Requirements can be viewed on the [DLC’s website](#), and apply to indoor and outdoor luminaires, retrofit kits, and replacement lamps.

The “Overview of LUNA V1.0 Requirements” column in **Table 3** describes additional requirements that a product must meet to attain LUNA qualification.

Table 3: Overview of existing DLC SSL V5.1 Technical Requirements and additional LUNA requirements for outdoor luminaires

Topic	Summary of SSL V5.1 requirements for outdoor luminaires	Summary of LUNA V1.0 requirements in addition to or different from SSL V5.1 requirements
Light Output and Efficacy	<ul style="list-style-type: none"> • Minimum light output by General Application and PUD • Minimum efficacy: <ul style="list-style-type: none"> ○ Standard: 105 lm/W ○ Premium: 120 lm/W • Efficacy allowances are available for luminaires with low CCT ($\leq 2700\text{K}$) and/or high color rendition 	<ul style="list-style-type: none"> • Efficacy allowances are available for shielded luminaires, per Table 11 • Efficacy allowance of 25% for bollards
Light Distribution	<ul style="list-style-type: none"> • Zonal lumen distribution requirements by PUD • BUG ratings reported 	<p>Highlights from Table 4:</p> <ul style="list-style-type: none"> • Required U Ratings from BUG, per Table 5 • Shield option or accessory required to be available • Maximum allowable tilt of +/- 10 degrees • Images of luminous intensity distribution will be shown on QPL

Topic	Summary of SSL V5.1 requirements for outdoor luminaires	Summary of LUNA V1.0 requirements in addition to or different from SSL V5.1 requirements
Spectral Quality	<p>Color Rendition:</p> <ul style="list-style-type: none"> • Option 1: ANSI/IES TM-30-18: <ul style="list-style-type: none"> ○ IES $R_f \geq 70$ ○ IES $R_g \geq 89$ ○ $-18\% \leq \text{IES } R_{cs,h1} \leq +23\%$ • Option 2: CIE 13.3-1995: <ul style="list-style-type: none"> ○ $R_a \geq 70$ ○ Report R_9 <p>Correlated Color Temperature (CCT):</p> <ul style="list-style-type: none"> • 2200K – 6500K <p>Color Maintenance:</p> <ul style="list-style-type: none"> • Maximum chromaticity shift ($\Delta u'v'$ ≤ 0.007) 	<p>Highlights from Table 6:</p> <p>SPD Data:</p> <ul style="list-style-type: none"> • Image and .spdx file available on QPL <p>Correlated Color Temperature (CCT):</p> <ul style="list-style-type: none"> • 2200K - 3000K
Controllability	<ul style="list-style-type: none"> • Continuous or stepped dimming required • Integral control sensors and capabilities reported • Communication protocols reported 	<p>Highlights from Table 7, Table 8, and Table 9:</p> <ul style="list-style-type: none"> • Continuous dimming capability to $\leq 20\%$ of max output power required • More detailed reporting of the dimming standard protocol required • Additional types of integral control capabilities are available for reporting • Additional communication standard protocols are available for reporting
Lumen Maintenance	<ul style="list-style-type: none"> • Standard: $L_{70} \geq 50,000$ hours • Premium: $L_{90} \geq 36,000$ hours 	<ul style="list-style-type: none"> • Same as SSL V5.1
Electrical Performance	<ul style="list-style-type: none"> • Minimum Power Factor (PF): ≥ 0.90 • Maximum Total Harmonic Distortion (THD): $\leq 20\%$ 	<ul style="list-style-type: none"> • Same as SSL V5.1
Warranty	<ul style="list-style-type: none"> • Minimum warranty: 5 years 	<ul style="list-style-type: none"> • Same as SSL V5.1

LUNA Version 1.0 Technical Requirements

Scope of Technical Requirements

Version 1.0 of the LUNA Technical Requirements establishes pathways for DLC LUNA qualification for luminaires that minimize light pollution, minimize lighting energy use, and provide appropriate visibility for people. Version 1.0 addresses metrics for light distribution by establishing requirements and reporting standards for distribution; spectral quality by limiting eligible CCTs; and controllability by setting required dimming thresholds using common industry standards – all of which are intended to mitigate light trespass and sky glow.

Some aspects of outdoor lighting are beyond the scope of LUNA Version 1.0 (though may be considered in future revisions). Research and standards for outdoor lighting continue to evolve, and while various effects of outdoor lighting on humans and on other species are the topics of ongoing research, metrics are still under development. As more predictive metrics that address issues such as discomfort glare, sky glow, and the interactions of spectral components with various species at various times of the night and year become standardized, these metrics may be incorporated into future revisions of the LUNA requirements.

Light Distribution Requirements

Rationale

Uplight emitted directly from luminaires is unused light, wasting energy and increasing sky glow ([PNNL-26411](#), [ANSI/IES TM-37-21](#)). In some applications, environmental features such as buildings, trees, canopies, and other surfaces prevent uplight from luminaires and other reflective surfaces from reaching the atmosphere and causing sky glow. However, these features are not present in all applications and no consensus performance model exists that takes surface reflection and obstruction into account. As a result, the LUNA Technical Requirements use prescriptive Uplight (U) Rating thresholds from BUG Ratings (as defined by Annex A in the [ANSI/IES TM-15-20 Luminaire Classification System for Outdoor Luminaires](#)) to set maximum limits on uplight emitted directly (light ≥ 90 degrees) from listed luminaires. PUDs that are typically installed under overhead surfaces, such as fuel pump canopy lighting, are permitted a higher threshold U Rating value, under the assumption that the overhead surface will stop much of the uplight from reaching the sky dome.

BUG ratings have been adopted and are referenced by many national, state and/or local ordinances, regulations, and policies. They are also required by both primary and secondary references such as LEED v4.1, LEED for Cities and Communities, and the WELL Community Standard. BUG rating data published in the *Reported Photometric Performance* section of the DLC SSL QPL product detail page will support compliance with these regulations.

Luminaires with internal or external auxiliary shielding and/or performance optics may improve the quality of the light distribution, as light is only delivered where it is intended, rather than potentially



causing light trespass on neighboring locations. Manufacturers may offer a variety of shielding options such as house-side shields (HSS), cul-de-sac shields (CSS), front-side shields (FSS), left- and right- shields, and glare shields. The DLC acknowledges that luminaire efficacy will be reduced with a shield mounted on the luminaire and is introducing a LUNA shielding efficacy allowance to encourage well-shielded products to be listed on the QPL.

LUNA Requirements for Light Distribution

The following section outlines the LUNA requirements for light distribution.

Table 4 includes columns for the metric or application and its associated requirements. The “QPL Listing” column describes the information that will appear as publicly available on the QPL, if applicable. The “Method of Evaluation” column describes how products will be evaluated for qualification, whether by compliance with industry standards, manufacturer claims, or other DLC verification methodology.

