

Model Specification for Networked Outdoor Lighting Control Systems

Version: 2.0

Prepared by:
MSSLC Lighting Control Task Force

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The MSSLC welcomes questions about the goals and development of this tool, and suggestions for its improvement. Municipalities or utilities that are particularly interested in further developing the model specification are encouraged to inquire about joining the MSSLC task force that continues to seek ways to improve this resource. Please send comments and questions to MSSLC@pnnl.gov

BACKGROUND

The U.S. Department of Energy (DOE) Municipal Solid-State Street Lighting Consortium's effort to develop a model specification for adaptive control and remote monitoring of LED roadway luminaires began on September 29, 2010 with the initiation of a task force consisting of representatives of municipalities, electric utilities and others who recognized the potential this technology held to improve service and further conserve energy.

The DOE Municipal Solid-State Street Lighting Consortium's Model Specification for Networked Outdoor Lighting Control Systems (formerly known as the Model Specification for Adaptive Control and Remote Monitoring of LED Roadway Luminaires) is a tool designed to help cities, utilities, and other local agencies accelerate their adoption of systems that can further reduce the energy and maintenance costs of operating their streetlights. While the capabilities of monitoring and control systems on the market are enticing, many of these raise questions for users who are uncertain about how (or even if) they should be implemented, and how their true value can be assessed. As a result, user interests currently vary widely and are likely to continue to do so for the foreseeable future, until adaptive lighting best practices and the ability to forecast energy and maintenance savings (along with the value of other features) become more universally proven.

The model specification provides both a suggested set of high-level requirements and a template for translating unique user needs into clear and consistent specification language. The first version of the document underwent a formal public review, where input from users, technology providers, and other industry stakeholders was used to determine: what requirements should be mandatory; how best to support the breadth of system architectures and features available in the marketplace; and where the development of standards that reduce user risk could be encouraged. The market for this technology and its commercial offerings are still in their infancy, however, and likely to evolve over time. The model specification is therefore intended to be a living document, open to ongoing public review and comment, which will likewise evolve to accommodate changes in the market.

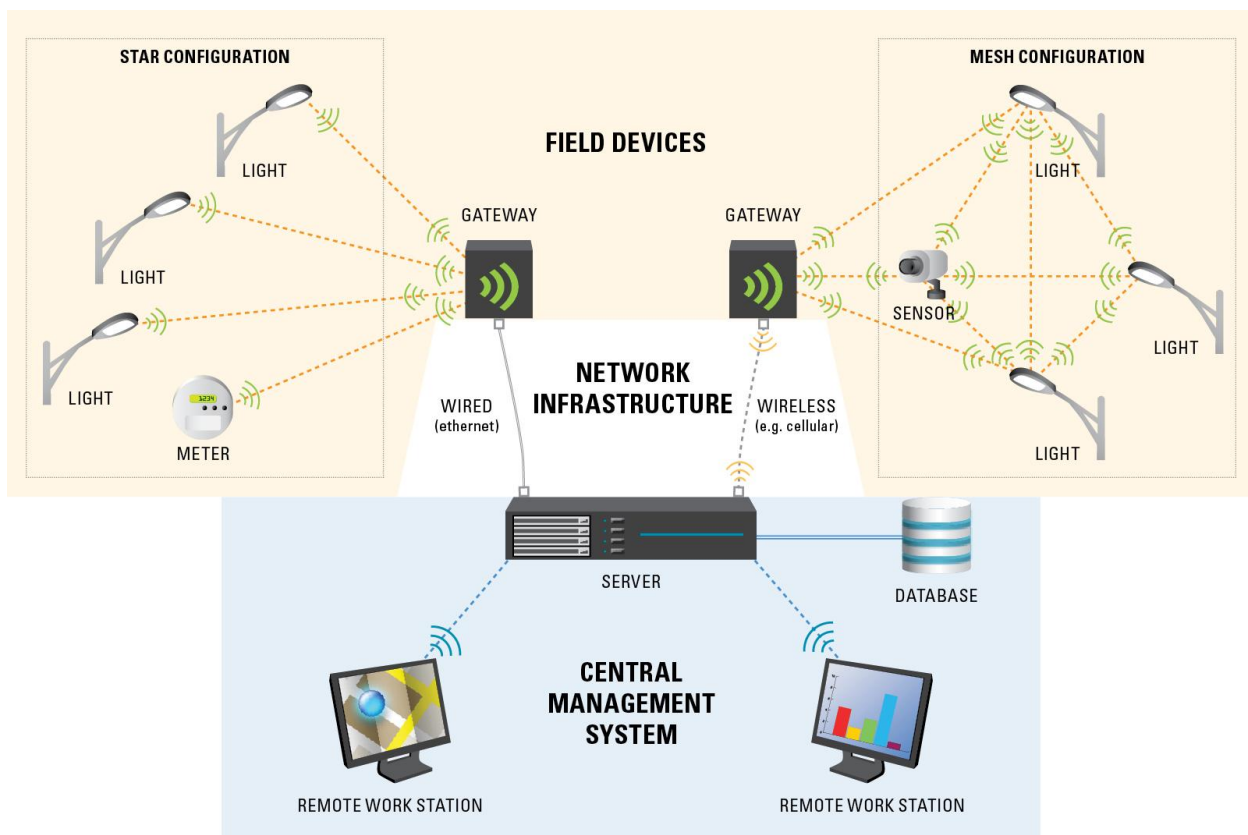
ACKNOWLEDGEMENTS

This Model Specification for Networked Outdoor Lighting Control Systems was conceived and primarily developed by the MSSLC Lighting Controls Task Force. The MSSLC and the Task Force are, however, grateful for all contributions made to the development of this Model Specification, including those made by members of the MSSLC at large and outdoor lighting equipment manufacturers. The MSSLC would like to specifically acknowledge the contributions of the following individuals, who spent significant time developing material for this document: Ron Bernstein, Jessica Garcia, Phillip Jessup, Michael Poplawski, Laura Stuchinsky, and Daniel Young.

INSTRUCTIONS

Networked control systems can typically be conceptually described as a set of three interacting component tiers: Field Devices, Network Infrastructure, and a Central Management System (CMS). While the tiers contain different types of physical devices, information is shared across all tiers.

The features of any System are established by the network of Field Devices, which fundamentally consume and produce data. Field Device networks always include Controllers, which necessarily consume data in order to implement some control function according to internal programming, and may also include Sensors, which produce data. Outdoor lighting system Controllers typically both consume data in the form of instructions to turn lights on and off and perhaps set dimmed levels, and produce data in the form of measurements of luminaire power and energy consumption. Multiple Controllers typically route data through Gateways, which at minimum act as communication bridges to outside networks, but may also provide other system functions. Field Device networks may be accessed and managed remotely by a Central Management System, which typically facilitates user interaction through Graphical User Interfaces (GUIs) and consolidates and stores retrieved data. Central Management Systems communicate to Field Devices through Network Infrastructure, consisting of one or more Backhaul Communication Networks that may take various (e.g. wired and wireless) forms.



Major Components of an Outdoor Lighting Control System
(Image Credit: California Lighting Technology Center, UC Davis)

INSTRUCTIONS

USE

The MSSLC exists to share experiences among outdoor lighting Users, and develop guidance and tools that enable Users to better achieve their goals. The Model Specification is intended to serve as a modular reference for drafting Requests for Qualifications (RFQ's), Requests for Information (RFI's), Requests for Proposals (RFP's) or similar documents.

The MSSLC is not a Standards creation body. The Model Specification is not intended to serve as a standard specification, and therefore should not (and in unedited form, can not) be used to create a list of qualified products that can meet the needs of all or many Users.

Requirements inherently vary from jurisdiction to jurisdiction, and consequently a product that meets the needs of one user will not necessarily meet the needs of another. In all applications, the model specification should be customized as needed to meet the needs of a specific User.

CONTENT

The Model Specification contains suggested content for drafting Requests for Qualifications, Requests-for-Information, Requests-for-Proposals, and other types of procurement documents. Some suggested content is considered suitable for all Users, and therefore presented as mandatory requirements. Other suggested content is considered suitable for only some Users, and is therefore presented as Optional requirements.

FORMATTING

☐ Optional: Optional requirements are provided with a checkbox and labeled

Instructions: Instructions to the user on how to adapt a specific portion of the model specification to meet his or her own needs are labeled and underlined.

Gray Boxes contain guidance for interpreting and customizing the subsequent content. In most cases, it will be appropriate to delete them from a final specification.

PROJECT STAGING AND DOCUMENT ORGANIZATION

Project staging is often used to maximize the likelihood of achieving desired results. Successful networked lighting control System projects are typically comprised of the following stages:

Optional: Request for Qualifications

STAGE 1: Request for Proposal

STAGE 2: Bid submission

STAGE 3: Bid evaluation

STAGE 4: Contract award

INSTRUCTIONS

STAGE 5: Component Installation (as applicable)

STAGE 6: System Start-Up (as applicable)

STAGE 7: System Commissioning (as applicable)

A basic flow diagram for such a staged project, including key inputs and outputs, decisions, and analyses, is shown in Figure 2-1.

Projects are formally initiated with a RFP, which is primarily comprised of a technical specification that describes desired features and other requirements, as well as complimentary submitted material requirements. A RFP for a networked lighting control system might contain technical specifications for an entire System, or for only a portion of a System. For example, a User that already has a Backhaul Communication Network might only issue a RFP for a Central Management System and Field Devices.

Similarly, a user might issue a RFP for a networked lighting control system that contains technical specifications for the Components that comprise or will be integrated into a System as well as requirements for the Installation, Start-Up, and Commissioning of the System, or may choose to issue separate RFPs for one or more of the post-procurement activities (i.e. Installation, Start-Up, and Commissioning).

The suggested content in the Model Specification is organized into multiple Parts.

PART 1 – INTRODUCTION contains lists of normative and informative standardized references, a structure for incorporating user-specific references, and a set of definitions.

PART 2 – SUBMITTED MATERIALS contains suggested non-technical content that might be included in a RFQ, presented at the announcement of an RFP, included in a RFP, presented prior to signing a Contract, or included in Contract terms.

PART 3 – SYSTEM DESCRIPTION contains suggested content for describing the scope of a new project in terms of what Components are being procured as well as what Components comprise an existing System.

Subsequent Parts are focused on either a Component type or project stage.

This version of the Model Specification contains Parts for three Component types, as well as a Part containing suggested warranty terms for Components to be installed as part of the System:

PART 4 – CENTRAL MANAGEMENT SYSTEM

PART 5 – BACKHAUL COMMUNICATION NETWORK

PART 6 – FIELD DEVICES

PART 7 – COMPONENT WARRANTY

INSTRUCTIONS

This version of the Model Specification contains Parts for three post-procurement activities, as well as a Part containing suggested content for specifying a System maintenance contract:

PART 8 – COMPONENT INSTALLATION

PART 9 – SYSTEM START-UP

PART 10 – SYSTEM COMMISSIONING

PART 11 – SYSTEM MAINTENANCE

Finally, this version of the Model Specification contains Appendices with suggested structure and examples for describing seven types of existing equipment that comprise an existing System, or will be integrated separately into the System:

Appendix A: Existing Central Management System

Appendix B: Existing Backhaul Communication Network(s)

Appendix C: Existing Field Devices

Appendix D: Existing Luminaires

Appendix E: Existing Sensor(s)

Appendix F: Existing Asset Management System(s)

Appendix G: Existing Intelligent Traffic System(s)

SUPPORT

The MSSLC has and will continue to develop guidance (e.g. webinars, white papers) for using the Model Specification, based on user feedback.

