Networked Lighting Control System Technical Requirements

Draft Version NLC5.1

Released for comment: April 22, 2024

This draft version of the Technical Requirements document contains updates and clarifications made to the previously released NLC5.0 document, which are highlighted in yellow.

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 interior control systems. Systems designed and marketed exclusively for exterior 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 exterior 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	2024	Updated recommendations for energy reporting, criteria for acceptable cybersecurity standards and services, explanation of NLC Primary Use Designation.

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 interior and exterior networked lighting control (NLC) systems associated with commercial and industrial buildings, roadways, and exterior environments. Note that while the DLC accepts exterior 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. For example, a *Portfolio/Enterprise* systemo would provide a centralized dashboard for energy monitoring and scene control across multiple sites (such as all the buildings of a college campus). The *Room or Zone* PUD is defined in the Energy Monitoring section below. 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 three Primary Uses for indoor systems:

- Room or Zone
- Portfolio/Enterprise
- Structured Parking

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

- Structured Parking
- Area/Building Exterior/Parking
- Streetlight (Residential Streets)
- Roadway (Highways)
- Smart City

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

64 provide information on the availability of these capabilities and characteristics. Key information
65 provided by the manufacturer will be published on the QPL.

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

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

76 # Requirements Other Than Control Capabilities

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

79 **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: • Continuous Dimming • Individual Addressability • Luminaire Level Lighting Control (LLLC, embedded) • Networking • Ease of Implementation • Type of User Interface • Cybersecurity • Control Persistence

Row	Requirement	Definition
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.
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.

Row	Requirement	Definition
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.

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 from multi-system operation and optimization. For background context, please 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 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.
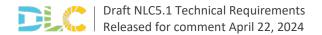
   Reporting:

   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

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[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.

[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

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 as a system that is designed to control lighting in a single room or space, 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.

In order for a system to qualify for this exemption, the DLC review process must confirm that the product claims only "Room or Zone" for interior 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. The original version of **Tables EM-1** and **EM-2** were derived from the 2017 DLC report "Energy Savings from Networked Lighting Control (NLC) Systems", Appendix A, Tables 8 and 9.

NLC5.1 introduces revised tables, developed in a 2021 DLC working group, reported in a 2022 DLC webinar, and revised in 2023 with ongoing stakeholder input.

Table EM-0. Efficiency Program Use Case Support Table

Row	Topic	Specification
0.01	Standard for energy reporting	Conform to ANSI C137.5-2021
0.02	Reported energy metric	Period of cumulative energy use (not savings)
0.03	Reported unit	Kilowatt-hours (kWh)

0.04	Spatial granularity	Collections of NLC devices, larger than an individual luminaire and smaller than a whole building, from contiguous areas that make sense based on the function or location of the space. Ideally organized by space type lighting classification.
0.05	Reporting format	.CSV or Excel file preferred. Alternatively, API is also acceptable to the DLC, and possibly some efficiency programs.
0.06	Record duration and data interval	Two years of 15-minute interval data *or:* Four weeks of 15-minute interval data* and 12 months of daily interval data**
0.07	Reporting resolution	Minimum resolution of 1 kWh, *and* sufficient fractional kWh resolution to match the accuracy level specified in ANSI C137.5-2021. In many groups, over a 15-minute interval, this will be in the ten-thousandths of a kWh (0.1 Wh = 0.0001 kWh).

173 *Table notes:*
174 * During the first year after original configuration, the preceding four weeks of 15-minute interval data may
175   be reported at any time; for instance, after four weeks of a new academic term or new production cycle.
176 ** During the first year after original configuration, daily interval data since original configuration may be reported.

