Networked Lighting Control System Technical Requirements

Version NLC5.1

Released: June 28, 2024

This version of the Technical Requirements document contains updates and clarifications made to the previously released NLC5 document. These updates are denoted by yellow highlighted line numbers or table rows.

Schedule of Revisions

Revision	Date	Description
1.0	Apr. 21, 2016	Initial Technical Requirements published.
1.01	May 7, 2016	Clarified that the Technical Requirements are for indoor control systems. Systems designed and marketed exclusively for outdoor applications are not eligible to be qualified.
1.02	Feb. 24, 2017	Clarified that the Technical Requirements do not cover DC or PoE systems.
2.0	Jun. 1, 2017	Version 2.0 published, with addition of outdoor control systems.
3.0	Jun. 1, 2018	Version 3.0 published, with addition of DC/PoE systems, scenes, and multi-year plans for energy monitoring and cybersecurity.
4.0	Jun. 10, 2019	Version 4.0 published, with addition of energy monitoring requirement, criteria for cybersecurity certifications, and building management systems capable of networked lighting control.
5.0	Jun. 23, 2020	NLC5 published, with addition of cybersecurity requirement. Energy monitoring definition aligned with ASHRAE 90.1-2016. Three capabilities labeled as supporting Interoperability.
5.1	June 28, 2024	NLC5.1 published with updated criteria for acceptable cybersecurity standards and services, and new section on NLC Primary Use Designations. The words “Interior” and “Exterior” were changed to “Indoor” and “Outdoor” to align with other DLC documents.

This document defines requirements to be met and capabilities to be reported for lighting control systems listed on the DesignLights Consortium (DLC) Networked Lighting Controls Qualified Products List (QPL).

Contents

Scope of Technical Requirements

These are requirements for indoor and outdoor networked lighting control (NLC) systems associated with commercial and industrial buildings, roadways, and outdoor environments. Note that while the DLC accepts outdoor NLC systems, these systems are not addressed comprehensively at present. NLC systems are defined for the purposes of these requirements as the combination of sensors, network interfaces, and controllers that effect lighting changes in luminaires, retrofit kits or lamps. Luminaires, retrofit kits, and lamps are qualified separately by the DLC's Solid-State Lighting Technical Requirements and Qualified Products List.

DC and PoE networked lighting control systems are eligible to be qualified, in conjunction with the SSL Testing and Reporting Requirements for DC and PoE Lamps, Luminaires, and Retrofit Kits.

Building management systems that control networked lighting plus other building systems, such as HVAC, are eligible to be qualified as NLC systems and listed on the QPL, provided that they meet all of the DLC's requirements for NLC. Note that the DLC does not claim to qualify any HVAC-specific capabilities of these systems at this time.

Horticultural control systems are not eligible to be qualified at this time.

Primary Use Designation

Different NLC systems are appropriate for different uses based on their capabilities. Each QPL-listed NLC system will qualify for one or more Primary Use Designations (PUDs), based on its capabilities, as listed below.

- *Room or Zone*: This phrase indicates a "room-based system", defined by the DLC as a system that is designed to control lighting in a single room or zone, and where the control, configuration, and management of the system is contained within the room or space illuminated by the system. In order to interact with the system, (for instance, to change any settings or to download any data), a user must be physically present in, or in close proximity to, the room or space illuminated by the system.
- A *Whole Building* system provides a centralized dashboard for energy monitoring and scene control across multiple rooms or zones within a single building.
- A *Portfolio/Enterprise* system provides a centralized dashboard for energy monitoring and scene control across multiple sites (such as multiple buildings across a college campus or multiple stores of a retail franchise).
- The *Structured Parking* PUD can apply to either indoor or outdoor systems that meet the indoor or outdoor requirements with weatherproof equipment.

The DLC NLC QPL reports on these Primary Uses for indoor systems:

- Room or Zone
- Whole Building
- Portfolio/Enterprise
- Structured Parking

The DLC NLC QPL reports on these Primary Uses for outdoor systems:

- Structured Parking

- Area/Building Outdoor/Parking
- Streetlight (Residential Streets)
- Roadway (Highways)

Definition of Required Versus Reported Capabilities

The Technical Requirements are built on **required** and **reported** system capabilities.

Required Capabilities: Required capabilities must be available in all systems to be listed on the QPL. Systems that do not offer these capabilities are not eligible to be listed. A successful application will provide information on the availability of these capabilities and characteristics. Key information provided by the manufacturer will be published on the QPL.

Note: While the DLC requires systems to offer a particular capability, the DLC does not specify whether a capability must be installed on a project. For example, while the DLC requires systems to have daylight harvesting/photocell capability, the DLC does not specify which rooms or luminaires on a project must be installed with daylight harvesting/photocell capability. Project-specific requirements for rebates and incentives are determined by individual efficiency programs.