Table 4: LUNA Distribution Requirements

Metric / Application	LUNA V1.0 Requirements	QPL Listing	Method of Measurement/ Evaluation
Uplight Rating (from the IES BUG system)+	<p>Products shall have a U-Rating of 0, 1 or 2, depending on Primary Use Designation indicated in Table 5.</p> <p>ANSI/IES LM-63 .ies files (and optionally ANSI/IES TM-33-18 .xml documents[‡]) containing luminous intensity distribution data shall be submitted for a representative product for each unique distribution pattern included in the application.</p>	<p>BUG ratings for parent products will be generated by the DLC using tested photometric data and will be listed under the Tested Data section. BUG ratings for child products are reported by the applicant and listed under the Reported Data section.</p> <p>The DLC will create a .png image for the tested product to be shown on the QPL, based on the submitted .ies file[‡].</p>	<p>ANSI/IES LM-79 per the <i>Additional Reporting Guidelines</i>.</p> <p>BUG ratings generated per ANSI/IES TM-15-20 Annex A using luminaire photometric data.</p>

Metric / Application	LUNA V1.0 Requirements	QPL Listing	Method of Measurement/ Evaluation
Aiming	Products shall only include mounting options that will not allow tilt angles beyond +/- 10 degrees, in order to align the luminaire parallel with the roadway surface (see Figure 2).	Model number will include allowed mounting options. Products with mounting accessories are eligible for LUNA and will be listed on the QPL with the mounting accessories that meet all of the technical requirements. Eligible mounting accessories will be listed in parentheses on the QPL.	Specification sheet, supplemental documentation, or installation instructions shall include photos or illustrations of mounting options or accessories with allowable tilt angles (and degree values), or fixed mounting options clearly documented.
Shielding	Shielding as an available accessory or option shall be included on specification sheets or supplemental documentation (e.g. house side shields (HSS), cul-de-sac shields (CSS), front-side shields (FSS), or glare shields) for pole/arm-mounted area/roadway/ decorative PUDs (Primary Use letters A and B), and specialty hazardous area lighting and specialty hazardous pole/arm-mounted area and roadway PUDs.	<p>Specific product configurations without shielding will be listed on the QPL per the LUNA requirements as long as a shield is available as an accessory or option.</p> <p>For those who voluntarily choose to list their shielded products and are seeking efficacy allowances, within each given shielding subgroup, shielded products with the lowest efficacy will be listed as worst-case efficacy parent products on the QPL.</p> <p>Shielded products with the highest house-side lumens for products with a HSS or CSS, or street-side lumens for products with a FSS, will be listed as worst-case distribution parent products on the QPL.</p>	Specification sheet or supplemental documentation review to determine that at least one shielding accessory or option is available.

* Performance-affecting mounting structures (e.g., post-top yokes or brackets) shall be included in photometric testing for Outdoor Pole/Arm-Mounted Area and Roadway Luminaires (Primary Use letter A), Outdoor Pole/Arm-Mounted Decorative Luminaires (Primary Use letter B) and Specialty Hazardous Outdoor Pole/Arm-Mounted Area and Roadway Luminaires.

‡ .ies files may be submitted alone without also submitting TM-33 .xml documents up until the LUNA Version 1.0 delist date, which will not occur until V5.1 applications are no longer accepted in a future Technical Requirements revision. If .xml documents are submitted, .ies files must also be submitted so that Photometric Toolbox can be used by DLC reviewers for evaluation. See the [Provisional Testing and Reporting section](#) for more information.

Table 5: PUDs eligible for LUNA qualification and respective U Rating thresholds

Primary Use Letter	Primary Use Designations Eligible for LUNA Qualification	Maximum U Rating Threshold
A	Outdoor Pole/Arm-Mounted Area and Roadway Luminaires	1
B	Outdoor Pole/Arm-Mounted Decorative Luminaires	2
C	Outdoor Full-Cutoff Wall-Mounted Area Luminaires	1
E	Bollards	1
G	Fuel Pump Canopy Luminaires	2
n/a	Specialty: Hazardous Area Lighting	1
	Specialty: Hazardous Outdoor Pole/Arm-Mounted Area and Roadway Luminaires	1
	Specialty: Hazardous Wall Mounted Luminaire	1
	Specialty: Canopy Lighting	2
	Specialty: Directional Fuel Pump Canopy Luminaires	2
	Specialty: Transportation	2

The lighting intensity distribution test reports required to list products under the LUNA qualification are as follows:

- A full LM-79/distribution report in PDF format, per the [Additional Reporting Guidelines](#), for the products that have the highest total lumen output for each optical variation within the family at the highest qualifying CCT (e.g., 3000K), tested at the maximum (non-dimmed) light output. Worst-case performance-affecting mounting options available from the manufacturer that interact with the luminous intensity distribution shall be included with each optical variation (e.g., mounts that increase uplight the most or reflect light in any unintended direction). For example, the optical variation tested could be “ABC-100W-30K80CRI-HA”, where HA is the nomenclature/ordering code for a horizontal arm mounting option, or “ABC-100W-30K80CRI (with accessory HA)”, where HA is the nomenclature/ordering code for a horizontal arm mounting accessory.
 - Performance-affecting mounting structures and housing may use any available material color.
- An .ies file, and [optionally, a TM-33-18 .xml document](#), both based on the LM-79 test data, shall be submitted along with the PDF distribution report.
- Product image(s) of the tested product showing the optics, worst-case performance affecting mounting structures, and shields if applicable, shall be included in the PDF distribution report. Product image(s) may be of the tested product on the bench, not in the measuring equipment. Images will be used by reviewers to understand the product being tested, and will not be published on the QPL.

- For tested products, threshold U Ratings from the BUG Ratings will be verified using the .ies files associated with the full LM-79/distribution test report.
- For all products where LM-79/distribution reports are not required, reported data, including BUG ratings, shall be reported in the reported values on the application form.
- DLC reviewers will analyze the submitted .ies files using Photometric Toolbox (Lighting Analysts, Inc., version 2.7 or newer) to verify BUG Ratings and house-side or street-side lumens (for products pursuing shielding efficacy allowances) using the submitted tested photometric files.
- DLC reviewers will evaluate drawings and text information on the submitted specification sheets and installation instructions to verify that the qualified mounting bracket does not allow a tilt angle greater than 10 degrees. For products with permitted mounting options or accessories, the mounting bracket and related maximum tilt angle shall be graphically shown on either the specification sheet or installation instructions (see **Figure 2**).

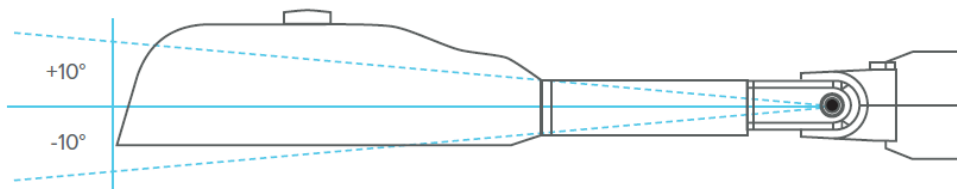


Figure 2: Acceptable mounting bracket tilt angle for LUNA qualification.

- To attain LUNA qualification, listed pole/arm-mounted area/roadway/decorative PUD products shall offer at least one specifiable shielding option or accessory on the product specification sheet or supplemental documentation. The shields may be external to the luminaire, or internal to the glass or optic. DLC reviewers will evaluate submitted documentation to ensure that a shield option or accessory is available.

Distribution interactions with other DLC policies: Field-Adjustable Light Distribution (FALD) and Field-Adjustable Light Output (FALO)

Field-adjustable light distribution (FALD) products are not eligible for LUNA qualification. Field-adjustable light output (FALO) products are eligible for LUNA qualification. Please note that this may require the separation of models that were otherwise able to be combined on the SSL QPL, to clearly delineate those that are qualified under LUNA and those that are not.