177 **Table EM-1. Energy Data Reporting Guidelines: Static Data**

Row	Data Level	Recommended Header	Definition	Unit
1.01	Site/System			
1.02		Site name	A uniquely identifiable name of the site of the NLC installation.	Text
1.03		System rated power	Total lighting power of the system, regardless of controls.	kW
1.04	Space Type			
1.05		Space Type ID	Uniquely identifiable name for this non-overlapping collection of luminaires, ideally organized by space type lighting classification.	Text
1.06		Rated power	Total rated power of all luminaires within this non-overlapping collection.	kW
1.07		High-end trim	The percentage of maximum output power programmed for this space type (e.g. 100% = no high-end trim).	%
1.08		Occupancy/vacancy sensing	Indicate whether occupancy/vacancy sensing is enabled for this space type.	Y/N
1.09		Daylight harvesting	Indicate whether daylight harvesting is enabled for this space type.	Y/N

178 **Table EM-2. Energy Data Reporting Guidelines: Dynamic Variables**

Row	Recommended Header	Definition	Unit	Note
2.1	Timestamp	Date and time in UTC when energy consumption is reported based on the reporting duration and data interval.	Excel Date & Time Value in UTC	Must support arithmetic and pivot table grouping in Excel.
2.2	Group ID	Uniquely identifiable name for each non-overlapping group of luminaires.	text	Must match the names in the static data table.
2.3	Active Energy	The integral of the instantaneous power over a time interval, cumulative since device initialization, non-resettable.	kWh	

179 ## Cybersecurity

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

183 • While the standards in **Table CS-1** and services in **Table CS-2** can be applied to NLCs, not all of
184   their requirements may be relevant for various applications of lighting control systems.

185 • Manufacturers and their certification bodies should review each option to identify the
186   appropriate requirements for each system being qualified, and customers should select product
187   requirements based on the risk profile of each project.

188 • In order to claim the cybersecurity capability, a system must, at the time of qualification, have a
189   valid certification for one or more of the specified standards in **Table CS-1**, or services in **Table**
190   **CS-2**.

191 • The list of applicable standards in **Table CS-1** and services in **Table CS-2** will be reviewed for each
192   incremental revision to the Technical Requirements, or annually, whichever comes sooner.
193   Applications referring to a potential new standard or service will only be accepted for review
194   after the new standard or service has been vetted, and an updated set of Technical Requirement
195   has been published. The addition of a new standard or service may only warrant a minor
196   Technical Requirements dated update.

197 • Certification in any one of the four categories of **Table CS-1** (Process, Components, System,
198   Cloud Services) is sufficient.

199 • **Table CS-3** describes how DLC reviewers will confirm compliance.

200 • The DLC will confirm that cybersecurity certification will be valid for at least 12 months after the
201   time of application submission. If the certification will expire within a year, the NLC
202   manufacturer must submit a letter of intention of renewal with the application and must
203   provide an updated certificate upon its expiration, in compliance with **Table CS-2** or **CS-3**, to
204   avoid being delisted.

205 • The DLC will confirm cybersecurity certification once a year in July. If a certificate has lapsed, a
206 system must recertify in order to avoid being delisted.

207 • Some cybersecurity certifications offer different levels of compliance based on risk
208 management. For instance, some standards offer lower performance requirements for room
209 level systems that cannot be upgraded to add a permanent internet connection. Therefore, the
210 DLC cybersecurity requirement applies to all systems—with the understanding that
211 comprehensive systems with many capabilities are subject to more rigor, compared to simple
212 systems with few capabilities.

213 **Cybersecurity Standards Definitions:**

214 • **Cloud Services:** Standards for cloud services that address secure integration with services from a
215 remote cloud computing provider.

216 • **Components:** Standards that address the cybersecurity of each individual physical end device in
217 a networked system.

218 • **Cybersecurity:** The practice of defending networked systems and data from malicious attacks.

219 • **Process:** Standards that address the development process in order to reduce the number of
220 cybersecurity vulnerabilities that are designed into components, systems, and services, and that
221 manifest over the product lifecycle.

222 • **System:** Standards that address the networked system, including aspects such as authentication,
223 data confidentiality, system integrity, service availability, protocol converters, firewalls,
224 gateways, web servers, and web services interfaces.