Reported Capabilities: The DLC reports on the presence or absence of, type, and/or characteristics of each reported capability for qualified systems. While systems are not required to include these capabilities, a successful application will provide information on the presence or absence of these capabilities and their characteristics. Key information provided by the manufacturer will be published on the QPL.

Requirements Other Than Control Capabilities

Table 0 describes requirements for all DLC-qualified NLC systems, beyond the control capabilities described in **Tables 1, 1.1, 2, 2.1** and **3**. The complete qualification process is described here.

90 **Table 0. Requirements Other Than Control Capabilities**

Row	Requirement	Definition
1	Customer Available Information	In order for an applicant to claim a capability listed in **Tables NLC-1**, **NLC-1.1**, **NLC-2**, and/or **NLC-2.1**, the manufacturer's customer literature must specify that the system has the capability, with instructions, for how to configure and/or use this feature. *Customer available* means the documentation is for a finished product available publicly on a website, and/or included with the product packaging, and/or provided to the customer upon request. It may not be a document produced for the sole purpose of obtaining DLC qualification without further use or availability for customers. The DLC reserves the right to accept, reject, or require changes to documentation to satisfy this requirement. Any documentation provided to the DLC will be used for the purpose of verifying compliance with the DLC Technical Requirements and will not be made available or distributed publicly. The following capabilities from **Tables NLC-1**, **NLC-1.1**, **NLC-2**, and **NLC-2.1** are exempt from this requirement because their functionality does not depend on operator understanding: • Continuous Dimming • Individual Addressability • Luminaire Level Lighting Control (LLLC, embedded) • Networking • Ease of Implementation • Type of User Interface • Cybersecurity • Control Persistence
2	Warranty	The DLC requires a minimum warranty of five years for all components of the system addressed by the requirements, with the exception of software, on-premises computer server(s), and cloud service. An optional warranty extension to five years is acceptable for meeting this requirement; however, the NLC QPL will identify that an extended warranty must be purchased to meet the requirements.

Row	Requirement	Definition
3	Commercial Availability and Verification	Before they can be listed, all systems must be fully commercially available in the U.S. and/or Canada, must be able to be purchased, and must have complete, final documentation and literature readily available on the manufacturer's website or available to the customer upon request, as described in Row 1, "Customer Available Information". The DLC requires that a qualified system has been installed and operated successfully in at least one actual field installation at a third-party site (not occupied by the applicant or an agent of the applicant). The DLC will verify this through a case study and/or a customer reference. The facility may be of any size where all of the DLC-required capabilities are functional. Multiple sites may be used; for instance, occupancy sensing may be implemented at one site and high-end trim at another. If daylight harvesting is not available at a third-party site, then it may be demonstrated in a live webinar in an installation at a building owned by the manufacturer. Daylight harvesting is the only DLC-required capability eligible for this exception. Manufacturers of private label systems may submit an application two weeks before the system is launched. This approach requires the private label applicant to submit a letter of intent (template available here) during the application submission process confirming that the system will be launched within two weeks. When the system is commercially available, the applicant must notify the DLC at info@designlights.org. If the system is not yet commercially available after the two-week launch window, it will be temporarily delisted from the NLC QPL until it has been launched.
4	System Overview Presentation	As part of the application review process, the DLC requires a system overview to be presented via webinar or in-person to the DLC. (See the application form for more information.) For annual re-listings of a previously qualified system for which a recording of a prior presentation is available and the system has not changed extensively, this requirement may be waived or shortened.
5	Case Study, Customer Interview	A case study or a customer reference for a field site where the NLC system has been installed, that the DLC may contact to verify all DLC-required capabilities of the system, is required. The site may not be an office of the manufacturer or a business partner directly connected to the applicant, such as a lighting sales representative. The DLC wishes to confirm with an unbiased third party that the system has been installed and operated successfully in at least one actual field installation. This contact information will not be shared with any other parties. *Note:* The Customer Interview is required only for new OEM applications.

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Multi-Year Plans

In order to serve the long-term planning needs of stakeholders, the DLC has included multi-year plans for energy monitoring and cybersecurity in versions 3.0, 4.0, 5.0, and 5.1 of the Technical Requirements. These plans outline a general direction for each topic, subject to refinement through the stakeholder input process. After the release of NLC5, the DLC will develop a new multi-year plan for NLC. The process will involve extensive stakeholder engagement, including virtual and/or in person event(s).

Interoperability

Building systems, including networked lighting control (NLC) systems, increasingly need to cooperate and communicate with other systems beyond their boundaries to achieve a higher level of operational efficiency and energy savings. This communication of systems or system components and the ability to act upon the communicated information is called "interoperability". Interoperability among building components and systems is the key enabler for unlocking the benefits of multi-system operation and optimization. For background context, see the DLC's report "Interoperability for Networked Lighting Controls", published May 2020.