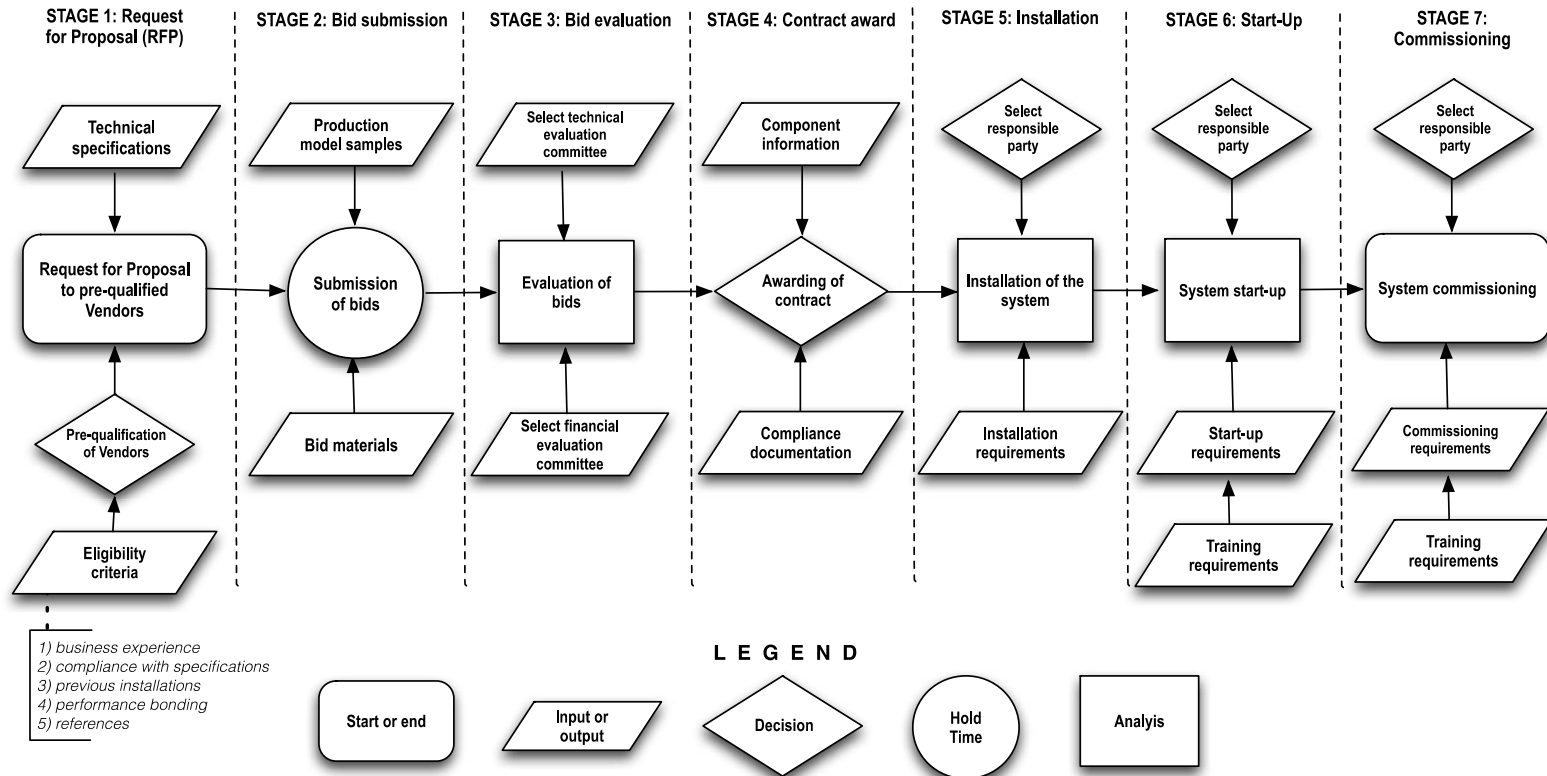
See the MSSLC website for currently available resources:

<http://www1.eere.energy.gov/buildings/ssl/consortium.html>.

Suggestions or requests for assistance should be sent to MSSLC@pnnl.gov.

INSTRUCTIONS

NETWORKED LIGHTING CONTROL SYSTEM PROJECT STAGING



Version 0.5: Model Specification baseline, subjected to an initial formal public review

Major updates in Version 1.0 of the Model Specification

- Narrow scope updates based on feedback received during the Version 0.5 public comment period
- Integration of all definitions into a single section
- Incorporation of new specification section: System Definition/Integration
- Separation of Central Management System and Field Device (Controller and Gateway) requirements
- Separation of Start-Up and Commissioning requirements
- Consolidation of interchangeability and interoperability requirements into new Central Management System and Field Device sections
- Simplification of Appendices, now focused on describing existing equipment

Major updates in Version 1.01 of the Model Specification

- Incorporation of new preface section: Introduction
- Incorporation of gray box user notes
- Reorganization of Part 4 (Central Management System) and Part 5 (Field Devices) requirements into three sections: Physical Features and Requirements, Logical Features and Requirements, and Management or Control Features and Requirements
- Consolidation and simplification of Field Devices Control Features and Requirements

Major updates in Version 2.0 of the Model Specification

- Renaming to “Model Specification for Networked Outdoor Lighting Control Systems” to better reflect evolving scope
- Incorporation of new preface section: Instructions
- Incorporation of new specification section: Backhaul Communication Network
- Incorporation of an Introduction to all specification sections
- Separation of Start-Up and Commissioning sections with updated or enhanced requirements for both
- Further refinement focused on facilitating independent bids for Central Management System(s), Backhaul Communication Network(s), and Field Devices, thereby allowing users to tender multi-vendor, multi-bid projects

Goals for Future Versions of the Model Specification

- Expansion of Introduction section
- Incorporation of new preface section that reviews the benefits and trade-offs of compatibility, interoperability, and interchangeability
- Incorporation of new specification section: Sensors

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- Incorporation of consensus true power metering, energy reporting, and data security requirements
- Incorporation of (optional) Field-to-Field Device communication requirements
- Further refinement focused on facilitating independent bids for Central Management System(s), Backhaul Communication Network(s), and Field Devices, thereby allowing users to tender multi-vendor, multi-bid projects

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PART 1 — GENERAL

1.1 INTRODUCTION

The following sections contain lists of normative and informative standards that are referenced in the Model Specification, a structure for incorporating user-specific references, and a set of definitions, excerpted or modified from existing referenced standards, when possible.

1.2 NORMATIVE REFERENCES

The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by their basic designation only. Versions listed shall be superseded by updated versions as they become available.

Note: These references may be superseded by local codes and norms, which should be used as required.

- A. [American National Standards Institute](#) (ANSI)
 - 1. C12.1-2008 “American National Standard for Electrical Meters – Code for Electricity Metering”
 - 2. C12.19-2008 “American National Standard for Utility Industry End Device Data Tables”
 - 3. C12.20-2010 “American National Standard for Electricity Meters – 0.2 and 0.5 Accuracy Classes”
 - 4. C136.10-2010 “American National Standard for Roadway and Area Lighting Equipment— Locking-Type Photocontrol Devices and Mating Receptacles—Physical and Electrical Interchangeability and Testing”
 - 5. C136.35-2009 “American National Standard for Roadway and Area Lighting Equipment— Luminaire Electrical Ancillary Devices (LEAD)”
 - 6. C136.41-2-2013 “For Roadway and Area Lighting Equipment – Dimming Control Between an External Locking Type Photocontrol and Ballast or Driver”
- B. Council of the European Union (EC)
 - 1. Directive 2002/95/EC, Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)
- C. U.S. Department of Defense
 - 1. MIL-HDBK-271F(2) (1995) “Reliability Prediction of Electronic Equipment”
- D. U.S. Department of Energy Municipal Solid-State Street Lighting Consortium (DOE MSSLC)
 - 1. “Model Specification for LED Roadway Luminaires”
- E. U.S. Federal Communications Commission (FCC)
 - 1. Title 47, Chapter 1, Subchapter A, Part 15, Radio Frequency Devices
- F. [International Electrotechnical Commission](#) (IEC)
 - 1. 60529 ed2.2b (2013), “Degrees of protection provided by enclosures (IP Code)”
 - 2. 60929 ed4.0 (2011-05) “AC and/or DC-supplied electronic control gear for tubular fluorescent lamps - Performance requirements, Annex E (normative), Control interface for controllable control gear”

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3. 62386-101 ed1.0 (2009-06) "Digital addressable lighting interface (DALI) - Part 101: General requirements – System"
4. 62386-102 ed1.0 (2009-06) "Digital addressable lighting interface - Part 102: General requirements - Control gear"
5. 62386-207 ed1.0 (2009-08) "Digital addressable lighting interface - Part 207: Particular requirements for control gear - LED modules (device type 6)"
- G. [LonMark International](#)
 1. 35.12 Version 1.0 (October 2011) "Outdoor Luminaire Controller"
 2. 35.14 Version 1.0 (December 2013) "Smart Luminaire Controller"
 3. 72.30 "Lighting Gateways"
- H. [National Electrical Manufacturers Association](#) (NEMA)
 1. 250-2008 "Enclosures for Electrical Equipment (1000 Volts Maximum)"
- I. [National Fire Protection Association](#) (NFPA)
 1. 70 (2011) "National Electrical Code" (NEC)
- J. [National Transportation Communications for ITS Protocol](#) (NTCIP), a joint standardization project of the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electronics Manufacturers Association (NEMA)
 1. 1213 v02 (2011), NTCIP Object Definitions for Electrical and Lighting Management Systems (ELMS)
- K. [TALQ Consortium](#)
 1. TALQ Specification (available to members of the TALQ Consortium, both Regular as well as Associate Members.)
- L. [Telcordia](#)
 1. SR-332 (2011) "Reliability Prediction Procedure for Electronic Equipment"
- M. [Underwriters Laboratories](#) (UL)
 1. 916 (2007) "Energy Management Equipment"

1.3 INFORMATIVE REFERENCES

- A. [Illuminating Engineering Society](#) (IES)
 1. RP-16-10 "Nomenclature and Definitions for Illuminating Engineering"
 2. TM-23-11 "Lighting Control Protocols"
 3. DG-28-XX "The Guide for Selection, Installation, Operations and Maintenance of Roadway Lighting Control Systems"

Note: As of April 2014, DG-28 is not approved or published

- B. [International Electrotechnical Commission](#) (IEC)
 1. 61968 series

Note: The IEC 61968 series of standards is being developed by Working Group 14 of Technical Committee 57 (IEC TC 57 WG14). It aims to define common information exchanges

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of electrical distribution system data. The following documents may be relevant to Networked Outdoor Lighting Control Systems, now or in the future.

- a. 61968-4 ed1.0 (2007), "Application integration at electric utilities - System interfaces for distribution management - Part 4: Interfaces for records and asset management"
- b. 61968-8 (in progress), "Application integration at electric utilities - System interfaces for distribution management - Part 8: Interface Standard For Customer Support"
- c. ~~61968-9 ed1.0 (2009), "Application integration at electric utilities - System interfaces for distribution management - Part 9: Interfaces for meter reading and control"~~

Note: 61968-9 has been withdrawn; a replacement has not been identified.

2. 61970 series

Note: The IEC 61970 series of standards is being developed by Working Group 13 of Technical Committee 57 (IEC TC 57 WG13). It aims to define common information exchanges of energy management system data. The following documents may be relevant to Networked Outdoor Lighting Control Systems, now or in the future.

- a. ~~61970-301 ed2.0 (2009), "Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base"~~

Note: 61970-301 has been withdrawn; a replacement has not yet been identified.

- b. 61970-401 ed1.0 (2005), "Energy management system application program interface (EMS-API) - Part 401: Component interface specification (CIS) framework"
- c. 61970-501 ed1.0 (2006), "Energy management system application program interface (EMS-API) - Part 501: Common Information Model Resource Description Framework (CIM RDF) schema"

3. 62056 series

Note: The IEC 62056 series of standards is being developed by Working Group 14 of Technical Committee 13 (IEC TC 13 WG14). It aims to define common information exchanges of electricity metering data. The following documents may be relevant to Networked Outdoor Lighting Control Systems, now or in the future.