Spectral Quality Requirements

Rationale

Spectral quality requirements are included in LUNA to mitigate negative impacts of outdoor LED lighting at night. The requirements align with industry standards recommended for mitigating sky glow (e.g. [ANSI/IES LP-2-20 Lighting Practice: Designing Quality Lighting for People in Outdoor Environments](#) and [ANSI/IES LP-11-20 Lighting Practice: Environmental Considerations for Outdoor Lighting](#)) while facilitating visibility and energy efficiency for continued acceptance of and persistence of energy savings achieved through LED lighting at night.

Since sky glow (and more specifically the Rayleigh scatter causing sky glow) is wavelength dependent, the Department of Energy (DOE) found CCT to be a poor predictor of sky glow. Research and solutions for considering spectral impacts on sky glow are emerging, but there is no industry standard consensus-based metric to replace CCT in place to date. In the meantime, industry best practices limit the maximum CCTs in outdoor environments to reduce short-wavelength emissions. [ANSI/IES LP-11-20](#) recommends maximum CCTs of 3000 Kelvin (i.e., 3000 K) for area lighting in commercial zones, and CCTs lower than 2200 K¹ for area lighting in sensitive environments.

LUNA Requirements for Spectral Quality

The spectral quality requirements for LUNA products that extend beyond SSL V5.1 requirements are outlined in **Table 6**. The “QPL Listing” column describes the information that will appear as publicly available on the QPL, if applicable. The “Method of Evaluation” column describes how products will be evaluated for qualification, whether by compliance with industry standards, manufacturer documentation, or other DLC verification methodology.

¹ No ANSI (or other) standards define CCT ranges extending beyond what is considered ‘white’ lighting per [ANSI C78.377-2017](#). As such, the DLC is proposing that non-standardized chromaticities are ineligible for listing under LUNA V1.0.

Table 6: LUNA Spectral Quality Requirements

Metric and/or Application	LUNA V1.0 Requirements	QPL Listing	Method of Measurement/Evaluation
Chromaticity (CCT & D_{uv})	<p>All products shall exhibit chromaticity consistent with at least one of the basic, flexible, or extended, nominal 7-step quadrangle CCTs from 2200 K - 3000 K.</p> <p>Products tested to meet LUNA spectral quality requirements shall submit an ANSI/IES TM-27-20 .spdx file containing spectral power distribution data in increments of ≤5nm. ANSI/IES TM-33-18 .xml documents are also acceptable in addition to .spdx files, but are not required at this time.*</p>	<p>SPD data and image‡, CCT and D_{uv} for parent products listed as Tested Data.</p> <p>Nominal CCT for child products listed as Reported Data.</p>	<p>ANSI/IES LM-79 (per Additional Reporting Guidelines)</p> <p>ANSI C78.377-2017</p> <p>ANSI/IES TM-27-20 or IES TM-27-14</p> <p>Optionally: ANSI/IES TM-33-18</p>

* [.spdx files \(ANSI/IES TM-27\)](#) will be accepted up until the LUNA Version 1.0 delist date, which will not occur until V5.1 applications are no longer accepted in a future Technical Requirements revision. Please note that the DLC intends to require [ANSI/IES TM-33-18](#) .xml documents in a future LUNA Technical Requirements revision.

‡ The DLC will create a .png image for parent products to be shown on the QPL based on the submitted [ANSI/IES TM-27-20 \(or IES TM-27-14\)](#) .spdx file. Submitted [ANSI/IES TM-27-20](#) (or [IES TM-27-14](#)) will be available for download on the QPL. Please ensure submitted .spdx files do not contain information inappropriate for QPL display.

In addition to the test report and implementation requirements applicable to DLC Standard and Premium classifications under SSL V5.1, the spectral quality test reports required to list products under the LUNA qualification are as follows.

Within a product family, LUNA products are required to test and report the following:

- 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.
- All LM-79/color tests of the highest CCT option offered shall be conducted at the highest total lumen output for at least one optical variation within the family when operating at the maximum (non-dimmed) light output, and the .xml document based on the LM-79 test data

shall include both spectral and luminous intensity distribution data, per the [Additional Reporting Requirements](#).

- For the product with the highest CCT (at highest lumen output), the TM-33 .xml document shall include both the emitter spectral data and the emitter luminous intensity data for a single tested product, if submitted.
- For the product with the lowest CCT (at highest lumen output), the TM-33 .xml document may include only the emitter spectral data without the emitter luminous data for a single tested product, if submitted.

Spectral quality interactions with other DLC policies: Color-Tunable Products

For [color-tunable](#) (white-tunable and warm-dimming) products, an additional clarification to meet the LUNA spectral quality requirements is provided below.

White-tunable and warm-dimming products are eligible for LUNA, but shall not be tunable to chromaticities outside the LUNA chromaticity requirements (i.e., color-tunable products are eligible for LUNA, so long as the product(s)' tunable range is limited to between 2200-3000K).

Controllability Requirements

Rationale

Sky glow and light trespass can be reduced with high end trim, enabling designers to meet design requirements without overlighting. In addition, light pollution can be reduced flexibly throughout the night by dimming down as far as appropriate, as frequently as appropriate, based on lower volumes of traffic and pedestrian conflict at some times of the night. Solutions include luminaires with standalone motion sensors and photocells; smart photocells with part-night-dimming and field-adjustable high-end trim; and networked lighting controls (NLC) with remote diagnostics, scheduling, dashboards, etc. In many applications, reducing light output can reduce light pollution while saving energy by delivering precisely the illumination that is needed, only when it is needed. Continuous dimming also facilitates compliance with energy code requirements for light level reduction, including recent versions of [ASHRAE 90.1](#), [IECC](#), and [California’s Title 24](#).

LUNA Requirements for Controllability

The following section outlines LUNA requirements for controllability. The “QPL Listing” column in **Table 7** describes the information that will appear as publicly available on the QPL. The “Acceptable Terminology” columns in **Table 7**, **Table 8**, and **Table 9** describe how products will be evaluated for qualification, whether by compliance with industry standards, manufacturer claims, or other DLC verification methodology.

The “Acceptable Terminology” columns will be updated periodically to include additional equivalent terms. Manufacturers completing an application to qualify a product for LUNA should refer to the most recent dated version of the LUNA Technical Requirements on the DLC website in order to use the most current list of acceptable terms.

Note that every LUNA product must identify its communication method for dimming.

Table 7: LUNA Controllability Requirements

Metric	LUNA V1.0 Requirements	QPL Listing	Acceptable Terminology
Dimming Capability	Continuous dimming capability to $\leq 20\%$ of max output power is required.	Minimum dimming level (%)	Product specification sheet shall clearly identify continuous dimming capability, to a percentage of maximum output current or power, less than or equal to 20%. (A percentage of light output is not sufficient). In addition, each product must support at least one Communication method for dimming (either wired communication for a single control point, or communication between multiple controls points).