Interoperability is recognized in NLC5.1 as a new type of NLC capability. The interoperability capabilities shown in **Tables 1.1** and **2.1** below will assist in selection of products that support interoperability in relation to specific use cases. Over time, the DLC plans to recognize additional use cases and to report the system capabilities that support these use cases in order to assist end users in choosing appropriate systems for various uses.

As a starting point, the DLC has identified three use cases for initial priority in reporting interoperability. These three use cases are addressed by three corresponding capabilities: External Systems Integration, Load Shedding/Demand Response, and Energy Monitoring. Under the interoperability umbrella, the basic energy monitoring capability is **required**, while advanced aspects of energy monitoring, such as data content and format, are **reported**. Other capabilities are reported, but not required, as described in the section **Definition of Required Versus Reported Capabilities**, above. The DLC continues to track relevant standards as they develop.

Descriptions of the Three Initial Interoperability Use Cases:

1. **External Systems Integration:**
   Data from NLC components, such as luminaires, sensors, and controllers, is made available through an Application Programming Interface (API) or BMS[1], and can be utilized by other building systems to improve their operational efficiencies. Accessing the NLC component data using the API or BMS allows integration with other building systems, including the heating ventilation and air conditioning (HVAC) system, energy management system, security system, etc. For example, an HVAC system might use occupancy data from an NLC system.

   Reporting:
   An example of data about external systems integration that already exists in the DLC database is

[1] While open BMS protocols can be used instead of API, the need for extensive customized site-specific programming may limit the scalability of integration.

occupancy data granularity. Under NLC5.1, this data will be presented on the QPL as an aspect of interoperability. The NLC5.1 application will include additional **reported** information questions regarding communications with external systems through APIs and reporting frequency/latency/format.

2. **Load Shedding/Demand Response (LS/DR):**
Basic/1-way: A demand response signal is received by an NLC system, and the energy consumption of the system is reduced in a pre-defined way, on a temporary basis, without manual intervention.
Advanced/2-way: A control feedback loop and communication is established between a building's demand response server and a demand control originator (such as a grid operator, energy provider, microgrid, or onsite Distributed Energy Resource), so that the building modifies its real-time energy consumption in response to the originator's needs, and reports the results to the originator. The NLC participates in this ecosystem as one of the load-responding building systems.

Reporting:
Examples of data about communication for LS/DR[2] that already exist in the DLC database include power data availability, granularity, and accuracy; and supported versions of OpenADR. The NLC5.1 application may include additional **reported** information questions regarding LS/DR. The DLC will work with a multi-stakeholder group to explore LS/DR 1-way and 2-way communication, and to promote an ecosystem of load responding building systems that meet the requirements of **Table 3**, Row 16.

3. **Energy Monitoring (EM):**
Lighting system energy data is reported by the NLC and can be shared electronically (automatically or manually generated email) with authorized entities. For example, utility energy efficiency programs for NLCs can receive the energy data to verify energy savings. The lighting energy data may also be accessed for central display of facility energy end-use status or for a building portfolio management provider to benchmark energy performance. Ideally, the data will use a standardized data model, when available.

Requirement:
The basic capability of energy monitoring is **required**, with an exception for room-based systems. Data is reported via a .CSV file and/or an API. Methods of energy monitoring may include automated measurement methods and methods that require manual input of wattage to measure energy use. As part of the application or re-application process, each product that qualifies for energy monitoring must provide the DLC with a sample .CSV file or API documentation.

The energy monitoring capability is not required for room-based systems. A "room-based system" is defined in the **Primary Use Designation** section above. In order for a system to qualify for this exemption, the DLC review process must confirm that the product claims only

[2] For a recent exploration of this topic, see "The Value Proposition for Cost-Effective, Demand Responsive-Enabling, Nonresidential Lighting System Retrofits in California Buildings", April 2019, Peter Schwartz et al, https://www.energy.ca.gov/2019publications/CEC-500-2019-041/CEC-500-2019-041.pdf

"Room or Zone" for indoor scope as listed on the DLC QPL; and that if a room-based system is capable of being upgraded with an internet connection, then that upgraded system must meet all of the required capabilities of the Technical Requirements and be listed on the QPL.

The basic capability of energy monitoring is loosely aligned with ASHRAE 90.1-2016 Section 8.4.3 "Electrical Energy Monitoring", as outlined below in **Table 3**, Row 11.

Advanced capabilities of energy monitoring are reported information. In the absence of a more detailed applicable standard (beyond ASHRAE 90.1) describing energy data reports, details about data content in the following tables are **reported, not required**.