- a. 62056-51 ed1.0 (1998), "Electricity metering - Data exchange for meter reading, tariff and load control - Part 51: Application layer protocols"
- b. 62056-5-3 ed1.0 (2013), "Electricity metering - Data exchange for meter reading, tariff and load control - Part 5-3: DLMS/COSEM application layer"

1.4 RELATED DOCUMENTS

Instructions: Insert a list of all documents containing User-specific requirements and conditions not addressed in this specification

- A. [e.g. Contract Forms or Documents]
- B. [e.g. Contract Conditions]

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- C. [e.g. Special Conditions]
- D. [e.g. Addendums]
- E. [e.g. Drawings]

1.5 DEFINITIONS

Lighting terminology is used herein consistent with IES RP-16-10, with clarifications and exceptions noted as necessary. Lighting control terminology is used herein consistent with IES TM-23-11, with clarifications and exceptions noted as necessary.

1. Adaptive Control – a method of controlling a system according to parameters that vary or are initially uncertain. Examples of relevant varying parameters for outdoor lighting systems include ambient light or traffic (e.g. pedestrian, bike, automobile) levels that vary periodically (predictably or unpredictably) over the course of a day, infrastructure (e.g. building, road) characteristics that vary by location, and equipment characteristics that vary (i.e. typically degrade) with the passage of time.
2. Astronomical Clock – a device that determines the expected time of sunrise and sunset for a given calendar date (i.e. day, month, year) and geographical location.
3. Backhaul Communication Network – a communication system linking the Central Management System to one or more networks of Field Devices.
4. Central Management System – a computer environment that functions as the core of the System by providing all shared System services, and consolidating and storing (or managing the storage of) all System data.
5. Compatibility – the ability of a device to operate on a network or in the same physical environment with another device without corrupting, interfering with, or hindering the operation of the other device. For example, a Controller in an outdoor environment is compatible with a nearby telecommunication device (e.g. supporting an overhead cable TV communication system) if neither device corrupts, interferes with, or hinders the operation of the other device.
6. Component – any installed, replaceable and/or upgradable item with a unique product number that is necessary to meet the requirements of this specification.
7. Control Point – the location where a Luminaire is installed on a pole or other apparatus.
8. Controller – from IES TM-23-11: the device that originates a command to execute a lighting change. Most commonly associated with a lighting control station or control console, a controller may also be a sensor or other automatic device operating without human interaction. For the purposes of this document, refers specifically to a device that physically monitors and controls Luminaires installed at Control Points, reacts and responds to logical and physical inputs, makes control decisions using internal algorithmic and logic functions, and communicates via a network protocol.
9. Electric Service Point – the location where electrical service is delivered to one or more luminaires. In addition to service conductors, this point may contain protective devices and other equipment required for providing a customer interface to electrical service.

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10. Field Devices – the entire set of networked Components (hardware and embedded software, consisting of Controllers and possibly Gateways) installed in the field that, following purchase, installation, start-up and commissioning, function together to adaptively control and remotely monitor Luminaires.
11. Functional Profile – a model defining a set of specific required and optional functionality, interfaces, and resources for a device, a subsystem, or a system. The Functional Profile should be well enough defined such that multiple vendors' products can be tested and certified for interoperability.
12. Gateway – from IES TM-23-11: a device designed for interfacing between two communication networks that use different protocols, such as BACnet to DALI, or DMX512 to 0-10VDC. A Gateway may contain devices such as protocol translators, impedance matching devices, rate converters, fault isolators, or signal translators as necessary to provide system interoperability. For the purposes of this document, refers specifically to a device that (at a minimum) serves as the interface between one or more Field Devices and a Central Management System, typically translating from a wireless Field Device protocol to a standardized Wide Area Network (WAN) protocol, such as WiFi (i.e. IEEE 802.11xx), Ethernet (i.e. IEEE 802.3), or LTE Cellular (i.e. 3GPP Release 8)
13. Graphical User Interface (GUI) – from IES TM-23-11: a screen-based, pictorial or diagrammatic representation of a system. In many lighting control systems, the GUI becomes one point of contact between the system and a user.
14. Host Site – The physical location of the Central Management System. For the purposes of this document, refers specifically to a facility owned and operated by the User, the Vendor, or an independent 3rd party. The Central Management System is said to be hosted by the owner and operator of the Host Site.
15. Interchangeability – the ability of a device to operate on a network in the exact same manner as a like device, where each device can be exchanged for the other in the system with no configuration, performance, or functional differences.
16. Interoperability – the ability of a device to operate on a network in a consistent manner with a similar or related device, sharing a common defined set of information.
17. Latency – the measure of time delay in a system. For the purposes of this document, refers specifically to the time delay between a creation and execution of a command (e.g. the time delay between an automated or manually created command to change the light output of a set of luminaires in the System and actual change in light output).
18. Luminaire – from IES RP-16-10: a complete lighting unit consisting of a lamp(s) and ballast(s) (when applicable) together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to a power supply. For the purposes of this document, refers specifically to a roadway lighting Luminaire installed with electrical service at a Control Point. While LED Luminaires designed for roadway lighting are not constructed with traditional lamp, ballast, and optics architectures, they perform the same function as their traditional counterparts.
19. Management Station – a device that provides an interface to users with appropriate privileges to access the Central Management System. These devices may come in various

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form factors (e.g. mobile, desktop), and facilitate various levels of interaction (e.g. update status, configure, access historical data).

20. Network – from IES TM-23-11: a group of systems that function cooperatively and/or interdependently to provide a chain of command for lighting control. For the purposes of this document, refers specifically to either a Field Device Network or a Backhaul Network. The Field Device Network is typically a Local Area Network (LAN) that connects and enables communication between(exclusively) Field Devices. The Backhaul Network is typically a Wide Area Network (WAN) that connects and facilitates communication between (at a minimum) one or more Field Device networks with a Central Management System.
21. Online Operation: the normal operating condition whereby Field Devices are communicating with the Central Management System.
22. Offline Operation –any condition whereby Field Devices are not communicating with the Central Management System. Such conditions can occur during Start-Up or Commissioning, or as a result of an unplanned event that interrupts an existing network connection.
23. Photoelectric Sensor – a device that measures the ambient light level and compares it with a preset threshold. The Photoelectric sensor itself may be installed at a Control Point,or located remotely, such as at an electrical service point with multiple light contactors.
24. Protocol/Communication Mode/Method – from IES TM-23-11: a set of standard rules – the syntax, semantics, and synchronization – for communicating over a computer network or a lighting control system or both. The protocol defines the methods for data representation, signaling, authentication and error correction to ensure control or enable the connection, communication, and data transfer between computing or control endpoints. Protocols may be implemented by hardware, software, or a combination of the two. At the lowest level, a protocol defines the behavior or a hardware connection. For the purposes of this document, protocols/communication modes/methods are only introduced and used when referenced to a standard that is explicitly identified in Section 1.1 REFERENCES. For example, the use of “0-10VDC” as the required protocol for communication between a Controller and Luminaire may include a reference to IEC 60929, which is explicitly identified in Section 1.1 REFERENCES as 60929 ed4.0 (2011-05) “AC and/or DC-supplied electronic control gear for tubular fluorescent lamps - Performance requirements”, Annex E (normative) “Control interface for controllable control gear”.
25. Vendor –the seller of any Component of the System.
26. User –the purchaser of Components and/or operator of the System.
27. Scalability – the ability of a system to handle a growing amount of work, or its ability to be enlarged to accommodate that growth. For the purposes of this document, may refer to the ability of the System to handle the transport of a greater amount of data (e.g. retrieve more information from each Controller), to transport data at a higher data rate (e.g. reduce command latency or scheduled time between data updates), or to be enlarged to accommodate the described increase in work, or accommodate additional Control Points.
28. The System – the entire set of networked Components (hardware and software, typically consisting of Field Devices, Backhaul, a Central Management System, and one or more

[Insert User name here]

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Management Stations) that, following purchase, installation, start-up, and commissioning, function together to adaptively control and remotely monitor Luminaires.

29. Testing Bodies –bodies identified by the US Occupational and Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL), including UL (Underwriters Laboratory), CSA (Canadian Standards Association), and Intertek.

PART 2 — SUBMITTED MATERIALS

2.1 INTRODUCTION

The Model Specification contains suggested content for drafting Request for Qualifications (RFQs) Requests-for-Information (RFIs), and Requests-for-Proposals (RFPs). The following sections contain suggested non-technical content that might be included in a RFQ, presented at the announcement of an RFP, included in a RFP, presented prior to signing a Contract, or included in Contract terms.

2.2 PRE-BID AND BID MATERIALS (PRE-CONTRACT)

Submitted materials shall be provided in orderly bound hardcopy form or bookmarked Portable Digital Format (PDF).

Note: PRE-BID AND BID MATERIALS requirements are typically included in a RFQ, presented at the announcement of an RFP, or included in a RFP.

A. VENDOR ELIGIBILITY

1. Only Vendors offering field-proven products are eligible to submit a proposal. The submittal shall include documentation highlighting example of previous field installations.
2. ☐ Optional: Only qualified Buy American Vendors are eligible to submit a proposal. The submittal shall include documentation of Buy American qualification.
3. ☐ Optional: Only Vendors with the following qualifications are eligible to submit a proposal. The submittal shall include documentation verifying the following qualifications:

Instructions: Enter list of required qualifications

- a. [e.g. Previous installation size, location]
- b. [e.g. Performance bonding requirements]
4. ☐ Only Vendors pre-qualified during the corresponding Request for Qualifications (RFQ) are eligible to submit a proposal. The following Vendors have been pre-qualified:

Instructions: Enter list of eligible Vendors

- a. [Vendor 1]
- b. [Vendor 2]

B. VENDOR BACKGROUND

1. The submittal shall include a summary of the Vendor's business experience in the area of outdoor lighting control systems.
2. The submittal shall include a summary of the Vendor's technical expertise in the area of outdoor lighting control systems.

C. PRODUCT VERIFICATION

1. The Vendor shall make available, at User's request, standard production model samples of any Component to be used in the proposed System for inspection.

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2. Prior to purchase, The Vendor shall allow the User to submit for independent testing (at the User's cost) any provided Component to be used in the proposed System, to verify performance and/or compliance with any specifications.
- D. COSTS AND FEES
1. The submittal shall include costs (one-time) and fees (recurring) for Components and/or a System (as applicable) that fully meets this specification, and does not require any additional options or upgrades. A specification that "the System shall be capable..." refers to a System requirement, as priced.
 2. The submittal shall include costs (one-time) and fees (recurring) broken out separately for each of the following categories, as applicable:
 - a. Hardware Components (including any extended warranty and/or maintenance, license fees)
 - b. Software Components (including any extended warranty and/or maintenance, license fees)
 - c. Any and all mandatory upgrades
 - d. Installation Support
 - e. Installation and Maintenance Tools (required and optional)
 - f. Personnel Training
 - g. Backhaul Service
 - h. Hosting
 - i. Component or System Maintenance
 - j. Any other one time and/or recurring costs such as taxes, fees, etc.
- E. The submittal shall include a list of user-replaceable Components and their unit costs.
- F. ☐ Optional: The submittal shall include pricing for a single-source written Hardware Component replacement warranty covering material and workmanship for EXTENDED periods, beyond the requirement specified. Pricing shall be provided for the following EXTENDED periods, at a minimum:

Instructions: Select ONE OR MORE, as desired

1. ☐ Five Years
 2. ☐ Ten Years
 3. ☐ Fifteen Years
 4. ☐ Twenty Years
 5. ☐ Twenty Five Years
 6. ☐ Other _____
- G. ☐ Optional: The submittal shall include pricing for a single-source written Software Component replacement warranty covering material and workmanship for EXTENDED periods, beyond the requirement specified. Pricing shall be provided for the following EXTENDED periods, at a minimum:

Instructions: Select ONE OR MORE, as desired

1. ☐ One Year

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2. ☐ Two Years
 3. ☐ Three Years
 4. ☐ Four Years
 5. ☐ Five Years
 6. ☐ Other _____
- H. ☐ Optional: The submittal shall include pricing for System maintenance for EXTENDED periods, beyond the requirements specified. Pricing shall be provided for the following terms, at a minimum:

Instructions: Select ONE OR MORE, as desired

1. ☐ One Year
 2. ☐ Two Years
 3. ☐ Three Years
 4. ☐ Four Years
 5. ☐ Five Years
 6. ☐ Other _____
- I. PAYMENT TERMS
1. The submittal shall include Payment Terms.
 2. Payment Terms shall address specified Component (material), INSTALLATION, TRAINING AND START-UP, and COMMISSIONING costs, and payment timing.
- J. FINANCING OPTIONS

The submittal shall:

Instructions: Select ONE OR MORE, as desired

1. ☐ Include Vendor financing options
2. ☐ Include Vendor specified 3rd Party financing options
3. ☐ Not include financing options

2.3 CONTRACT MATERIALS (PRE-INSTALLATION)

Submitted materials shall be provided in orderly bound hardcopy form or bookmarked Portable Digital Format (PDF).