Metric	LUNA V1.0 Requirements	QPL Listing	Acceptable Terminology
Wired Communication for a Single Control Point	The Wired Communication for a Single Control Point is reported. ⁺	Wired Communication for a Single Control Point	<p>SSL V5.1 Wired Communication Protocols for LUNA products will be superseded with the following more detailed options:</p> <ul style="list-style-type: none"> • Wired Analog Standard <ol style="list-style-type: none"> 1. 0-10V IEC 60929 Annex E 2. 0-10V ANSI C137.1-2019 (8-Volt) 3. 0-10V ANSI C137.1-2019 (9-Volt) 4. Forward Phase NEMA SSL 7A-2015 (R2021) • Wired Digital Standard <ol style="list-style-type: none"> 1. DALI 2. DALI 2 3. D4i 4. DMX512 • Other (text) <ol style="list-style-type: none"> 1. For instance, “Proprietary PWM”
Integral Controls	Capability for integral controls is reported. [‡]	Integral control capabilities and receptacle(s)	Product specification sheet shall clearly identify available integral control capabilities and receptacles, if any, with the ordering code option for each.
Communication Between Multiple Control Points	Communication standard protocol is reported.	Communication Between Multiple Control Points	Product specification sheet shall clearly identify available standards selected from Table 9 below, with the ordering code option for each.

⁺ Unlike SSL V5.1 products, model numbers qualified under LUNA must indicate specific communication protocols available. Multiple communication protocols may not be wildcarded in a single model number if product changes are necessary to achieve the dimming functionality. If a driver accepts only analog or only digital dimming control, then each analog or digital standard that is available with the luminaire shall be identified on the product specification sheet, with the ordering code and specific model number separated out for each dimming standard option. If a single product with a single ordering code can accept multiple dimming protocols, then all protocols shall be identified.

[‡] Unlike SSL V5.1 products, model numbers qualified under LUNA must indicate specific integral control capabilities available. Multiple integral control capabilities may not be included in a single model number if product changes are necessary to achieve the integral controls capability functionality. **Table 8** below shows integral control capabilities beyond those listed in Table 8 of [SSL Technical Requirements V5.1](#), and also a list of integral control receptacles.

Dimming capability

Dimming is required in many energy codes, and the capability to dim down to 20% of maximum output power addresses multiple dark sky challenges. High end trim and part night dimming are broadly applicable; and occupancy-based dimming is applicable in some situations depending on sensor performance related to coverage area, sensitivity, and mounting height.

In order to support dimming, each product is required to support at least one communication method for dimming: wired communication for a single control point, and/or communication between multiple control points.

Wired Communication for a Single Control Point

In order for a luminaire to dim, a sensor or control module communicates the desired dimming level to the driver, using a dimming protocol. This protocol is typically either an analog 0-10V signal, or a digital signal such as [DALI](#), [DALI2](#) or [D4i](#).

Integral controls

Several types of integral control sensors and capabilities are described in the Controllability section of [SSL V5.1 Technical Requirements](#) in Table 8, entitled “Integral Control Sensor and Capability Descriptions.” In addition, the following types of control capabilities and receptacles are accepted under LUNA as types of “integral controls.” Note that information about the receptacle type is necessary, but not sufficient, to choose controls appropriate for a particular receptacle on a particular luminaire. For instance, [ANSI C136.41](#) has 19 signal sets and multiple mechanical interconnection configurations; and Zhaga Book 18 has an undefined pin. Also, various functions support various uses and orientations, such as receptacles mounted facing downwards, sideways, or upwards.

Table 8: Integral control capabilities and receptacles recognized by LUNA, in addition to those in SSL Technical Requirements V5.1

Topic	Additional Types of Integral Controls	Acceptable Terminology
Integral control capabilities beyond those listed in SSL V5.1	Part night dim	Part night dimming
	Photocontrol with self-calibrating astronomic time clock	Photocontrol/Photosensor with astronomic time clock/timer, Dusk to dawn timer
	Low-end trim for vacancy mode	Low-end trim for unoccupied state
Integral control receptacles for outdoor luminaires	ANSI C136.41-2013 (NEMA 5-pin)	C136.41 5-pin ANSI 5-pin NEMA 5-pin
	ANSI C136.41-2013 (NEMA 7-pin)	C136.41 7-pin ANSI 7-pin NEMA 7-pin
	ANSI C136.58-2019 (Zhaga Book 18)	Zhaga Book 18 ANSI C136.58
	Other	In order to be accepted, text in this field must include a URL directing to a website that references the physical dimensions, electrical properties, and functional aspects of the control receptacle, including dimming.

Communication Between Multiple Control Points To support the selection of luminaires and control systems, the information in **Table 9** is reported for LUNA qualified products. This information supplements Table 9 in [SSL Technical Requirements V5.1](#), entitled “Control Communication Descriptions.” Note that it is not only the communication protocol, but the functionality of the system that impacts compatibility of systems.

Table 9: Communication Between Multiple Control Points (reported capability)

Physical Medium	Standard Protocol	Acceptable Terms or Conditions
Wired	DALI	DALI, “Registered” at https://www.dali-alliance.org/products
	DALI2	DALI2, DALI-2, “Certified product” at https://www.dali-alliance.org/products
	DMX512	DMX512
	BACnet	BACnet
	LONworks	LONworks
	Modbus	Modbus
	Other (describe)	
Wireless	Bluetooth Mesh	
	<ul style="list-style-type: none"> BLE MDP v2 	Bluetooth SIG mesh version 2, BLE SIG mesh v2
	<ul style="list-style-type: none"> BLE SIG Mesh v1.x 	Bluetooth SIG mesh version 1, BLE SIG mesh v1
	<ul style="list-style-type: none"> BLE Proprietary 	Bluetooth mesh, BLE mesh, Product listing at https://launchstudio.bluetooth.com/Listings/Search
	Cellular	
	<ul style="list-style-type: none"> 4G 	4G, IMT-2000, LTE Advanced, IEEE 802.16m
	<ul style="list-style-type: none"> 5G 	5G, 3GPP 5G NR, IMT-2020
	EnOcean	EnOcean, Product listing at https://www.enocean-alliance.org/products/
	Wi-Fi	Wi-Fi, WiFi, IEEE 802.11, Wi-Fi Certified, Product listing at https://www.wi-fi.org/product-finder
	Zigbee Certified Product	Zigbee Certified Product, Product listing as “Zigbee Certified Product” at https://zigbeealliance.org/product_type/certified_product/
	Zigbee 3.0	Zigbee 3.0
	Zigbee Proprietary	Zigbee
	Other (describe)	

Controllability interactions with other DLC policies: dimming protocols and integral controls

Unlike SSL V5.1 products, model numbers qualified under LUNA must indicate specific communication protocols and integral control capabilities available. Please note that this may require the separation of models that were otherwise able to be combined on the SSL QPL, to clearly delineate those that are qualified under LUNA and those that are not.

Allowances and Tolerances

Efficacy allowance for bollard PUDs

Bollards that meet all LUNA requirements for distribution, spectrum, and controllability are provided with a 25% efficacy allowance. This allowance may be added to other spectral quality allowances provided under SSL V5.1.

There are no allowances for light output. All PUDs seeking LUNA qualification must meet the minimum light output requirement listed in the SSL V5.1 Technical Requirements.

Efficacy allowance for shielded luminaires

Auxiliary shielding may increase the quality of the light distribution of a luminaire, as light is only delivered where it is intended and does not cause light trespass on neighboring locations. However, the application of shields often results in lower luminaire efficacies, and in many cases, shielded products cannot meet the DLC's minimum efficacy requirements. Based on DLC outreach, comments from lighting designers indicated that shielded photometry is used when available. Although manufacturers must demonstrate that at least one shield option or accessory is available for LUNA qualification, listing additional specific LUNA qualified products with shields is voluntary. Manufacturers that choose to list LUNA qualified products with shields shall test their products with shields as described below.