Tables EM-1 and **EM-2** describe the recommended (but not required) contents of an energy monitoring data report. The NLC QPL will report which systems offer these contents. This table is derived from the 2017 DLC report Energy Savings from Networked Lighting Control (NLC) Systems, Appendix A, Tables 8 and 9. The DLC is participating in the ANSI/NEMA C137 Committee to develop more specific data requirements. After the ANSI C137.9 "American National Standard for Lighting Systems—Networked Lighting Control Systems Configuration Report" has been published, the DLC will update the recommendations below to refer to ANSI C137.5 for the accuracy of data measurements, and to C137.9 for reports of configuration (static) data. In the meantime, the required content of an energy monitoring data report is described in **Table 3**, Row 11.

Table EM-1: Recommended Energy Data Reporting Guidelines for .CSV or API; Static Data

Row	Topic	Data Element	Definition	Note
1.1	Headings	For each field	Each type of data element is identified by a heading.	Text such as "Manufacturer", "Product", etc.
1.2	System	Manufacturer	The manufacturer of the NLC system.	Text
1.3	System	Product	The name of the NLC system.	Text
1.4	Site	Building/Business Type *[*Note A]*	The main business function in the portion of the building where the NLC system is installed.	From ASHRAE 90.1-2016 Table 9.5.1
1.5	Baseline for NLC	Maximum Rated Power with no control strategy enabled	The maximum possible power consumption of the lighting system without any control strategy in effect. If a luminaire retrofit has occurred, this value is equal to the maximum rated power of the new luminaire(s). The spatial granularity matches the energy measurements. For instance, if energy is reported at each luminaire, then the baseline power is reported at each luminaire.	Separate data for indoor vs. outdoor. Units = kilowatts

Row	Topic	Data Element	Definition	Note
1.6	Energy	Energy Reporting Interval *[*Note B]*	The frequency an energy measurement is reported (15 minutes or less).	Units = minutes
1.7	Energy	Data method	How is energy interval data calculated?	Text such as "15 minute average from 3 samples spaced 5 minutes apart"
1.8	Energy	Energy Data units	Energy data is in Wh or kWh?	Units = text such as "Wh" or "kWh"

Table EM-2: Recommended Energy Data Reporting Guidelines for .CSV or API; Dynamic Variables

Row	Topic	Data Element	Definition	Note
2.1	Headings	For each field	Each type of data element is identified by a heading.	Text such as "Unix Time", "Energy Data kWh", etc.
2.2	Energy	Timestamp	Date and time of each energy measurement.	Unix time or RFC 3339 time
2.3	Energy	Energy Data	The actual energy readings that are recorded for each luminaire or group of luminaires.	Units = kWh or Wh
2.4	Energy	Confidence Level	The percentage of all possible samples expected to include the true population parameter.	Units = %
2.5	Energy	Nominal Accuracy	% accuracy of the energy data. *[*Note C]*	Text such as "+/-3% or 0.005 kWh, whichever is larger"
2.6	Energy	Recorded Period	Months of 15 minute interval data in this particular record.	Units=months

Note A: For Building/Business Type, ASHRAE Standard 90.1-2016, "Energy Standard for Buildings Except Low-Rise Residential Buildings" Table 9.5.1 can be viewed at https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards, on page 155.

Note B: The need for 15 minute interval data is derived from the IPMVP Options A and B, as typically implemented by utility programs (International Performance Measurement and Verification Protocol: Core Concepts and Options for Determining Energy and Water Savings EVO-10000-1.2016, Efficiency Valuation Organization, https://evo-world.org).

Note C: The accuracy of the energy data as defined by the manufacturer. In the future, the DLC expects to recognize standards of accuracy as they become available from ANSI C136 and C137.

Note D: The required interval of the energy data as defined in **Table 3** below.

Cybersecurity

In alignment with the multi-year cybersecurity plan previously published in versions 3.0 and 4.0 of this document, the cybersecurity capability is now **required**. The criteria have been expanded to offer more options for compliance.

- While the standards in **Table CS-1** and services in **Table CS-2** can be applied to NLCs, not all of their requirements may be relevant for various applications of lighting control systems. Manufacturers and their certification bodies should review each option to identify the appropriate requirements for each system being qualified, and customers should select product requirements based on the risk profile of each project.
- In order to claim the cybersecurity capability, a system must, at the time of qualification, have a valid certification for one or more of the specified standards in **Table CS-1**, or services in **Table CS-2**.
- The list of applicable standards in **Table CS-1** and services in **Table CS-2** will be reviewed for each incremental revision to the Technical Requirements, or annually, whichever comes sooner. Applications referring to a potential new standard or service will only be accepted for review after the new standard or service has been vetted, and an updated set of Technical Requirements has been published. The addition of a new standard or service may only warrant a minor Technical Requirements dated update.
- Certification in any one of the four categories of **Table CS-1** (Process, Components, System, Cloud Services) is sufficient.
- **Table CS-3** describes how DLC reviewers will confirm compliance.
- The DLC will confirm that cybersecurity certification will be valid for at least 12 months after the time of application submission. If the certification will expire within a year, the NLC manufacturer must submit a letter of intention of renewal with the application and must provide an updated certificate upon its expiration, in compliance with **Table CS-2** or **CS-3**, to avoid being delisted.
- The DLC will confirm cybersecurity certification once a year in July. If a certificate has lapsed, a system must recertify in order to avoid being delisted.
- Some cybersecurity certifications offer different levels of compliance based on risk management. For instance, some standards offer lower performance requirements for room level systems that cannot be upgraded to add a permanent internet connection. Therefore, the DLC cybersecurity requirement applies to all systems—with the understanding that comprehensive systems with many capabilities are subject to more rigor, compared to simple systems with few capabilities.