Note: CONTRACT MATERIALS requirements are typically presented prior to signing a Contract, or included in the Contract terms.

- A. The submittal shall include Project Summary Documentation, including (at a minimum) the following:
1. Project name and submittal date
 2. Vendor name and contact information
 3. Manufacturer name(s) and contact information
- B. The submittal shall include Component Information, including (at a minimum) the following:

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1. Technical Specifications (i.e. cut sheets) for all Components, including Components intended for installation inside luminaires, including (at a minimum) the following:
 - a. Complete and unique catalog numbers. All catalog number elements (describing options) shall be noted and explained
 - b. Complete specifications, without references to other documents unless those documents are also submitted
 - c. Power requirements, as specified
 - d. Rated Life and Reliability, as specified
 - e. Field Device safety certifications and listing number (which can be used to identify the manufacturer and product category; also known as file number or control number)
2. Brochures, technical bulletins, parts lists, descriptions of serviceability, drawings, calculations and other technical information describing the Components to be used in the proposed System.
3. Compliance Documentation, as applicable
 - a. RoHS
 - b. Recyclability and/or end-of-life support
 - c. Made in America
- C. ☐ Optional: The submittal shall include documentation of System topology and layout, including (at a minimum) the following:
 1. Proposed Field Device topology (e.g. Star or Mesh communication) and layout (including Field Device locations, as applicable)
 2. Representative (including worst case) System communication paths between Field Devices and Backhaul Communication Network(s)
 3. Analyses that verify that the proposed Field Device topology and layout will address installation site characteristics (e.g. available mounting locations, active and passive sources of interference) and meet key System performance specifications (e.g. reporting frequency, expandability)
 4. A description of the analysis methods used to support the proposed Field Device topology and layout, System communication paths, and confidence in System performance
- D. ☐ Optional: The submittal shall include documentation of required and optional Tools for installation, and start-up, and commissioning, as applicable
- E. ☐ Optional: The submittal shall include documentation of required and optional Tools for network management, as applicable
- F. The submittal shall include documentation of Maintenance coverage, as specified
- G. The submittal shall include documentation of Warranty coverage, as specified
- H. The submittal shall include documentation of requirements that the proposed Components or System cannot meet
- I. The submittal shall include documentation of non-required features provided by the proposed Components or System

PART 3 — SYSTEM DESCRIPTION

3.1 INTRODUCTION

Networked control systems conceptually consist of a set of three interacting Component tiers: Field Devices, Network Infrastructure, and a Central Management System. Networked control system projects can vary significantly in scope. While a User with no existing networked control system infrastructure will need to specify, purchase, and install Components for all three tiers, a User that has already installed network infrastructure, for example, will only need to specify, purchase, and install interoperable Field Device and Central Management System Components.

The following sections contain suggested content for describing the scope of a new project, including the size and scalability of the envisioned System, which Components are already in place, and which Components will be specified for purchase and installation.

3.2 SYSTEM SIZE AND SCALABILITY

- A. The System shall be capable of performing all functions and meeting all requirements described herein for a minimum of [Instructions: enter appropriate number] Control Points.
- B. ☐ Optional: The System shall be capable of being upgraded (e.g. through the incorporation of additional Gateways, or higher performing Gateways) to handle up to [Instructions: enter appropriate number] additional Control Points.
- C. ☐ Optional: The System shall be capable of being upgraded (e.g. through the incorporation of additional Gateways, or higher performing Gateways) to transport a greater amount of data (e.g. retrieve more information from each Controller) while maintaining specified command Latency and Reporting Frequency.
- D. ☐ Optional: The System shall be capable of being upgraded (e.g. through the incorporation of additional Gateways, or higher performing Gateways) to transport data at a higher data rate, thereby facilitating a reduction in command Latency or increase in Reporting Frequency.

3.3 CENTRAL MANAGEMENT SYSTEM

Note: A System typically uses only ONE Central Management System, although several software applications may be used to manage System operation.

Instructions: Select ONE

- A. ☐ The System shall use a Central Management System that meets the requirements specified in Part 4, and is hosted by the User or a User specified 3rd Party.
- B. ☐ The System shall use a Central Management System that meets the requirements specified in Part 4, and is hosted by the Vendor. Hosting fees are not allowed.
- C. ☐ The System shall use a Central Management System that meets the requirements specified in Part 4, and is hosted by the Vendor. Hosting fees are allowed.
- D. ☐ The System shall use an existing Central Management System that is specified in Appendix A.

3.4 BACKHAUL COMMUNICATION NETWORK

Note: A System may use ONE or MORE Backhaul Communication Networks.

Instructions: Select ONE or MORE, as desired

- A. ☐ The System shall use a Backhaul Communication Network that meets the requirements specified in Part 5.
- B. ☐ The System shall use an existing Backhaul Communication Network that is specified in Appendix B.
- C. ☐ The System shall use a Backhaul Communication Network specified by the Vendor. The Vendor shall provide all available Backhaul Communication Network options, EXCLUDING those which have pre-defined fees (e.g. Vendor negotiated cellular contracts).
- D. ☐ The System shall use a Backhaul Communication Network specified by the Vendor. The Vendor shall provide all available Backhaul Communication Network options, INCLUDING those which have pre-defined fees (e.g. Vendor negotiated cellular contracts).

3.5 FIELD DEVICES

Note: A System may use ONE or MORE Field Device networks, or sets of connected Field Devices. Interoperability or Interchangeability between Field Devices in different Field Device networks is specified in Part 5.

Instructions: Select ONE or MORE, as desired

- A. ☐ The System shall use Field Devices that meet the requirements specified in Part 6.
- B. ☐ The System shall use existing Field Devices that are specified in Appendix C.

PART 4 — CENTRAL MANAGEMENT SYSTEM

4.1 INTRODUCTION

The Central Management System is a computer environment that functions as the core of a Networked Outdoor Lighting Control System by providing all shared System services, and consolidating and storing (or managing the storage of) all System data. A System typically uses only ONE Central Management System, although several software applications may be used to manage System operation. A User may specify a Central Management System as part of a complete integrated System, or as a Component (or set of Components) to be integrated with other (existing, or procured separately) interoperable Components (or sets of Components), such as a Backhaul Communication Network or network of Field Devices.

The following sections contain suggested technical specifications for a Central Management System to be installed as part of the System.

4.2 PHYSICAL FEATURES AND REQUIREMENTS

- A. The Vendor shall disclose what features and functions are provided via a Graphical User Interface(GUI).
- B. The Vendor shall disclose what features and functions are provided via a report or other mechanism.
- C. The Vendor shall provide sample screen images of each GUI page or section.
- D. The Vendor shall provide sample screen images depicting the following features and functions, as applicable:
 - 1. Map Data
 - 2. Satellite Image Data
 - 3. Control Point location
 - 4. Control Point equipment type (i.e. luminaire type, sensor type)
 - 5. Controller and Gateway status(i.e. online, online reporting error, offline)
 - 6. Luminaire status (On, Off)
 - 7. Luminaire Dimmed State
 - 8. System power quality requirements (Current requirement, Peak requirement in last prescribed time period e.g. Peak in last 24 hours)
 - 9. System energy consumption (Daily over last prescribed time period – e.g. Daily for last 7 days)
- E. The Central Management System shall be accessible to individual users only by name and password.
- F. The Central Management System shall be capable of restricting user access to specific functions. At a minimum, these functions shall include the following:
 - 1. Creating and managing users and groups
 - 2. Configuration
 - 3. Monitoring

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4. Control
5. Basic report generation
6. Custom report generation
- G. ☐Optional: The Central Management System shall be accessible through a handheld mobile device via a WEB BROWSER that renders content in a format designed to accommodate the size and user interface of the mobile device.
- H. ☐Optional: The Central Management System shall be accessible through a handheld mobile device via a NATIVE APPLICATION that has been designed to accommodate the size and user interface of the mobile device.
- I. All asset data shall be stored on the Central Management System.
- J. The Central Management System shall be capable of storing the following asset information for all Control Points:
 1. Pole number
 2. Pole type
 3. Pole GPS location
 4. Pole grouping
 5. Luminaire make, model, and firmware version (if applicable)
 6. Luminaire nominal input voltage
 7. Luminaire power requirement (wattage)
 8. Luminaire installation date
 9. Utility billing account number
- K. The Central Management System shall be capable of RETRIEVING and STORING all remote monitoring data.

4.3 LOGICAL FEATURES AND REQUIREMENTS

- A. The Central Management System shall ensure secure communication between itself and all Field Devices by logically enabling security features inherent to the underlying communications protocols.
- B. The Central Management System shall be capable of detecting communication failures between Field Devices and the Central Management System.
- C. The Central Management System shall be capable of delivering Field Device firmware upgrades over the Backhaul Communication Network.
- D. The Central Management System shall be capable of remotely monitoring Field Device performance, in order to identify and report any exception to normal Field Device operation.

4.4 FUNCTIONAL FEATURES AND REQUIREMENTS

- A. The Central Management System shall be capable of RETRIEVING and STORING the following online Control Point parameters:
 1. Controller status (Online, Offline, Warnings, Errors)
 2. Luminaire status (ON, OFF, Dimmed State, Warnings, Errors)
 3. Average input voltage (RMS) in ON state

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4. Average input current (mA) in ON state
 5. Average input true power (W) in ON state
 6. Average input power factor in ON state
 7. Cumulative ON state time (minutes)
 8. Cumulative energy consumption (kWh)
 9. ☐ Optional: LED Driver status (e.g. Warning or Error codes)
 10. ☐ Optional: Ambient light level (via integral sensor)
 11. ☐ Optional: GPS location (via integral sensor)
 12. ☐ Optional: Temperature (via integral sensor)
- B. The Central Management System shall be capable of programming the Reporting Frequency of online Control Point parameters for ALL Control Points.
- C. ☐ Optional: The Central Management System shall be capable of programming the Reporting Frequency of online Control Point parameters for A SINGLE Control Point.

Note: For some Systems, the Reporting Frequency for a SINGLE Control Point is effectively the maximum that the System can deliver, and not explicitly programmable.