225 **Criteria for Acceptable Cybersecurity Standards:**

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

228 1. Certifiable with a methodology established through one of the following:

229 a. A voluntary consensus process such as ANSI, ISO, IEC, etc.
230 b. A federal agency of the USA or Canada
231 c. A collaborative multi-stakeholder engagement process such as the Cloud Security
232 Alliance

233 2. Applies to one or more of the following:

234 a. Product development process lifecycle
235 b. Components/Embedded Devices
236 c. System
237 d. Cloud Services

238 3. Includes at least 3 of the following technical content, for (2.b, 2.c, and/or 2.d) above:

239 a. Penetration testing
240 b. Communication robustness testing
241 c. Vulnerability identification testing
242 d. Multiple levels of security
243 e. Root of Trust with trusted boot and secure storage of encrypted data

244 f. Assessment by accredited entity

List of Certifications:

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

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

251 **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	

252 **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
CSA Cybersecurity Verification Program (CVP) (CSA T200) *	Copy of certificate or letter from CSA
Intertek Cyber Assured	Copy of certificate or letter from Intertek

253 * This Service has now been published as a Standard.

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

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

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 3rd party auditor.
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?status=Compliant;FedRAMP%20Ready&sort=productName
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.

257 *Table note:* Renewal is required at least every three years for a certificate to remain valid.

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Requirements for Interior Lighting Systems

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260 **Table 1** summarizes **required** and **reported** system capabilities for interior lighting systems, and **Table**
261 **1.1** summarizes **required** and **reported** system capabilities pertaining to interoperability for interior
262 lighting systems.

263 **Table 1: Required and Reported Capabilities for Interior Lighting Systems**

Required Interior System Capabilities	*Reported* Interior System Capabilities
Networking of Luminaires and Devices	Control Persistence
Occupancy Sensing	Scheduling
Daylight Harvesting/Photocell Control	Device Monitoring/Remote Diagnostics
High-End Trim	Type of User Interface
Zoning	Luminaire Level Lighting Control (LLLC, integrated)
Individual Addressability	Personal Control
Continuous Dimming	Plug Load Control
Cybersecurity	Emergency Lighting
	Color Changing/Tuning
	Ease of Implementation
	Scene Control

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265 **Table 1.1: Interior Lighting System Capabilities Focused on Interoperability**

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

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268 Requirements for Exterior Lighting Systems

269 **Table 2** summarizes **required** and **reported** system capabilities for exterior lighting systems, and **Table**
270 **2.1** summarizes **required** and **reported** system capabilities pertaining to interoperability for exterior
271 lighting systems.

272 **Table 2: "Required" and "Reported" Capabilities for Exterior Lighting Systems**

Required Exterior System Capabilities	*Reported* Exterior System Capabilities
Networking of Luminaires and Devices	Control Persistence
Occupancy Sensing AND/OR Traffic Sensing	Device Monitoring/Remote Diagnostics
Daylight Harvesting/Photocell Control	Type of User Interface
High-End Trim	Luminaire Level Lighting Control (LLLC, integrated)
Zoning	Emergency Lighting
Individual Addressability	Color Changing/Tuning
Continuous Dimming	Ease of Implementation
Scheduling	Scene Control
Cybersecurity	

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274 **Table 2.1: Exterior Lighting System Capabilities Focused on Interoperability**

Required Exterior System Capabilities	*Reported* Exterior System Capabilities
Energy Monitoring	Load Shedding/Demand Response
	External Systems Integration

275

Capability and Requirement Definitions

276

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

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

290 **Table 3: Definitions of Capabilities & 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 exterior environment. Exterior 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. Exterior 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 exterior environment. This capability is typically called daylight harvesting for interior systems, and photocell control for exterior 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). *Interior:* 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. *Exterior:* 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 interior systems and required for exterior systems. Exterior 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:
		   o Sample .CSV file with documentation
		   o API documentation
		• The basic, **required** capability of energy monitoring is aligned with ASHRAE 90.1-2016 Section 8.4.3. as follows:
		   o Energy use by interior lighting (if applicable), exterior lighting (if applicable) and receptacle circuits (if monitored by the NLC) can be monitored independently.
		   o For buildings with tenants, the data for each tenant space can be reported to each tenant.
		   o Energy use data can be transmitted to a building control system (if present) and graphically displayed.
		   o 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**. In order for room-based systems to claim the optional energy monitoring capability:
		   o Energy data can be retrieved by a user in the room when required - hourly, daily, monthly or yearly; or on demand; ==and==
		   o Energy data can be retrieved in the form of a CSV file and/or API; ==and==
		   o 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 interior 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)