- Shields that are offered as options shall have the shield indicated in the luminaire catalog/ordering code number and will be shown on the QPL as such.
- Shields that are offered as accessories shall have the accessory listed in the luminaire catalog/ordering code number and will be displayed on the QPL in parentheses (e.g., “ABC-100W-30K80CRI-HA (with accessory HSS-Black)”, where HA is the nomenclature/ordering code for a horizontal arm, and HSS-Black is the nomenclature/ordering code for this shield accessory).
 - QPL performance and testing required on products with accessories included with the model number in the application will be treated as though the accessory is an option within the model number (i.e., performance will reflect product performance with accessory attached, worst-case testing will include products with accessory attached, etc.).

If a manufacturer offers more than one configuration of a specific shield type (HSS, CSS, and FSS), the variety of configurations under each shield type is treated as a shield type subgroup within the product family (e.g., an HSS subgroup could include internal and external HSS, or an HSS subgroup could include a Type II HSS with a 30-degree shielding angle² and a Type II HSS shield with a 45-degree shielding angle). Each shielding option configuration will be listed as a separate reported family member, with the effect on the distribution and light output of the luminaire documented. If products are available with multiple shield colors, the shield color and/or finish shall be specified in the model number, cannot

² Shielding angle is defined in [ANSI/IES LS-1-20](#) as “the angle between a horizontal line through the light center and the line of sight at which the bare source first becomes visible.”

be listed as a wildcard option in the listing, and cannot be combined, because lighter color shields will potentially reflect more light to the sky dome and not meet the required U Rating threshold for that PUD. An example of a hypothetical shield subgroup is shown in **Table 10** below.

In all cases, the testing to achieve the specified shielding efficacy allowance is in addition to other testing specified in these technical requirements and all other V5.1 testing requirements, unless specific provisions are made for an exception to the approach in this policy. Shielded products must meet all other SSL V5.1 and LUNA requirements, and are offered efficacy allowances as long as specific reductions in relevant zonal lumens are achieved. For example, if a family includes model numbers with house-side shielding accessories or options, of which some meet the efficacy requirement with an allowance and some do not, testing would be required for 1) the worst-case-efficacy house-side shielded product that meets the allowance requirement, and 2) for the product with the lowest house-side lumen reduction as a function of the shield. Shielded products that have efficacies better than the worst-case shielded products, or the lowest house-side lumen reduction, can be child products. Submitters shall supply the reported performance for their shielded and unshielded products, as specified in **Table 5**. The allowance would apply to the specific subgroup of products using the given shield (e.g. HSS or CSS). Shield types may not be combined to create a larger subgroup. In other words, cul-de-sac shields and house-side shields may not be combined to create one subgroup.

Table 10 provides an example of a luminaire family with various HSS and FSS options. The worst-case efficacy parent in each subgroup (HSS or FSS) is the product that results in the lowest efficacy, assuming that all HSS or FSS products in the subgroup meet the requirements in **Table 10** (i.e., reduce the house-side lumens by at least 50% compared to the unshielded equivalent product, and all FSS products reduce the street-side lumens by at least 30% compared to the unshielded equivalent product). The worst-case distribution parent in each subgroup is the product that reduces the house-side or street-side lumens the least.

Table 10: Example of hypothetical shielded products and identified worst-case efficacy and distribution parents for one luminaire family with two shield type subgroups (HSS and FSS)

Row #	Family name	Optic	Luminaire efficacy w/o shielding (LPW)	House-side (or street-side) lumens w/o shield	Shield type	Shielding angle	Shield type subgroup	Luminaire efficacy with shield (lm/W)	House-side (or street-side) lumens with shield	House/street side reduction	Test required
1	AXBXC	Type II	125	3000	HSS	30	A	85	1400	53%	LM-79/color
2	AXBXC	Type II	125	3000	HSS	45	A	88	1200	60%	
3	AXBXC	Type III	125	3500	HSS	30	A	87	1700	51%	LM-79/distribution
4	AXBXC	Type III	125	3500	HSS	45	A	89	1500	57%	
5	AXBXC	Type II	125	10000	FSS	30	B	88	6500	32%	LM-79/color
6	AXBXC	Type II	125	10000	FSS	45	B	90	5000	47%	
7	AXBXC	Type III	125	9500	FSS	30	B	89	7000	30%	LM-79/distribution
8	AXBXC	Type III	125	9500	FSS	45	B	91	6000	40%	

Note: Worst-case-efficacy parent for each shield type subgroup is shown in yellow. LM-79 color testing is required for the least efficacious shielded luminaire in shield type subgroup A (HSS), and the least efficacious shielded luminaire in shield type subgroup B (FSS) – rows 1 and 5. Worst-case distribution parent in each shield type subgroup is shown in blue. LM-79 distribution testing is required for the luminaires with the lowest reduction in house or street side lumens.

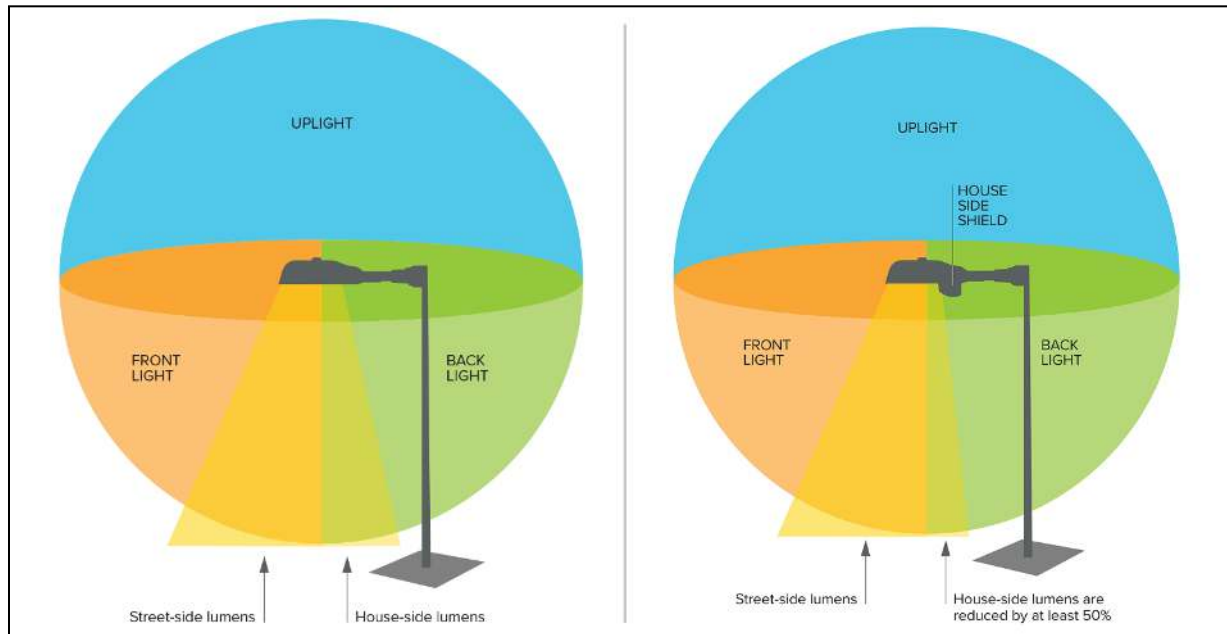


Figure 3: Example of a hypothetical product with a house-side-shield (HSS) (right image) and without (left image). This hypothetical product with a HSS would be eligible for a shielding efficacy allowance if the house-side lumens are reduced by at least 50% compared to an unshielded equivalent product. Note that other shielding efficacy allowances for other shield types will require different reduction in house-side or street-side lumens, per **Table 11**.