- D. The Central Management System shall be capable of defining Luminaire groups.
- E. The Central Management System shall be capable of Manual Control, whereby the ON/OFF and DIMMED state of a single Luminaire or group of Luminaires is modified in response to commands created by the Central Management System.
- F. The Central Management System shall be capable of creating programs for Scheduled Control, whereby the ON/OFF and DIMMED state of a single Luminaire or a group of Luminaires is modified according to a predefined schedule.
- G. The Central Management System shall be capable of creating programs for Scheduled Control containing a minimum of (Instructions: enter appropriate number) times/events per day).
- H. The Central Management System shall be capable of creating programs for Scheduled Control that is either time-based, whereby Controllers modify Luminaire operation when a specific time in the schedule occurs, or event-based, whereby Controllers modify Luminaire operation when the next event in the schedule occurs.
- I. The Central Management System shall be capable of creating programs for time-based Scheduled Control that are defined:

Instructions: Select ONE or MORE, as desired

1. ☐ On a daily recurring basis
 2. ☐ On a weekday recurring basis
 3. ☐ On a weekend recurring basis
 4. ☐ For special events which occur on a daily or daily recurring basis
- J. The Central Management System shall be capable of creating programs for event-based Scheduled Control that are defined according to inputs from sensors or commands from the Central Management System.

Note: Sensors available for event-based Scheduled Control are specified in Appendix E

- K. The Central Management System shall be capable of creating programs for DynamicControl, whereby the ON/OFF and DIMMED state of a single Luminaire or a group of Luminaires is modified in response to dynamic inputs from sensors or commands from the Central Management System.

Note: Sensors available for Adaptive Control are specified in Appendix E

- L. The Central Management System shall be capable of creating programs for Prioritized Control, whereby the Scheduled Control of individual Luminaires or groups of Luminaires is modified or overridden according to input from sensors or commands from the Central Management System.
- M. ☐ Optional: The Central Management System shall be capable of creating commands and programs for True Input Power Control, whereby the Luminaire DIMMED state is actuated to achieve to a desired true input power (percent relative watts).

Note: This feature requires knowledge of the relationship between Luminaire input control signal and true input power (watts), which must be imported (manually or automatically) according to some pre-defined means, or measured using some internal (metering) capability.

- N. ☐ Optional: The Central Management System shall be capable of creating commands and programs for Light Output Control, whereby the Luminaire DIMMED state is actuated to achieve a desired light output (percent relative lumens).

Note: This feature requires either a) knowledge of the relationship between Luminaire input control signal and light output (lumens) or b) knowledge of both the relationship between Luminaire input control signal and true input power (watts) and the relationship between Luminaire true input power (watts) and light output (lumens); these relationship(s) must be imported manually or automatically according to some pre-defined means.

- O. ☐ Optional: The Central Management System shall be capable of creating commands and programs Constant Light Output Control, whereby the Luminaire DIMMED state is automatically actuated to achieve a maintained constant light output (lumens) over time by compensating for Luminaire lumen depreciation.

Note: This feature requires either a) knowledge of the relationship between Luminaire input control signal and light output over time (lumen depreciation) or b) knowledge of both the relationship between Luminaire input control signal and true input power (watts) and the relationship between Luminaire true input power (watts) and light output over time (lumen depreciation); these relationship(s) must be imported (manually or automatically) according to some pre-defined means or measured using some internal capability. This feature will also result in increasing Luminaire true input power over time.

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- P. ☐ Optional: The Central Management System shall be capable of creating programs for ensuring that a maximum Luminaire true input power (watts) is never exceeded.
 - Q. The Central Management System shall be capable of creating pre-defined asset reports.
 - R. The Central Management System shall be capable of creating customized asset reports.
 - S. The Central Management System shall be capable of comparing all reported Control Point parameters with optional pre-defined maximum and minimum thresholds, and generating error messages in real-time (based on reported data availability) for any condition that violates a specified threshold a specified number (1 or more) of times.
 - T. The Central Management System shall be capable of creating Remote Monitoring reports:
 - 1. Based on the generation of an error message
 - 2. Based on a schedule
 - U. The Central Management System shall be capable of creating pre-defined Remote Monitoring reports containing:
 - 1. Instances of communication loss between Field Devices and the Central Management System
- Note: For very large systems, this functionality may be provided by a separate network management application.
- 2. Control Points with error conditions, sorted by error type and/or Electrical Service Point location
 - 3. Energy Consumption Data for individual Luminaires and/or groups of Luminaires
 - V. The Central Management System shall be capable of creating customized Remote Monitoring reports.
 - W. The Central Management System shall be capable generating Notifications, whereby specified Remote Monitoring reports (pre-defined or customized) are sent to assigned users and/or user groups via text message (SMS) and/or email.
 - X. ☐ Optional: The Central Management System shall be capable of detecting and reporting wire theft through use of an algorithm that identifies when the following conditions exist:
 - 1. A user-defined number of Controllers report a loss of electrical service
 - 2. The loss of electrical service occurs within a user-defined time window
 - 3. The Controllers are physically located consecutively along a roadway

4.5 INTERCHANGEABILITY AND INTEROPERABILITY

- A. ☐ Optional: The Central Management System shall be certified as compliant with the TALQ v____ standard, and Interoperable with TALQ certified Field Devices or Field Device networks.
- B. ☐ Optional: The Central Management System shall be Interoperable with LonMark certified Field Devices or Field Device networks.
- C. ☐ Optional: The Central Management System shall be Compatible with the Computing Infrastructure specified in Appendix A.
- D. ☐ Optional: The Vendor shall demonstrate Central Management Software Compatibility with the existing Computing Infrastructure described in Appendix A prior to INSTALLATION.

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- E. ☐ Optional: The Vendor shall provide standard production model samples of all Central Management Software Components required for User verification of Compatibility with the existing Computing Infrastructure described in Appendix A prior to INSTALLATION.
- F. ☐ Optional: The Central Management System shall be Interoperable with the Backhaul Communication Network(s) specified in Appendix B.
- G. ☐ Optional: The Vendor shall demonstrate Central Management System Interoperability with the existing Backhaul Communication Network(s) described in Appendix B prior to INSTALLATION.
- H. ☐ Optional: The Vendor shall provide standard production model samples of all Central Management System Components required for User verification of Interoperability with the existing Backhaul Communication Network(s) described in Appendix B prior to INSTALLATION.
- I. ☐ Optional: The Central Management System shall be Interoperable with the Field Devices specified in Appendix C.
- J. ☐ Optional: The Vendor shall demonstrate Central Management System Interoperability with the existing Field Devices described in Appendix C prior to INSTALLATION.
- K. ☐ Optional: The Vendor shall provide standard production model samples of all Central Management System Components required for User verification of Interoperability with the existing Field Devices described in Appendix C prior to INSTALLATION.
- L. ☐ Optional: The Central Management System shall be Interoperable with the Asset Management System specified in Appendix F.
- M. ☐ Optional: The Vendor shall demonstrate Central Management System Interoperability with the existing Asset Management System described in Appendix F prior to INSTALLATION.
- N. ☐ Optional: The Vendor shall provide standard production model samples of all Central Management System Components required for User verification of Interoperability with the existing Asset Management System described in Appendix F prior to INSTALLATION.

Note: Options L-N require “full interoperability” with the Asset Management System described in Appendix F. Some Users may not need “full interoperability”. Options O-R describe various forms of “limited interoperability” that may meet the needs of certain Users.

- O. ☐ Optional: The Central Management System shall be capable of importing asset information from the Asset Management System specified in Appendix F for the creation of Control Points.
- P. ☐ Optional: The Central Management System shall be capable of exporting asset information created in the System in a format compatible with the Asset Management System specified in Appendix F.
- Q. ☐ Optional: The Central Management System shall be capable of synchronizing asset information between its database of Control Points and the Asset Management System specified in Appendix F, such that changes made in the Central Management System are automatically reflected in the appropriate fields of the Asset Management System.
- R. ☐ Optional: The Central Management System shall be capable of synchronizing asset information between its database of Control Points and the Asset Management System

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specified in Appendix F, such that changes made in the Asset Management System are automatically reflected in the appropriate fields of the Central Management System.

- S. ☐ Optional: The Central Management System shall have an API capable of supporting integration through web services (e.g. SOAP, Restful) available in the Asset Management System specified in Appendix F.
- T. ☐ Optional: The Central Management System shall be Interoperable with the Intelligent Traffic System(s) specified in Appendix G.
- U. ☐ Optional: The Vendor shall demonstrate Central Management System Interoperability with the existing Intelligent Traffic System described in Appendix G prior to INSTALLATION.
- V. ☐ Optional: The Vendor shall provide standard production model samples of all Central Management System Components required for User verification of Interoperability with the existing Intelligent Traffic System described in Appendix G prior to INSTALLATION.
- W. ☐ Optional: The Central Management System shall be Interoperable with the Sensor(s) specified in Section 6.2-P and/or Appendix E.
- X. ☐ Optional: The Vendor shall demonstrate Central Management System Interoperability with the existing Sensor(s) specified in Section 6.2-P and/or Appendix E prior to INSTALLATION.
- Y. ☐ Optional: The Vendor shall provide standard production model samples of all Central Management System Components required for User verification of Interoperability with the existing Sensor(s) specified in Section 6.2-P and/or Appendix E prior to INSTALLATION.
- Z. ☐ Optional: Future requirement supporting CIM messaging according to IEC standard(s)

Note: CIM messaging for Central Management Systems will be addressed in future versions of the Model Specification, based on User interest and market availability.

PART 5 — BACKHAUL COMMUNICATION NETWORK

5.1 INTRODUCTION

A Backhaul Communication Network links the Central Management System to one or more networks of Field Devices. A User may specify a Backhaul Communication Network as part of a complete integrated System, or as a Component (or set of Components) to be integrated with other (existing, or procured separately) interoperable Components (or sets of Components), such as a Central Management System or network of Field Devices.

The following sections contain suggested technical specifications for a Backhaul Communication Network to be installed as part of the System.

5.2 PHYSICAL FEATURES AND REQUIREMENTS

- A. Backhaul Communication Network components shall be capable of normal operation over an ambient temperature range of:

Instructions: Select ONE

1. ☐ -40 degrees C to 70 degrees C (full commercial environment)
2. ☐ -40 degrees C to 50 degrees C (cold environment)
3. ☐ 0 degrees C to 70 degrees C (hot environment)

- B. Backhaul Communication Network components installed external or remote to luminaires shall be rated:

Instructions: Select ONE

1. ☐ IP54
2. ☐ IP65
3. ☐ IP66

- C. Backhaul Communication Network components shall operate from the following (nominal $\pm 10\%$) input :

Instructions: Select ONE OR MORE, as desired

1. Dedicated AC input (RMS Volts) ☐ 120 ☐ 208 ☐ 240 ☐ 277 ☐ 347 ☐ 480
2. Universal AC input (RMS Volts) ☐ 120-277 ☐ 347-480 ☐ Other _____
3. Dedicated DC input (Volts) ☐ 5 ☐ 12 ☐ 24

5.3 LOGICAL FEATURES AND REQUIREMENTS

- A. The Backhaul Communication Network shall use an open, standard-based physical layer for communication such as IEEE 802.15.4g for wireless mesh networks or Global System for Mobile communications (GSM) standards for cellular networks.
- B. The Backhaul Communication Network shall be capable of connecting to Central Management Systems using open, standard-based networking technologies such as http, SMTP, SNMP, COAP, TCP, UDP or FTP.