Cybersecurity Standards Definitions:

- **Cloud Services:** Standards for cloud services that address secure integration with services from a remote cloud computing provider.
- **Components:** Standards that address the cybersecurity of each individual physical end device in a networked system.

- **Cybersecurity:** The practice of defending networked systems and data from malicious attacks.
- **Process:** Standards that address the development process in order to reduce the number of cybersecurity vulnerabilities that are designed into components, systems, and services, and that manifest over the product lifecycle.
- **System:** Standards that address the networked system, including aspects such as authentication, data confidentiality, system integrity, service availability, protocol converters, firewalls, gateways, web servers, and web services interfaces.

Criteria for Acceptable Cybersecurity Standards:

The DLC recognizes the cybersecurity standards listed in **Table CS-1** that meet criteria 1-3 below, and the cybersecurity services listed in **Table CS-2** that meet criteria 2-3 below:

1. Certifiable with a methodology established through one of the following:
    a. A voluntary consensus process such as ANSI, ISO, IEC, etc.
    b. A federal agency of the USA or Canada
    c. A collaborative multi-stakeholder engagement process such as the Cloud Security Alliance
2. Applies to one or more of the following:
    a. Product development process lifecycle
    b. Components/embedded devices
    c. System
    d. Cloud services
3. Includes at least 3 of the following technical content, for (2.b, 2.c, and/or 2.d) above:
    a. Penetration testing
    b. Communication robustness testing
    c. Vulnerability identification testing
    d. Multiple levels of security
    e. Root of Trust with trusted boot and secure storage of encrypted data
    f. Assessment by accredited entity

List of Certifications:

Cybersecurity standards and cybersecurity services that meet the criteria listed above are shown in **Tables CS-1** and **CS-2**, respectively. Once a certification (i.e., a standard or a service) is listed here, the DLC does not expect to remove it with less than two years' notice.

As new cybersecurity standards and/or certification pathways become available, the DLC will evaluate them and update these tables accordingly.

271 **Table CS-1: Cybersecurity Standards Recognized by the DLC**

Standard	Process	Components/ Embedded Devices	System	Cloud Services
ANSI/UL 2900-1	y	y		
ANSI/ISA/IEC 62443	62443-4-1	62443-4-2	62443-3-3	
SOC 2	y		y	y
ISO 27001	y			
ISO 27017 (with 27001)				y
FedRAMP				y
CSA STAR				y
ioXt		y	y	y
PSA Certified		y	y	
CSA/ANSI T200*	y	y	y	

272 * This was previously a cybersecurity service that is now a published Standard.

273 **Table CS-2: Cybersecurity Services Recognized by the DLC**

Service	Proof of Compliance
UL IoT Security Rating (UL 1376)	Copy of certificate or letter from UL
Intertek Cyber Assured	Copy of certificate or letter from Intertek

274 **Table CS-3: Proof of Cybersecurity Standard Compliance**

Standard	Proof of Compliance
ANSI/UL 2900-1	Certification claim listed on applicant's website, plus a compliance letter or copy of certificate issued by an accredited certification body.
IEC 62443	ISASecure registry of a component, system, or Certified Development Organization at https://www.isasecure.org/en-US/End-Users, or Copy of IECEE certificate, or listed at https://certificates.iecee.org/ods/cb_hm.xsp, or Copy of certificate from other accredited agency, such as UL, VDE, DEKRA, etc.
SOC 2	Certification claim listed on applicant's website, plus a compliance letter from third-party auditor.