To encourage the listing of shielded products, the DLC is providing efficacy allowances for shielded area lighting, roadway lighting, and pole- or arm-mounted decorative lighting with house-side shields or cul-de-sac shields, if the related house-side lumens are reduced by the specified percentage compared to an unshielded product. A similar efficacy allowance is also provided for shielded area lighting, roadway lighting, and pole- or arm-mounted decorative lighting with front-side shields, if the related street-side lumens are reduced by the specified percentage compared to an unshielded product.

Table 11 shows the efficacy allowances for LUNA products with shielding. These allowances may be added to other spectral quality allowances provided under SSL V5.1. The maximum allowance for a shielded LUNA product is not limited by the maximum allowance of 10% as stated in the SSL V5.1 requirements. Instead, for LUNA, it may be up to 45%, depending on the shield type.

Table 11: Efficacy allowances specific to LUNA products with shielding

Feature	Primary Use Designations	Performance Metric	Shielding Efficacy Allowance
Shielding	<ul style="list-style-type: none"> Outdoor Pole/Arm-Mounted Area and Roadway Luminaires Outdoor Pole/Arm-Mounted Decorative Luminaires Specialty: Hazardous Area Lighting Specialty: Hazardous Outdoor Pole/Arm-Mounted Area and Roadway Luminaires 	Luminaires with internal or external house-side shields (HSS) are offered an efficacy allowance of 20% if they reduce the house-side lumens by at least 50% compared to an equivalent unshielded product.	-20%
		Luminaires with internal or external cul-de-sac shields (CSS) are offered an efficacy allowance of 35% if they reduce the house-side lumens by at least 70% compared to an equivalent unshielded product.	-35%
		Luminaires with internal or external front-side shields (FSS) are offered an efficacy allowance of 20% if they reduce the street-side lumens by at least 30% compared to an equivalent unshielded product.	-20%

Testing Notes

To determine if the shielding efficacy allowance may be granted, applicants shall submit an .ies file of the equivalent unshielded product, with the same optical distribution and nominal light output as the submitted shielded worst-case efficacy parent. To confirm the shielding allowance, the .ies file associated with the unshielded product does not need to use absolute photometry (scaled photometry is acceptable). The submitted specification sheet or supplemental document should clearly show the relationship between the unshielded product and shielded product for the reviewer’s analysis. The DLC requires submitters to provide .ies files ([ANSI/IES LM-63-02](#) R2008 or [ANSI/IES LM-63-19](#)) up until the LUNA Version 1.0 delist date, which will not occur until V5.1 applications are no longer accepted in a future Technical Requirements revision.

In addition to the .ies file, the LM-79/distribution report for the worst-case distribution parent shall be submitted as a PDF file and shall include a product image with the shield with sufficient granularity that the shield is clearly visible in the image.

Tolerances

The DLC accepts measurement tolerances to certain metrics listed in the SSL V5.1 Technical Requirements. Please refer to the [SSL V5.1 Technical Requirements](#) for acceptable tolerances. There are no higher upper tolerances to the threshold Uplight Ratings given in **Table 5** of this document.

Provisional Testing and Reporting Requirements

The following testing and reporting requirements describe which test methods and reporting versions are acceptable in LUNA Version 1.0. Manufacturers may use any of the following testing and reporting file formats in their LUNA V1.0 applications up until the LUNA Version 1.0 delist date, which will not occur until V5.1 applications are no longer accepted in a future Technical Requirements revision. However, manufacturers will eventually need to provide [ANSI/IES LM-79-19](#) reports and [ANSI/IES TM-33-18](#) .xml documents prior to the LUNA Version 1.0 delist date for their products to maintain listing. The DLC intends to require [TM-33-18](#) .xml documents in the future.

LM-79 testing

LUNA Version 1.0 allows either the [IES LM-79-08](#) or [ANSI/IES LM-79-19](#) test method to be used. See the [Additional Reporting Guidelines](#) section for more details on any version requirements.

LM-79 reporting

Distribution: Manufacturers shall submit .ies files ([ANSI/IES LM-63-02](#) R2008 or [ANSI/IES LM-63-19](#)) along with the PDF distribution report. The DLC encourages manufacturers to submit [ANSI/IES TM-33-18](#) .xml documents for LUNA Version 1.0 as well, although it is not required for this version.

Spectral Quality: Manufacturers shall submit an [ANSI/IES TM-27-20](#) or [IES TM-27-14](#) .spdx file and may additionally, and optionally, submit an [ANSI/IES TM-33-18](#) .xml document for all new applications under LUNA Version 1.0.

Additional Reporting Guidelines: ANSI/IES LM-79 Reports and Accompanying Spectral and Luminous Intensity Distribution File(s)

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. [IES LM-79-08](#) or [ANSI/IES LM-79-19](#) reports are required. 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.

From a file format perspective, the DLC encourages adoption and use of [ANSI/IES TM-33-18](#) .xml documents, in addition to .ies and .spdx file formats, for the following reasons:

- Combines spectral and luminous intensity data
- Includes many commonly used metrics (e.g., color rendition metrics)
- Allows for calculation of alternative application metrics (e.g., to support metrics beyond lumens)

The DLC realizes that photometric testing and application software does not currently readily support [ANSI/IES TM-33-18](#) export/import and is providing reporting alternatives in LUNA Version 1.0. File types .ies and .spdx are required in LUNA Version 1.0, and [ANSI/IES TM-33-18](#) .xml documents are optional until the LUNA Version 1.0 delist date, which will not occur until V5.1 applications are no longer accepted in a future Technical Requirements revision.

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 unless specified. These color-specific test reports are generally referred to within this document 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
- As described in the [Provisional Testing and Reporting Requirements](#) section, .spdx files ([ANSI/IES TM-27-20](#) or [IES TM-27-14](#)) are required in LUNA Version 1.0 for all applications.
 - Manufacturer, Catalog Number, Description, Document Creator, Laboratory, Report Number, Report Date, Document Creation Date are correctly and pertinently indicated using the header elements <Manufacturer>, <CatalogNumber>, <Description>, <DocumentCreator>, <Laboratory>, <ReportNumber>, <ReportDate>, <DocumentCreationDate>, respectively.
 - Please ensure that submitted .spdx files do not include potentially proprietary information, as these files will be published to the QPL directly.
- (Optional) A TM-33 ([ANSI/IES TM-33-18](#)) .xml document meeting the following requirements:
 - Test report number, test lab, report date, manufacturer, luminaire catalog number, description are correctly and pertinently indicated using the header elements <ReportNumber>, <Laboratory>, <ReportDate>, <Manufacturer>, <CatalogNumber> and <Description>, respectively.
 - The Luminaire Dimension Elements (4.3.1) indicating the housing dimensions, and Number of Emitters are required. DLC reviewers will verify the luminaire dimensions in

the TM-33 .xml document against the luminaire physical dimensions that are provided either in the specification sheet, LM-79 test report, or as separate application submission materials.