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- C. All data communications over the Backhaul Communication Network (i.e. between Field Devices and the Central Management System) shall be secured using a standard-based security protocol (e.g. TLS, DTLS, IPsec).
- D. ☐ Optional: The Backhaul Communication Network shall be capable of communicating using Internet Protocol version 6 (IPv6). Every device must be addressable via an assigned IPv6 address.
- E. The Backhaul Communication Network shall allow only authenticated and authorized access to network services by a Central Management System or Field Device (or Field Device Network connected through a Gateway). For example, an unauthenticated Field Device (or Field Device Network connected through a Gateway) shall not be able to use the Backhaul Communication Network to report usage or accept commands from a Central Management System application.
- F. ☐ Optional: The Backhaul Communication Network and any connected device or system shall be able to authenticate each other by a standard-based mechanism (e.g. X.509 certificates or pre-shared keys).
- G. ☐ Optional: The Backhaul Communication Network and any connected device or system shall be able to authorize each other by a standard-based mechanism (e.g. X.509 certificates).
- H. ☐ Optional: The data exchange between the Backhaul Communication Network and any connected device or system shall be kept confidential using a standard-based algorithm (e.g. AES-128 or AES-256).
- I. ☐ Optional: The data exchange between the Backhaul Communication Network and any connected device or system shall be checked for integrity using a standard-based algorithm (e.g. keyed HMAC with SHA-256).
- J. The Backhaul Communication Network shall be capable of maintaining time either on its own or by synchronizing with a remote service.
- K. The Backhaul Communication Network shall provide a detailed view of the network and its topology, including all connected Field Devices (or Field Device networks connected through a Gateway), links, and ports.
- L. The Backhaul Communication Network shall provide a detailed view of network performance, including available bandwidth, Field Device (or Field Device network connected through a Gateway) reachability, round-trip times, path costs, and packet delivery success/failure.
- M. The Backhaul Communication Network shall provide a configuration management tool that provides the ability to view and remotely apply changes, updates, and patches to operating systems and applications on any single or a group of Backhaul Communication Network components.
- N. Backhaul Communication Network components shall be capable of logging time-stamped activity. The logging level shall be configurable. Any write and execute operations completed by the device shall be recorded together with the source IP address.
- O. The Backhaul Communication Network shall provide basic firewall capabilities, including filtering by port, protocol, source IP address, and destination IP address.

5.4 FUNCTIONAL FEATURES AND REQUIREMENTS

- A. The Backhaul Communication Network shall be capable of two-way communication.
- B. The Backhaul Communication Network shall support failover to alternate routes.
- C. The Backhaul Communication Network shall be capable of automatic retries during message/packet delivery attempts.
- D. The Backhaul Communication Network shall be capable of generating asynchronous alerts and routing both its own alerts and other devices' alerts to the Central Management System.
- E. The Backhaul Communication Network shall be able to prioritize the delivery of specified traffic types (e.g. high priority) over others (e.g. low priority).
- F. The Backhaul Communication Network shall be capable of addressing of groups of Field Devices(or Field Device networks connected through a Gateway) for bulk messages including remote firmware upgrades and configuration changes.
- G. ☐ Optional:The Backhaul Communication Network shall be capable of maintaining Network Availability:

Instructions: Select ONE

- 1. ☐ 98% of active and functional Field Devices (or Field Device networks connected through a Gateway) in 24 hours, 99.8% of active and functional Field Devices (or Field Device networks connected through a Gateway)in 48 hours
- 2. ☐ __% of active and functional Field Devices (or Field Device networks connected through a Gateway) in 24 hours, __._% of active and functional Field Devices (or Field Device networks connected through a Gateway) in 48 hours
- H. ☐ Optional:The Backhaul Communication Network shall be capable of maintaining a round trip message time (excluding low priority traffic) of:

Instructions: Select ONE

- 1. ☐ 120 seconds or less
- 2. ☐ __ seconds or less
- 3. ☐ 95% within 120 seconds, 99% within 240 seconds
- 4. ☐ __% within 120 seconds, __% within 240 seconds
- I. ☐ Optional:The Backhaul Communication Network shall be capable of maintaining latency for individual on-demand (high priority traffic) messages of average size (up to 400 bytes):

Instructions: Select ONE

- 1. ☐ 60 seconds or less
- 2. ☐ __ seconds or less
- J. ☐ Optional:The Backhaul Communication Network shall be capable of performing bulk firmware upgrades (as lower priority traffic):

Instructions: Select ONE

- 1. ☐ 95% in 24 hours, 100% in 4 days
- 2. ☐ __% in 24 hours, __% in 4 days

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5.5 INTERCHANGEABILITY AND INTEROPERABILITY

- A. ☐ Optional: The Backhaul Communication Network shall be Interoperable with the Central Management System specified in Appendix A.
- B. ☐ Optional: The Vendor shall demonstrate Backhaul Communication Network Interoperability with the existing Central Management System described in Appendix A prior to INSTALLATION.
- C. ☐ Optional: The Vendor shall provide standard production model samples of all Backhaul Communication Network Components required for User verification of Interoperability with the existing Central Management System described in Appendix A prior to INSTALLATION.
- D. ☐ Optional: The Backhaul Communication Network shall be Interchangeable with the Backhaul Communication Network(s) specified in Appendix B.
- E. ☐ Optional: The Vendor shall demonstrate Backhaul Communication Network Interchangeability with the existing Backhaul Communication Network described in Appendix B prior to INSTALLATION.
- F. ☐ Optional: The Vendor shall provide standard production model samples of all Backhaul Communication Network Components required for User verification of Interchangeability with the existing Backhaul Communication Network described in Appendix B prior to INSTALLATION.
- G. ☐ Optional: The Backhaul Communication Network shall be Interoperable with the Field Devices specified in Appendix C.
- H. ☐ Optional: The Vendor shall demonstrate Backhaul Communication Network Interoperability with the existing Field Devices described in Appendix C prior to INSTALLATION.
- I. ☐ Optional: The Vendor shall provide standard production model samples of all Backhaul Communication Network Components required for User verification of Interoperability with the existing Field Devices described in Appendix C prior to INSTALLATION.
- J. ☐ Optional: The Backhaul Communication Network shall be Interoperable with the Sensor(s) specified in Section 6.2-P and/or Appendix E.
- K. ☐ Optional: The Vendor shall demonstrate Backhaul Communication Network Interoperability with the existing Sensor(s) described in Appendix E prior to INSTALLATION.
- L. ☐ Optional: The Vendor shall provide standard production model samples of all Backhaul Communication Network Components required for User verification of Interoperability with the existing Sensor(s) described in Appendix E prior to INSTALLATION.

5.6 RATED LIFE AND RELIABILITY

- A. The rated life of all Backhaul Communication Network components at an ambient temperature of 25 degrees Celsius shall be:

Instructions: Select ONE

- 1. ☐ 10 years or more
- 2. ☐ 15 years or more
- 3. ☐ 20 years or more
- 4. ☐ __ years or more

[Insert User name here]

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- B. The Vendor shall report the reliability of the following Backhaul Communication Network components, as measured by Mean Time between Failures (MTBF):

Instructions: Select ONE or MORE, as desired

1. ☐ Gateway
2. ☐ Router

Instructions: enter list of other Components requiring reliability reporting

3. ☐ [Instructions: Describe other Component of interest]
- C. ☐ Optional: The reported MTBF shall be calculated according to Telcordia SR-332.
- D. ☐ Optional: The reported MTBF shall be calculated according to MIL-HDBK 217.

PART 6 — FIELD DEVICES

6.1 INTRODUCTION

Field Devices are networked Components (hardware and embedded software, consisting of Controllers and possibly Gateways) installed in the field that, following purchase, installation, start-up and commissioning, function together to adaptively control and remotely monitor Luminaires. A User may specify Field Devices as part of a complete integrated System, or as a Component (or set of Components) to be integrated with other (existing, or procured separately) interoperable Components (or sets of Components), such as a Central Management System or Backhaul Communication Network.

The following sections contain suggested technical specifications for Field Devices to be installed as part of the System.

6.2 PHYSICAL FEATURES AND REQUIREMENTS

- A. Field Devices shall be capable of normal operation over an ambient temperature range of:

Instructions: Select ONE

1. ☐ -40 degrees C to 70 degrees C (full commercial environment)
2. ☐ -40 degrees C to 50 degrees C (cold environment)
3. ☐ 0 degrees C to 70 degrees C (hot environment)

- B. Field Devices installed external or remote to luminaires shall be housed in enclosures rated:

Instructions: Select ONE

1. ☐ IEC IP54 or any of the following NEMA Types: 3, 3X, 3S, 3SX, 4, 4X, 6, 6P, 12, 12K, 13
2. ☐ IEC IP65 or any of the following NEMA Types: 4, 4X, 6, 6P
3. ☐ IEC IP66 or any of the following NEMA Types: 4, 4X, 6, 6P

Note: Electrical equipment enclosures are rated according to their ability to provide protection. Two methods of rating enclosures are commonly used in the industry. IEC 60529 provides a system for specifying enclosures using an IP rating, while NEMA 250 provides a system for specifying enclosures using a Type rating. IEC 60529 and NEMA 250 do not, however, test for the same set of conditions. For example, NEMA 250 tests for numerous environmental conditions that IEC 60529 does not test for. Consequently, multiple NEMA 250 ratings may provide protection that meets or exceeds a given IEC 60529 rating. For more information, see: <http://www.nema.org/Products/Documents/nema-enclosure-types.pdf>

- C. Field Devices shall operate from the following (nominal $\pm 10\%$) input:

Instructions: Select ONE OR MORE, as desired

1. Dedicated AC input (RMS Volts) ☐ 120 ☐ 208 ☐ 240 ☐ 277 ☐ 347 ☐ 480
2. Universal AC input (RMS Volts) ☐ 120-277 ☐ 347-480 ☐ Other _____
3. Dedicated DC input (Volts) ☐ 5 ☐ 12 ☐ 24

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- D. The Vendor shall provide an estimate of the peak and average power requirement of all Field Devices, and describe the methodology and assumptions used to create this estimate.
- E. Controllers shall be integrated (mechanically and electrically connected) at Control Points:

Instructions: Select ONE

- 1. ☐ Internal to LED Drivers, with a remote antenna if necessary
 - 2. ☐ Internal to Luminaires, with a remote antenna if necessary
 - 3. ☐ External to Luminaires, using a NEMA C136.10 standard 3-terminal polarized locking-type receptacle for electrical connectivity and a Vendor defined and described scheme for dimming control signal connectivity
 - 4. ☐ External to Luminaires, using a NEMA C136.41 standard 5-terminal polarized twist-lock receptacle for both electrical and dimming control signal connectivity
 - 5. ☐ Remote to Luminaires, using a Vendor defined and described scheme for both electrical and dimming control signal connectivity
 - 6. ☐ Using an integration method appropriate for the Luminaires specified in Appendix D
- F. ☐ Optional: Controller integration compatibility shall be verified for all Luminaires specified in Appendix D.
 - G. Controllers shall be capable of actuating the status (ON state, OFF state) of Luminaires.
 - H. ☐ Optional: Controllers shall be capable of actuating a Luminaire OFF state that results in a ZERO watt power requirement for the Luminaire. It is understood that the Controller will require power to remain online.

Note: a) this requirement is not compatible with luminaires that require a DALI control signal; b) this requirement necessitates switching both hot legs for 480V luminaires.