Standard	Proof of Compliance
ISO 27001	Copy of an accredited certification from a member of the ANSI-ASQ National Accreditation Board as listed at http://anabdirectory.remoteauditor.com, or Copy of an accredited certification from an organization accredited as "Management Systems Certification Bodies" for ISO 27001 by the International Accreditation Service (IAS) at https://www.iasonline.org/search-accredited-organizations-2
ISO 27017 (with 27001)	Copy of an accredited certification from a member of the ANSI-ASQ National Accreditation Board as listed at http://anabdirectory.remoteauditor.com
FedRAMP	"Authorized" at https://marketplace.fedramp.gov/products
CSA STAR	"Certification" or "Attestation" at https://cloudsecurityalliance.org/star/registry
ioXt	Copy of ioXt certificate or letter from accredited testing organization or certified at https://compliance.ioxtalliance.org/products
PSA Certified	Listed at https://www.psacertified.org/certified-products
CSA/ANSI T200	Certification claim listed on applicant's website, plus a compliance letter or copy of certificate, from CSA or from an accredited lab along with a copy of a letter of accreditation from CSA.

275 *Renewal is required at least every 3 years in order for a certificate to remain valid.*

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Requirements for Indoor Lighting Systems

Table 1 summarizes **required** and **reported** system capabilities for indoor lighting systems, and **Table 1.1** summarizes **required** and **reported** system capabilities pertaining to interoperability for indoor lighting systems.

Table 1: Required and Reported Capabilities for Indoor Lighting Systems

Required **Indoor System Capabilities**
Networking of Luminaires and Devices
Occupancy Sensing
Daylight Harvesting/Photocell Control
High-End Trim
Zoning
Individual Addressability
Continuous Dimming
Cybersecurity

Reported **Indoor System Capabilities**
Control Persistence
Scheduling
Device Monitoring/Remote Diagnostics
Type of User Interface
Luminaire Level Lighting Control (LLLC, integrated)
Personal Control
Plug Load Control
Emergency Lighting
Color Changing/Tuning
Ease of Implementation
Scene Control

Table 1.1: Indoor Lighting System Capabilities Focused on Interoperability

Required **Indoor System Capabilities**
Energy Monitoring (except room-based systems)

Reported **Indoor System Capabilities**
Energy Monitoring (room-based systems)
Load Shedding/Demand Response
External Systems Integration

Requirements for Outdoor Lighting Systems

Table 2 summarizes **required** and **reported** system capabilities for outdoor lighting systems, and **Table 2.1** summarizes **required** and **reported** system capabilities pertaining to interoperability for outdoor lighting systems.

Table 2: Required and Reported Capabilities for Outdoor Lighting Systems

Required **Outdoor System Capabilities**
Networking of Luminaires and Devices
Occupancy Sensing AND/OR Traffic Sensing
Daylight Harvesting/Photocell Control
High-End Trim
Zoning
Individual Addressability
Continuous Dimming
Scheduling
Cybersecurity

Reported **Outdoor System Capabilities**
Control Persistence
Device Monitoring/Remote Diagnostics
Type of User Interface
Luminaire Level Lighting Control (LLLC, integrated)
Emergency Lighting
Color Changing/Tuning
Ease of Implementation
Scene Control

Table 2.1: Outdoor Lighting System Capabilities Focused on Interoperability

Required **Outdoor System Capabilities**
Energy Monitoring

Reported **Outdoor System Capabilities**
Load Shedding/Demand Response
External Systems Integration

Capability and Requirement Definitions

Table 3 provides a definition of each capability. This table applies to both Indoor and Outdoor systems, except where noted. If an applicant answers 'yes' to a capability definition in **Table 3**, that capability can be claimed. If an applicant answers 'no', then the capability cannot be claimed. The DLC NLC application form specifies in more detail the information the DLC asks about each capability, and the information that will be published on the QPL. Beyond the basic definitions shown in **Table 3**, the DLC NLC application contains additional questions about most capabilities. After answering 'yes' to the first key question about a capability, an applicant can answer additional questions about that capability with any well-documented response.

Note: Some NLC systems control luminaires and retrofit kits, and some NLC systems control lamps within luminaires. The latter systems use a wireless controller integrated inside each lamp. The "luminaires/lamps" phrase indicates that a requirement applies to luminaires and retrofit kits if an NLC system controls luminaires and retrofit kits; and the requirement applies to lamps if an NLC system controls lamps.

Table 3: Definitions of Capabilities and Requirements

Row	Capability	Requirements
1	Networking of Luminaires and Devices	The capability of individual luminaires/lamps and control devices to exchange digital data with other luminaires/lamps and control devices on the system. This capability is required at the room, space, or area level, but not at the whole building level or beyond (e.g. non-lighting systems, or the internet).
2	Occupancy Sensing	The capability to affect the operation of lighting equipment based upon detecting the presence or absence of people in a space or outdoor environment. Outdoor systems must include either occupancy sensing or traffic sensing. They may include both, but that is not required.
3	Traffic Sensing	The capability to affect the operation of lighting or other equipment based upon detecting the presence or absence of moving vehicles in an area. Systems may satisfy this requirement through external systems integration as described below in lieu of in-system sensors if another source of data is used for presence or absence detection. Outdoor systems must include either occupancy sensing or traffic sensing. They may include both, but that is not required.
4	Daylight Harvesting / Photocell Control	The capability to 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, or outdoor environment. This capability is typically called daylight harvesting for indoor systems, and photocell control for outdoor systems.