- Emitter elements (4.5) shall include all required elements from Table 10 in [TM-33-18](#).
- Emitter spectral data with absolute luminaire-level spectral power distribution data from 380-780 nm in ≤ 5 nm increments.
- For the spectral subgrouping parent with the highest CCT and highest lumen output, the TM-33 .xml document shall either 1) include both the emitter spectral data and the emitter luminous intensity data for a single tested product, or 2) provide emitter spectral and emitter luminous intensity data for a single tested product in separate TM-33 .xml documents.
- For the products with the lowest CCT and highest lumen output, the TM-33 .xml document may include only the emitter spectral data without the emitter luminous data for a single tested product.
- The DLC recommends inclusion of additional, optional TM-30 elements that describe color quality attributes, such as Color Correlated Temperature (4.5.9) and Color Rendering (4.5.10), but they are not required at this time.
- Required TM-27 files and optional TM-33 documents shall report spectral data in wavelength increments of ≤ 5 nm.
- The product catalog number shall be present and match in all relevant TM-27/TM-33/LM-63 and LM-79 documents.
- All information listed above, except the accompanying .spdx and/or TM-33 .xml document, shall be included in a single LM-79/color test report.

Test reports that require distribution performance information (generally expected to be from testing with a goniophotometer) do not require color performance information unless specified. These distribution-specific test reports are generally referred to within this document 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)
- A photo of the product in the goniophotometer as tested with performance affecting structures shall be included in the distribution test PDF report.
- If submitting [LM-79-19](#) reports, stray light removal for the purposes of determining the threshold U Rating shall be performed and reported according to [ANSI/IES LM-75-19](#) (Section 9.0 including the reporting requirements in section 9.5).
- (Optional) A TM-33 ([ANSI/IES TM-33-18](#)) .xml document meeting the following minimum requirements:
 - Alongside other TM-33 required elements, test report number, test lab, report date, manufacturer, luminaire catalog number, and description are correctly and pertinently

- indicated using the header elements <ReportNumber>, <Laboratory>, <ReportDate>, <Manufacturer>, <CatalogNumber>, and <Description>, respectively.
- The Luminaire Dimension Elements (4.3.1) indicating the housing dimensions, and Number of Emitters are required. DLC reviewers will verify the luminaire dimensions in the TM-33 .xml document against the luminaire physical dimensions that are provided either in the specification sheet, LM-79 test report, or as separate application submission materials.
 - Emitter elements (4.5) shall include all required elements from Table 10 in [TM-33-18](#).
 - The Intensity Scaling Element (4.5.13.2.4.1) shall be 'false', meaning that the reported intensity data has not been scaled uniformly with respect to laboratory measurements.
 - The luminous intensity distribution shall be presented as emitter luminous intensity data.
 - If a given parent product or single product with a unique optic and the highest lumen output has been tested to meet both the spectral and distribution requirements, a TM-33 .xml document shall be submitted with both spectral and luminous intensity data or provide emitter spectral and emitter luminous intensity data for a single tested product in separate TM-33 .xml documents.
 - The emission area elements (4.5.23) shall appropriately reflect the luminous opening of the luminaire. In no circumstances shall the emission areas be zero or exceed the luminaire's housing dimensions.
 - The angular resolution for the emitter luminous intensity data in the TM-33 .xml document 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 shall be used for products whose luminous intensity changes rapidly as a function of angle.
 - The DLC will allow submitters to use the symmetry rules for horizontal angles from LM-63 to represent their luminous intensity distribution data in the .xml document.
 - Manufacturers shall also submit .ies files so that they can be evaluated using Photometric Toolbox.
 - .ies files ([ANSI/IES LM-63-19](#) or [ANSI/IES LM-63-02](#) R2008) shall be submitted up until the LUNA Version 1.0 delist date, which will not occur until V5.1 applications are no longer accepted in a future Technical Requirements revision.
 - Test report number, test lab, report date, manufacturer, luminaire catalog number, description, and issue date shall be included using keywords [TEST], [TESTLAB], [TESTDATE], [MANUFAC], [LUMCAT], [LUMINAIRE], and [ISSUEDATE] respectively.
 - For manufacturers submitting an [LM-63-19](#) .ies file, products shall be tested and reported using absolute photometry methods per [IES LM-63-19](#), not scaled photometry,

and shall include a [FILEGENINFO] keyword with information about the File Generation Type and the File Generation Type Value 1.10000 or 1.11000, per [IES LM-63-19](#) Table 2.

- For manufacturers submitting an [LM-63-02](#) R2008 .ies file, the scaling guidelines in SSL V5.1 shall be followed.
- All submitted .ies files shall report their Candela values using Type C photometric conventions following the horizontal angle and vertical angle reporting requirements in LM-63.
- .ies files shall appropriately reflect the dimensions of the luminous opening of the luminaire, and in no circumstances shall the luminous length and width be zero or exceed the luminaire's housing dimensions. 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.

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.

References

Standard # or Document Name	Title and URL
ANSI C136.41-2013	Roadway And Area Lighting Equipment—Dimming Control Between An External Locking Type Photocontrol And Ballast Or Driver https://webstore.ansi.org/Search/Find?in=1&st=c136.41
ANSI C136.58-2019	Roadway And Area Lighting Equipment – Luminaire Four-Pin Extension Module And Receptacle – Physical And Electrical Interchangeability And Testing https://webstore.ansi.org/Search/Find?in=1&st=c136.58
ANSI C137.1-2019	Lighting Systems – 0-10V Dimming Interface For LED Drivers, Fluorescent Ballasts, And Controls https://webstore.ansi.org/Standards/NEMA/ANSIC1372019-2392108
ANSI C137.4-2019	Lighting Systems - Digital Interface With Auxiliary Power https://webstore.ansi.org/Standards/NEMA/ANSIC1372019-2392109
ANSI C78.377-2017	Electric Lamps - Specifications For The Chromaticity Of Solid-State Lighting Products https://webstore.ansi.org/Standards/NEMA/ANSIC783772017
ANSI/ASHRAE/IES 90.1-2019	Energy Standard for Buildings Except Low-Rise Residential Building https://www.ashrae.org/technical-resources/bookstore/standard-90-1 , or https://store.ies.org/product/ash-st90-1-19-ansi-ashrae-ies-standard-90-1-2019-energy-efficiency-standard-for-buildings-except-low-rise-r for IES member discount
ANSI/IES LM-63-02 R2008	Lighting Measurement: APPROVED METHOD: IES STANDARD FILE FORMAT FOR THE ELECTRONIC TRANSFER OF PHOTOMETRIC DATA AND RELATED INFORMATION
ANSI/IES LM-63-19	Lighting Measurement: APPROVED METHOD: IES STANDARD FILE FORMAT FOR THE ELECTRONIC TRANSFER OF PHOTOMETRIC DATA AND RELATED INFORMATION https://store.ies.org/product/lm-63-19-approved-method-ies-standard-file-format-for-the-electronic-transfer-of-photometric-data-and-related-information/
ANSI/IES LM-75-19	Lighting Measurement: APPROVED METHOD: GUIDE TO GONIOMETER MEASUREMENTS AND TYPES, AND PHOTOMETRIC COORDINATE SYSTEMS https://store.ies.org/product/lm-75-19-approved-method-guide-to-goniometer-measurements-and-types-and-photometric-coordinate-systems/
IES LM-79-08	Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products
ANSI/IES LM-79-19	Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products https://store.ies.org/product/lm-79-19-approved-method-optical-and-electrical-measurements-of-solid-state-lighting-products/
ANSI/IES LP-11-20	Lighting Practice: Environmental Considerations for Outdoor Lighting https://store.ies.org/product/lp-11-20-lighting-practice-environmental-considerations-for-outdoor-lighting/
ANSI/IES LP-2-20	Lighting Practice: Designing Quality Lighting for People in Outdoor Environments https://store.ies.org/product/ansi-ies-lp-2-20-lighting-practice-designing-quality-lighting-for-people-in-outdoor-environments/