- I. Controllers shall be capable of actuating a Luminaire DIMMED state by creating a control signal that:

Instructions: select ONE or MORE, as desired

- 1. ☐ Complies with aspecified 0-10V standard (e.g. IEC 60929)
 - 2. ☐ Complies with a specified DALI standard (e.g. IEC 62386)
 - 3. ☐ Complies with a specified DALI derivative (i.e. proprietary extension to standardized DALI)
 - 4. ☐ Is appropriate for the Luminaires specified in Appendix D
- J. ☐ Optional: Controller dimming control signal interoperability shall be verified with all Luminaires specified in Appendix D.
 - K. Actuated changes to Luminaire DIMMED states by Controllers shall occur at the following rate:

Instructions: Select ONE or MORE, as desired

- 1. ☐ Instantaneously, or as dictated by the Luminaire
- 2. ☐ Over a user programmable range (% change per minute) disclosed by the Vendor
- 3. ☐ Greater than [Instructions: enter % change] per minute
- 4. ☐ Less than [Instructions: enter % change] per minute

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- L. Controllers shall be capable of measuring and monitoring over time the following power quality parameters:

1. RMS input voltage (Volts)
2. RMS input current (Amps)
3. Apparent power (VA)
4. True input power (Watts)
5. Power factor

- M. Controllers shall measure power quality parameters at each Control Point for:

Instructions: Select ONE

1. ☐ The Luminaire ONLY
2. ☐ The Luminaire AND the Controller

- N. Controllers shall measure energy consumption:

Instructions: Select ONE or MORE, as desired

1. ☐ With an accuracy and precision of $\pm 5\%$ over the ambient temperature range specified in 6.1-A and a load range of 0.1% to 100% relative power
2. ☐ With an accuracy and precision of $\pm 2\%$ over the ambient temperature range specified in 6.1-A and a load range of 0.1% to 100% relative power
3. ☐ With an accuracy and precision of $\pm 5\%$ over the ambient temperature range specified in 6.1-A and a load range of [Instructions: enter MAXIMUM luminaire input voltage and MINIMUM luminaire input power that will be connected to the System] to [Instructions: enter MINIMUM luminaire input voltage and MAXIMUM luminaire input power that will be connected to the System]
4. ☐ With an accuracy and precision of $\pm 2\%$ over the ambient temperature range specified in 6.1-A and a load range of [Instructions: enter MAXIMUM luminaire input voltage and MINIMUM luminaire input power that will be connected to the System] to [Instructions: enter MINIMUM luminaire input voltage and MAXIMUM luminaire input power that will be connected to the System]
5. ☐ In accordance with ANSI C136.50

Note: at this time, there is not a published ANSI standard that defines energy measurement accuracy and data security specifications directly applicable to outdoor lighting and other similar infrastructure. While ANSI C12.1 and ANSI C12.20 contain these types of specifications, they also contain requirements that are not applicable to outdoor lighting and other similar infrastructure. An ANSI C136 committee is currently working on a new standard that will be applicable.

- O. ☐ Optional: Controller energy consumption accuracy shall be verified with all Luminaires specified in Appendix D. Controllers shall be capable of integrally sensing (or otherwise determining) and monitoring over time the following environmental parameters:

Instructions: Select ONE or MORE, as desired

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1. ☐ Expected sunrise and sunset times (e.g. via an Astronomical Clock)
 2. ☐ Ambient light level (e.g. via a Photoelectric Sensor)
 3. ☐ GPS Location
 4. ☐ Temperature
- P. Field Devices shall be capable of logging
1. Cumulative hours in the Luminaire ON state for each Control Point
 2. Cumulative energy consumption of each Control Point
- Q. Field Devices shall log cumulative energy consumption according to the following specifications:

Instructions: Select ONE or MORE, as desired

1. ☐ IEC 61968-9
 2. ☐ The requirements specified by [Instructions: Enter name of utility], as documented in [Instructions: enter reference to appropriate document listed in Section 1.2]
- R. ☐ Optional: During Offline Operation, Field Devices shall be capable of STORING the following offline TIME-STAMPED Control Point parameters:
1. Controller status (Online, Offline, Warning or Error codes)
 2. Luminaire status (ON, OFF, Dimmed State, Warning or Error codes)
 3. Cumulative ON state time (minutes)
 4. Cumulative energy consumption (kWh)

Note: this feature requires the integration of some type of memory or data storage device, which will increase unit cost.

- S. ☐ Optional: During Offline Operation Field Devices shall be capable of STORING measurements of all offline parameters at a STORING frequency of less than once every [Instructions: enter maximum STORING frequency in hours or days].

Note: requiring shorter STORING frequencies may increase unit cost.

- T. ☐ Optional: During Offline Operation Field Devices shall be capable of STORING measurements of all offline parameters at the specified STORING frequency for a STORING period of greater than [Instructions: enter minimum STORING period in hours, days, or weeks].

Note: requiring longer STORING periods may increase unit cost.

- U. ☐ Optional: If a Field Device loses electrical service due to an unscheduled or otherwise unforeseen event, the Field Device shall:
1. Be capable of communicating the loss of electrical service to the Central Management System
 2. Be capable of communicating any STORED data to the Central Management System

Note: this feature requires the integration of some type of battery or energy storage device, which will significantly increase unit cost.

6.3 LOGICAL FEATURESAND REQUIREMENTS

- A. During Online Operation, Field Devices shall be capable of REPORTING the following online Control Point parameters:
1. Controller status (Online time, Offline time, Warning or Error codes)
 2. Luminaire status (ON, OFF, Dimmed State, Warning or Error codes)
 3. Average RMS input voltage (Volts) in the ON state
 4. Average RMS input current (Amps) in the ON state
 5. Average true input power (Watts) in the ON state
 6. Average input power factor in the ON state
 7. Cumulative ON state time (minutes)
 8. Cumulative energy consumption (kWh)
 9. ☐Optional: LED Driver status (e.g. Warning or Error codes)
 10. ☐Optional: Ambient light level (via integralsensor)
 11. ☐Optional: GPS location (via integral sensor)
 12. ☐Optional: Temperature (via integral sensor)

- B. During Online Operation, Field Devices shall be capable of REPORTING all online Control Point parameters for ALL Control Points at a maximum Reporting Frequency of once every:

Instructions: Select ONE

1. ☐ 24 hours
2. ☐ 12 hours
3. ☐ 60 minutes
4. ☐ 30 minutes

- C. During Online Operation, Field Devices shall be capable of REPORTING all Control Point parameters for A SINGLE Control Point at a maximum Reporting Frequency of once every:

Instructions: Select ONE

1. ☐ 15 seconds
2. ☐ 30 seconds
3. ☐ 1 minute
4. ☐ 5 minutes

Note: This specification establishes the maximum continuous update time during demonstration or troubleshooting, where a SINGLE Control Point is being operated or evaluated. For large networks or some network architectures, specifying a shorter time may result in higher system cost.

- D. Field Devices shall execute any single command received from the Backhaul Communication Network in less than:

Instructions: Select ONE

1. ☐ 5 seconds

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2. ☐ 15 seconds
3. ☐ 30 seconds
4. ☐ 60 seconds

Note: This specification establishes the maximum time for a single command to propagate through the Field Device network (if applicable) and be received and executed by a Field Device. If the command requires the reporting of data, this specification constrains only the time required to prepare the data for transmission, and NOT the subsequent propagation time back to the Backhaul Communication Network connection point.

- E. Field Devices shall automatically REPORT all data STORED during Offline Operation once Online Operation is restored.
- F. Field Devices shall utilize a secure boot up scheme to verify the integrity of firmware images that are to be executed, thereby preventing unauthorized or maliciously modified software from running on the device.

6.4 FUNCTIONAL FEATURES AND REQUIREMENTS

- A. Field Devices shall be capable of controlling a single Luminaire or groups of Luminaires.
- B. ☐ Optional: Changes in the ON/OFF or DIMMED states to groups of Luminaires shall be staggered to limit the inrush current through other electrical components (e.g. contactors, relays, circuit breakers) on the Luminaire group electrical circuit.
- C. Field Devices shall be capable of Manual Control, whereby the ON/OFF and DIMMED state of a single Luminaire or group of Luminaires is modified in response to commands from the Central Management System.
- D. Field Devices shall be capable of Scheduled Control, whereby the ON/OFF and DIMMED state of a single Luminaire or a group of Luminaires is modified according to a predefined schedule.
- E. Field Devices shall be capable of Scheduled Control that is defined for a minimum of (Instructions: enter appropriate number) times/events per day).
- F. Field Devices shall be capable of Scheduled Control that is either time-based, whereby Controllers modify Luminaire operation when a specific time in the schedule occurs, or event-based, whereby Controllers modify Luminaire operation when the next event in the schedule occurs.
- G. Field Devices shall be capable of time-based Scheduled Control that is defined:
Instructions: Select ONE or MORE, as desired
 1. ☐ On a daily recurring basis
 2. ☐ On a weekday recurring basis
 3. ☐ On a weekend recurring basis
 4. ☐ For special events which occur on a daily or daily recurring basis
- H. Field Devices shall be capable of event-based Scheduled Control that is defined according to inputs from integral sensors or the Central Management System.

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Note: sensors available for event-based Scheduled Control are specified in Appendix E.

- I. Field Devices shall be capable of Adaptive Control, whereby the ON/OFF and DIMMED state of a single Luminaire or a group of Luminaires is modified in response to dynamic inputs from integral sensors or the Central Management System.

Note: sensors available for Adaptive Control are specified in Appendix E.

- J. Field Devices shall be capable of Prioritized Control, whereby the Scheduled Control of individual Luminaires or groups of Luminaires is modified or overridden according to input from integral sensors or the Central Management System.

- K. During Offline Operation Field Devices shall be capable of maintaining Luminaire control by:

Instructions: Select ONE or MORE, as desired

1. ☐ Continuing to operate according to the most recently programmed Scheduled Control or a default Scheduled Control if one has not yet been programmed.
 2. ☐ Continuing to operate according to the most recently programmed Adaptive Control or a default Adaptive Control if one has not yet been programmed, using input from an integral sensor.
- L. ☐ Optional: Field Devices shall be capable of true input power control, whereby the Luminaire DIMMED state is actuated to achieve a desired true input power (percent relative watts).

Note: This feature requires knowledge of the relationship between Luminaire input control signal and true input power (watts), which must be imported (manually or automatically) according to some pre-defined means, or measured using some internal (metering) capability.

- M. ☐ Optional: Field Devices shall be capable of light output control, whereby the Luminaire DIMMED state is actuated to achieve a desired light output (percent relative lumens).

Note: This feature requires either a) knowledge of the relationship between Luminaire input control signal and light output (lumens) or b) knowledge of both the relationship between Luminaire input control signal and true input power (watts) and the relationship between Luminaire true input power (watts) and light output (lumens); these relationship(s) must be imported manually or automatically according to some pre-defined means.

- N. ☐ Optional: Field Devices shall be capable of automatically maintaining constant Luminaire light output (lumens) over time by compensating for Luminaire lumen depreciation.

Note: This feature requires either a) knowledge of the relationship between Luminaire input control signal and light output over time (lumen depreciation) or b) knowledge of both the relationship between Luminaire input control signal and true input power (watts) and the relationship between Luminaire true input power (watts) and light output over time (lumen depreciation); these relationship(s) must be imported (manually or automatically) according to

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some pre-defined means or measured using some internal capability. This feature will also result in increasing Luminaire true input power over time.

- O. ☐ Optional: Field Devices shall be capable of ensuring that a maximum Luminaire true input power (watts) is never exceeded.

6.5 INTERCHANGEABILITY AND INTEROPERABILITY

- A. ☐ Optional: Field Devices or Field Device networks shall be certified as compliant with the TALQ v_____ standard, and Interoperable with TALQ certified Central Management Systems.
- B. ☐ Optional: Field Devices or Field Device networks shall be certified as compliant with the LonMark v_____ Outdoor Luminaire Controller standard.
- C. ☐ Optional: Field Devices or Field Device networks shall be certified as compliant with the LonMark v_____ Smart Luminaire Controller standard.
- D. ☐ Optional: Field Devices shall be Interoperable with the Central Management System specified in Appendix A.
- E. ☐ Optional: The Vendor shall demonstrate Field Device Interoperability with the existing Central Management System described in Appendix A prior to INSTALLATION.
- F. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interoperability with the existing Central Management System described in Appendix A prior to INSTALLATION.
- G. ☐ Optional: Field Devices shall be Interoperable with the Backhaul Communication Network(s) specified in Appendix B.
- H. ☐ Optional: The Vendor shall demonstrate Field Device Interoperability with the existing Backhaul Communication Network(s) described in Appendix B prior to INSTALLATION.
- I. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interoperability with the existing Backhaul Communication Network(s) described in Appendix B prior to INSTALLATION.
- J. ☐ Optional: Field Devices shall be Interchangeable with the Field Devices specified in Appendix C.
- K. ☐ Optional: The Vendor shall demonstrate Field Device Interchangeability with the existing Field Devices described in Appendix C prior to INSTALLATION.
- L. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interchangeability with the existing Field Devices described in Appendix C prior to INSTALLATION.
- M. ☐ Optional: Future requirement for peer-to-peer interoperability with Field Devices specified in Appendix C.