Row	Capability	Requirements
5	High-End Trim*	The capability to set the maximum light output to a less-than-maximum state of an individual or group of luminaires/lamps at the time of installation or commissioning. High-end trim must be field reconfigurable. This capability is distinct from automatic compensation for lumen depreciation, which automatically increases output as a system operates over time. *While the DLC specifically requires "High-end trim", some manufacturers refer to this capability as "**task tuning**" or "**tuning**" within their system interfaces. Refer to NEMA LSD 64-2014 for definitions of lighting controls terminology.
6	Zoning	The capability to group luminaires/lamps and form unique lighting control zones for a control strategy via software-defined means, and not via physical configuration of mechanical or electrical installation details (e.g. wiring). *Indoor:* Zoning is required for occupancy sensing, high-end trim, and daylight harvesting control strategies except for systems that feature luminaire level lighting control (LLLC) capabilities as defined in these requirements under "Reported Capabilities", in which case zoning is only required for occupancy sensing and high-end trim control strategies. *Outdoor:* Zoning is required for high-end trim.
7	Individual Addressability	The ability to communicate digitally and uniquely with each individual luminaire/lamp, sensor, controller, and user interface device in the lighting system, allowing for software-controlled configuration and re-configuration of devices and control zones independent of electrical circuiting.
8	Continuous Dimming	The capability of a control system to provide control with sufficient resolution in output (100+ steps) to support light level changes perceived as smooth (as opposed to step dimming with a small number of discrete light levels). At least one user interface needs to support continuous dimming, but not every user interface needs to have that capability.
9	Control Persistence	The capability of a networked lighting control system's lowest-level ("edge device") luminaire/lamp controllers to execute three energy saving strategies (occupancy sensing, daylight harvesting, and high-end trim) at a room-level, or finer, resolution in the absence of communications with the next higher networked element in the system's topology.
10	Scheduling	A control strategy that controls lighting, equipment, or systems based on time of day or astronomical event. For example, scheduling building lighting to be automatically turned off at 6 p.m. or at sunset. Scheduling capability is reported for indoor systems and required for outdoor systems. Outdoor systems are required to have time-based scheduling, and "astronomical" scheduling functionality for sunrise and sunset programming, based on geographical location and time of year.

Row	Capability	Requirements

11	Energy Monitoring	The capability of a system to report the energy consumption of a luminaire/lamp and/or a group of luminaires/lamps.
		• Individual luminaire/lamp monitoring as well as energy monitoring on dedicated lighting circuits is acceptable.
		• The method by which the system implements this capability must be clearly described, including whether the system provides automated energy measurement or relies on numerical manual input during system setup for accurate measurement (such as inputting the wattage of each luminaire/lamp in a project).
		• Reference consists of one or both of:
		  ○ Sample .CSV file with documentation
		  ○ API documentation
		• The basic, **required** capability of energy monitoring is aligned with ASHRAE 90.1-2016 Section 8.4.3. as follows:
		  ○ Energy use by indoor lighting (if applicable), outdoor lighting (if applicable) and receptacle circuits (if monitored by the NLC) can be monitored independently.
		  ○ For buildings with tenants, the data for each tenant space can be reported to each tenant.
		  ○ Energy use data can be transmitted to a building control system (if present) and graphically displayed.
		  ○ The lighting system energy use can be recorded and stored in either of the two ways described below.
		  1) Data is recorded at least once every 15 minutes and reported at least hourly, daily, monthly, and annually, or recorded and reported upon state change, with data stored for at least 24 months, or
		  2) At any time during the first year after original configuration, the preceding 4 weeks of 15-minute interval data can be reported, and daily interval data can be reported since original configuration.
		• Energy monitoring is **reported** for room-based systems, but not **required**. A “room-based system” is defined in the “Primary Use Designations” section above. In order for room-based systems to claim the optional energy monitoring capability:
		  ○ Energy data can be retrieved by a user in the room when required - hourly, daily, monthly or yearly; or on demand; and
		  ○ Energy data can be retrieved in the form of a CSV file and/or API; and
		  ○ In order for a system to qualify for the room-based exemption, the DLC review process will confirm that the product claims only “Room or Zone” for indoor scope as listed on the DLC QPL.