Standard # or Document Name	Title and URL
ANSI/IES LS-6-20	Lighting Science: Calculation of Light and Its Effects https://store.ies.org/product/ls-6-20-lighting-science-calculation-of-light-and-its-effects/
ANSI/IES RP-8-18	Recommended Practice: For Design And Maintenance Of Roadway And Parking Facility Lighting https://webstore.ansi.org/Standards/IESNA/ANSIIESRP18
ANSI/IES TM-15-20 Annex A	Technical Memorandum: Luminaire Classification System for Outdoor Luminaires, Annex A https://store.ies.org/product/tm-15-20-technical-memorandum-luminaire-classification-system-for-outdoor-luminaires/
ANSI/IES TM-27-20 and IES TM-27-14	Technical Memorandum: IES Standard Format for the Electronic Transfer of Spectral Data https://store.ies.org/product/tm-27-20-technical-memorandum-ies-standard-format-for-the-electronic-transfer-of-spectral-data/
ANSI/IES TM-30-20	IES Method for Evaluating Light Source Color Rendition https://store.ies.org/product/tm-30-20-ies-method-for-evaluating-light-source-color-rendition/
ANSI/IES TM-33-18	Standard Format for the Electronic Transfer of Luminaire Optical Data https://store.ies.org/product/tm-33-18-technical-memoranda-standard-format-for-the-electronic-transfer-of-luminaire-optical-data/
ANSI/IES TM-37-21	Technical Memorandum: Description, Measurement, and Estimation of Sky Glow https://store.ies.org/product/tm-37-21-description-measurement-and-estimation-of-sky-glow/
BACnet	BACnet – A Data Communication Protocol for Building Automation and Control Networks http://www.bacnet.org
BLE MDP v1.x	Bluetooth Low Energy Mesh Device Properties, Revisions 1.0, 1.1, 1.2 https://www.bluetooth.com/specifications/specs/
BLE MDP v2	Bluetooth Low Energy Mesh Device Properties, Revision v2 https://www.bluetooth.com/specifications/specs/mesh-device-properties-2/
BSR/IES-43-2x	Recommended Practice: Lighting for People in Outdoor Environments Coming soon to https://store.ies.org/
CA Title 24	California Building Energy Efficiency Standards – Title 24 https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards
CIE 13.3-1995	METHOD OF MEASURING AND SPECIFYING COLOUR RENDERING PROPERTIES OF LIGHT SOURCES http://cie.co.at/publications/method-measuring-and-specifying-colour-rendering-properties-light-sources
D4i ANSI	D4i is the DALI standard for intelligent, IoT-ready luminaires. Aligned with NEMA/ANSI C137.4 Lighting Systems – Digital Interface With Auxiliary Power https://www.dali-alliance.org/d4i/ https://webstore.ansi.org/standards/nema/ansic1372019-2392109?gclid=CjwKCAjwT8uGBhBAEiwAayu_9YQ-kUCuUIAZkR05duKoPcXbMY7wpV5j2wjQZRjg7HU5ythgh4VxURoCSHQQA vD_BwE

Standard # or Document Name	Title and URL
DALI	IEC 62386 https://www.dali-alliance.org/
DALI2	Certification program based on parts of IEC 62386 and D4i https://www.dali-alliance.org/
DLC SSL Technical Requirements V5.1	DLC Solid State Lighting Technical Requirements V5.1 https://www.designlights.org/our-work/solid-state-lighting/technical-requirements/ssl-v5-1
DLC NLC5 Technical Requirements	DLC Networked Lighting Controls Technical Requirements Version 5 https://www.designlights.org/our-work/networked-lighting-controls/technical-requirements/nlc5/
DLC Horticultural Technical Requirements	DLC Horticultural Technical Requirements https://www.designlights.org/our-work/horticultural-lighting/technical-requirements
DMX512-A	ANSI E1.11-2008 (R2018) Entertainment Technology-USITT DMX512-A Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories https://tsp.esta.org/tsp/documents/docs/ANSI-ESTA_E1-11_2008R2018.pdf
EnOcean	EnOcean Alliance self-powered wireless communication https://www.enocean-alliance.org/
IEC 60929	IEC 60929:2011+AMD1:2015 CSV Consolidated version. AC and/or DC-supplied electronic control gear for tubular fluorescent lamps – Performance requirements https://webstore.iec.ch/publication/23568
IECC 2018	2018 International Energy Conservation Code (IECC) https://codes.iccsafe.org/content/IECC2018P4
IDA-IES MLO	IDA-IES Model Lighting Ordinance https://store.ies.org/product/ida-ies-mlo-11-model-lighting-ordinance-mlo-with-users-guide/
IES LS-1-20	Lighting Science: Nomenclature and Definitions for Illuminating Engineering https://www.ies.org/standards/definitions/
IES RP-33-14	Lighting for Exterior Environments Deprecated. Content moved to ANSI/IES LP-11-20 and BSR/IES-43-2x
LonWorks	ISO/IEC 14908 LonWorks local operating network https://www.lonmark.org
Modbus	Modbus https://www.modbus.org
PNNL-26411	An Investigation of LED Street Lighting’s Impact on Sky Glow https://www.energy.gov/sites/prod/files/2017/05/f34/2017_led-impact-sky-glow.pdf
US DoD UFC	Department of Defense Unified Facilities Criteria (DoD UFC) https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

Standard # or Document Name	Title and URL
US FEMP	Federal Energy Management Program (FEMP) https://www7.eere.energy.gov/femp/requirements/requirements_filtering/facility_energy_efficiency
US GSA P100	General Services Administration's (GSA) P100 Facilities Standards for the Public Buildings Service https://www.gsa.gov/real-estate/design-construction/engineering-and-architecture/facilities-standards-p100-overview
WiFi	Wi-Fi IEEE 802.11
Zigbee 3.0 Full Stack	IEEE 802.15.4-2011 Zigbee 3.0 Full Stack https://zigbeealliance.org/zigbee_products/?product_type=certified_product

Policy Clarifications and Updates

As the DLC processes applications for LUNA V1.0 and interacts with stakeholders, we encounter opportunities for minor corrections, terminology clarifications, and policy interpretations. In order to be as transparent as possible, the LUNA V1.0 Policy documents will be updated as needed, and the changes will be tracked in the table below and on the [DLC website](#). Table 12 shows the corrections or clarifications and where they can be found in the document.

Table 12: Corrections and clarifications published as needed

Date Updated	Subject	Change Type	Description	Affected Page(s)
4/20/2022	Controllability Requirements Terminology	Policy Change	Changes the name of two of the controllability metrics required for reporting and requires products to support at least one communication method for dimming, either between a single control point or multiple.	24-30