Row	Capability	Requirements
12	Device Monitoring / Remote Diagnostics	The capability to monitor, diagnose, and report operational performance including system and/or component failures.
13	Type of User Interface	The type of interface provided by the control system for users to read and adjust control system settings during system start-up, commissioning, and/or ongoing operation.
14	Luminaire Level Lighting Control (LLLC, integrated)	The capability to have a networked occupancy sensor and ambient light sensor installed for each luminaire or kit, and directly integrated or embedded into the form factor during the luminaire or kit manufacturing process. In addition to these required integrated components, LLLC systems must have control persistence capability as described in this document. To demonstrate commercial availability of the integrated component options, at least one family, luminaire or kit with integrated control must be verified by the DLC. Manufacturers may choose whether or not to list this information publicly on the QPL.
15	Personal Control	The capability for individual users to adjust to their personal preferences, via networked means, the illuminated environment of a light fixture or group on of light fixtures in a specific task area. The publicly available information must clearly describe a control interface for use by a single individual who does not have access to system-wide settings. A wireless dimmer switch may only be considered a personal control interface if product documentation: • Shows that the physical configuration is suitable for workstation use (i.e., a small, self-contained unit without any external wiring, suitable for use as a handheld remote control), and • Describes configuration for personal control within a larger area. A software-based interface may only be considered personal control if product documentation: • Shows it provides a specific interface intended for personal control by an individual user within a subsection of a larger space, and • The interface only allows access to personal control functions for the light fixtures in the specific areas being controlled (i.e., each occupant can control their own area, but not their neighbors' areas).

Row	Capability	Requirements
16	Load Shedding/ Demand Response	The capability to reduce the energy consumption of a lighting system, in a pre-defined way, on a temporary basis, in response to a demand response signal without manual intervention. The method by which the system implements this capability (managed by NLC and/or BMS) must be clearly described in the publicly available reference(s). The method for pre-defining the system behavior for temporary load reduction must be accessible through a user interface. The data the NLC can receive and interpret from other networked systems must include at least a signal that can be used for purposes such as LS/DR.
17	Plug Load Control	The capability to control the power delivered to receptacles through scheduling or occupancy sensing. The method by which the system implements this capability must be clearly described in the publicly available reference(s).
18	External Systems Integration (e.g. BMS, EMS, HVAC, Lighting, API, Cloud)	The capability to exchange data with other networked systems such as building or energy management systems (BMS/EMS), heating ventilation and air conditioning (HVAC) systems, or other lighting and building systems via BACnet, Modbus, LonWorks or other open protocols, application program interface (API) or other methods. In order to claim this **reported** capability, the data available from the NLC for exchange with other networked systems must include occupancy status at the zone, space, or area level and energy data at the zone-, circuit- or system-level. The data the NLC can receive and interpret from other networked systems must be digital, that can be used for purposes such as scene control, zones, groups, areas, regions, and/or presets. The method, including formats and languages, by which the system implements this capability must be clearly described in the publicly available reference(s).
19	Emergency Lighting	Publicly available documentation illustrating how a system's luminaires connect with an emergency power source. The QPL will provide the URL(s) for online documentation provided by manufacturers for system designers to refer to. This documentation will identify wiring diagrams, required components, and/or application guides needed to understand design considerations for integrating the system into an emergency lighting system.

Row	Capability	Requirements
20	Cybersecurity	A cybersecurity certification that meets the DLC criteria. The current standards are shown in **Table CS-1** and listed here: • ANSI/UL 2900-1 • IEC 62443 • SOC 2 • ISO 27001 • ISO 27017 (with 27001) • FedRAMP • CSA STAR • ioXt The current services are shown in **Table CS-2** and listed here: • UL IoT Security Rating (UL 1376) • CSA Cybersecurity Verification Program (CVP) (CSA T200) • Intertek Cyber Assured Documentation requirements to demonstrate certification are shown in **Tables CS-2** and **CS-3**.
21	Color Changing / Tuning	The capability to alter the output and color of tunable white and/or variable color output luminaires via a dedicated control interface(s). To demonstrate compliance with this capability, the interface(s) must be clearly described in the product literature and allow for at least two CCT settings. These settings may be described in terms of CCT, such as 3000K or 5000K, or simple descriptive terms for the desired setting such as 'Night' or 'Day'. The product literature must also specify installation and configuration requirements to implement this functionality.
22	Ease of Implementation	The QPL will identify the most typical responsible party and their required level of training to start-up and configure the system to the extent that all required capabilities are functioning. Documentation is not required.
23	Scenes	The capability of a system to provide two or more pre-programmed light level settings for a group or multiple groups of luminaires to suit multiple activities in a space, and allow for recall of these settings via a switch, control device, or signal from a BMS or API.

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Policy Clarifications and Updates

As the DLC processes applications for NLC5.1 and interacts with stakeholders, we encounter opportunities for minor corrections, terminology clarifications, and policy interpretations. In order to be as transparent as possible, the NLC Technical Requirements will be updated as needed, and the changes will be tracked in the table below and on the DLC website. **Table 4** will show the corrections or clarifications and where they can be found in the document.

Table 1: Updates and Clarifications, Published as Needed

Date Updated	Subject	Change Type	Description	Affected Page(s)