Note: Peer-to-peer interoperability for Field Devices will be addressed in future versions of the Model Specification, based on related standards development and market availability.

- N. ☐ Optional: Field Devices shall be Interoperable with the Luminaires specified in Appendix D.

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- O. ☐ Optional: The Vendor shall demonstrate Field Device Interoperability with the existing Luminaires described in Appendix D prior to INSTALLATION.
- P. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interoperability with the existing Luminaires described in Appendix D prior to INSTALLATION.
- Q. ☐ Optional: Field Devices shall be Interoperable with the Sensor(s) specified in Section 6.2-P and/or Appendix E.
- R. ☐ Optional: The Vendor shall demonstrate Field Device Interoperability with the existing Sensor(s) described in Appendix E prior to INSTALLATION.
- S. ☐ Optional: The Vendor shall provide standard production model samples of all Field Device Components required for User verification of Interoperability with the existing Sensor(s) described in Appendix E prior to INSTALLATION.

6.6 RATED LIFE & RELIABILITY

- A. The rated life of all Field Devices at an ambient temperature of 25 degrees Celsius shall be:

Instructions: Select ONE

- 1. ☐ 10 years or more
- 2. ☐ 15 years or more
- 3. ☐ 20 years or more
- 4. ☐ __ years or more

- B. The Vendor shall report the reliability of the following Field Devices, as measured by Mean Time between Failures (MTBF):

Instructions: Select ONE or MORE, as desired

- 1. ☐ Gateway
- 2. ☐ Controller

Instructions: enter list of other Components requiring reliability reporting

- 3. ☐ [Instructions: Describe other Component of interest]

- C. ☐ Optional: The reported MTBF shall be calculated according to Telcordia SR-332.
- D. ☐ Optional: The reported MTBF shall be calculated according to MIL-HDBK 217.

PART 7 — COMPONENT WARRANTY

7.1 INTRODUCTION

The following sections contain suggested warranty terms for Components to be installed as part of the System.

7.2 WARRANTY PERIOD

Instructions: Select ONE

- A. ☐ Warranty periods shall begin on date of commissioning. The Vendor shall provide the User with appropriate signed warranty certificates immediately upon completion of Commissioning.
- B. ☐ Warranty periods shall begin on date of shipment from Vendor. The Vendor shall provide the User with appropriate signed warranty certificates together with shipment.

7.3 HARDWARE

- A. All Components shall be covered by a single-source written replacement warranty covering material and workmanship for a period of:

Instructions: Select ONE

- 1. ☐ FIVE years
 - 2. ☐ TEN years
 - 3. ☐ TWENTY years
- B. Components which are provided to a luminaire Vendor for installation within the luminaire prior to field installation of the luminaire shall be warranted for the terms and conditions described herein by:

Instructions: select ONE

- 1. ☐ Luminaire Vendor
 - 2. ☐ Control Vendor
- C. The User may perform field measurements and/or send components to independent laboratories for testing to enforce warranty provisions at any time during the warranty period.
- D. ☐ Optional: The written replacement warranty shall be converted to a written ON-SITE replacement warranty if the field observed and documented MTBF (over any consecutive 12 month period) for any Component specified in 6.6B exceeds the Vendor specified MTBF. On-site warranty replacement includes removal and disposal of failed Components, along with delivery and installation of new Components.
- E. ☐ Optional: The written replacement warranty shall be converted to a written ON-SITE replacement warranty if the field observed and documented failure exceeds 5 percent for any installation of 100 or more identical Components. On-site warranty replacement includes removal and disposal of failed Components, along with delivery and installation of new Components.

7.4 SOFTWARE & FIRMWARE

- A. All software and firmware shall be covered by a written replacement warranty covering material and workmanship for a period of ONE year.

PART 8 — COMPONENT INSTALLATION

8.1 INTRODUCTION

The process of Component INSTALLATION results in a state where all Components have been provided the basic necessities required for them to operate as intended. Typical Component installation activities include mechanical mounting, the establishment of one or more electrical connections, and perhaps some provisioning for network communication or configuration of basic parameters to default or user specified settings. Component INSTALLATION does not result in a state where all Components are operating as intended or where all System functions and capabilities are available to the User.

The following sections contain suggested INSTALLATION terms for Components to be integrated into the System.

8.2 RESPONSIBILITY

- A. Component INSTALLATION training shall be performed by:

Instructions: Select ONE

1. ☐ The Vendor
2. ☐ The Vendor or a Vendor-specified agent or representative

Note: For most users, Component INSTALLATION training will be best performed directly by the Vendor.

- B. Component INSTALLATION shall be performed by:

Instructions: Select ONE

1. ☐ The Vendor
2. ☐ The following 3rd Party: [Instructions: Insert 3rd party name]
3. ☐ The User

Note: For most users, Component INSTALLATION will be best performed by the User or a 3rd party experienced with the users system and/or the equipment to be installed.

- C. All hardware necessary for Component INSTALLATION and provisioning for network communication shall be provided by:

Instructions: select ONE

1. ☐ The Vendor
2. ☐ The User

8.3 COMPONENT INSTALLATION TRAINING REQUIREMENTS

- A. The responsible party shall provide Component INSTALLATION training manuals and all supporting documentation in the Portable Document Format (PDF).

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- B. ☐ Optional: The responsible party shall provide Component INSTALLATION support in person, or via telephone and/or the Internet.
- C. ☐ Optional: The responsible party shall provide comprehensive Component INSTALLATION training at the User's facility.
 - 1. Training shall be scheduled based on availability of the User's staff.
 - 2. The responsible party shall provide all necessary instructional equipment to be used during the training sessions for training purposes.
 - 3. The User may elect to record the training sessions. The recordings shall be the sole property of the User and for the sole use of the User.

8.4 COMPONENT INSTALLATION REQUIREMENTS

- A. ☐ Optional: The responsible party shall identify a manufacturer or manufacturer-authorized representative that will be available to support System START-UP during the entire System START-UP period.
- B. The responsible party shall specify whatever coordination is needed with the User's IT staff in order to complete System INSTALLATION.
- C. The responsible party shall mount and electrically connect all Components, taking special care to ensure the following:
 - 1. All Components are mounted in a location sufficiently removed from sources of electromagnetic radiation (e.g. cellular base stations) that are likely to interfere with Component communication.
 - 2. All Components are installed with any accessories that are required or specified, and without any accessories that are not required or specified.
 - 3. All Components are electrically connected to an appropriate AC or DC input (as applicable).

Note: Luminaires with internally installed Controllers may warrant special attention. If the luminaire has a twist-lock receptacle, a shorting cap may need to be installed to provide power to the luminaire and controller. Conversely, if a photoelectric device is installed, power to the luminaire and controller may be disconnected in the presence of daylight.

- D. The responsible party shall provision for network communication, configure to default or user specified settings,
- E. The responsible party shall ensure that all installed Components have the basic necessities required to operate as intended, as applicable.
- F. ☐ Optional: The responsible party shall test all newly installed wiring for continuity.
- G. ☐ Optional: The responsible party shall test all newly installed wiring for insulation resistance (i.e. megger test).
- H. The responsible party shall inspect the installed System (i.e. set of Components) immediately following the installation of all Components and verify that all Components are capable of operating as intended.
- I. ☐ Optional: The responsible party shall inspect the installed System (i.e. set of Components) 72 hours after it has been fully energized and verify that all Components are capable of operating as intended, taking special care to ensure the following:

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1. All Component mountings are intact.
 2. All Component electrical connections are intact, and operation of the installed system (i.e. set of Components) has not resulted in any known short circuits, open circuits, or ground faults.
- J. ☐Optional: The responsible party shall submit a written report containing a list of all installed components, inspections and observations, tests performed and test results over the course of Component INSTALLATION.
- K. ☐Optional: The responsible party shall submit written documentation of any defective materials and workmanship issues found during inspections, as well as unsatisfactory test results.
- L. ☐Optional: The responsible party shall remedy any defective materials and workmanship issues found during inspections, and repair or replace any Components, as necessary, to achieve satisfactory test results.

PART 9 — SYSTEM START-UP

9.1 INTRODUCTION

The process of System START-UP results in a state where all Components are operating as intended and all System functions and capabilities are available to the User. Typical System START-UP activities include the configuration of System hardware, firmware, and software. SYSTEM START-UP does not (necessarily) result in a state where all System functions and capabilities are configured according to User desires.

The following sections contain suggested System START-UP terms for Components installed as part of the System.

9.2 RESPONSIBILITY

- A. System START-UP training shall be performed by:

Instructions: Select ONE

1. ☐ The Vendor
2. ☐ The Vendor or a Vendor-specified agent or representative

Note: For most users, System START-UP training will be best performed directly by the Vendor.

- B. System START-UP shall be performed by:

Instructions: Select ONE

1. ☐ The Vendor
2. ☐ The following 3rd Party: [Instructions: Insert 3rd party name]
3. ☐ The User

Note: For most users, System START-UP will be best performed by the Vendor.

- C. All hardware, software and firmware, and tools necessary for System START-UP shall be provided by:

Instructions: select ONE

1. ☐ The Vendor
2. ☐ The User

9.3 SYSTEM START-UP TRAINING REQUIREMENTS

- A. The responsible party shall provide System START-UP training manuals and all supporting documentation in the Portable Document Format (PDF).
- B. System START-UP training shall cover (at a minimum) the following (as applicable):
 1. Power-up and power-down sequences
 2. Hardware configuration, calibration and testing

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3. Software and firmware configuration, testing, and updating
4. Administration and operation
5. Troubleshooting
- C. The responsible party shall provide comprehensive System START-UP training at the User's facility.
 1. Training shall be scheduled based on availability of the User's staff.
 2. The responsible party shall provide all necessary instructional equipment to be used during the training sessions for training purposes.
 3. The User may elect to record the training sessions. The recordings shall be the sole property of the User and for the sole use of the User.

9.4 SYSTEM START-UP REQUIREMENTS

- A. The responsible party shall inspect the installed System and identify any issues that need to be remedied prior to System START-UP.
- B. ☐ Optional: The responsible party shall identify a manufacturer or manufacturer-authorized representative that will be available to support System START-UP during the entire System START-UP period.
- C. The responsible party shall specify whatever coordination is needed with the User's IT staff in order to complete System START-UP.
- D. The responsible party shall configure any and all hardware, firmware, or software as necessary to enable all System Components to operate as intended.
- E. The responsible party shall ensure that the latest applicable versions of all firmware and software are installed, and perform any necessary updates or upgrades.
- F. The responsible party shall successfully demonstrate all System functions and capabilities described during System START-UP training.
- G. Following User acceptance of a successful demonstration of all System functions and capabilities, a System START-UP trial period shall commence.
- H. The System START-UP trial period shall consist of:

Instructions: Select ONE

1. ☐ 14 consecutive calendar days of System operation
2. ☐ 28 consecutive calendar days of System operation
3. ☐ 42 consecutive calendar days of System operation
- I. Over the course of the System START-UP trial period, all System functions and capabilities shall operate normally for at least ninety-nine percent (99%) of the time.
- J. The responsible party shall remedy any issues discovered during the System START-UP trial period.
- K. ☐ Optional: Prior to the completion of System START-UP, the responsible party shall submit written documentation of all hardware, firmware, or software configurations required to enable all System Components to operate as intended. Written documentation of all hardware, firmware, or software configurations shall include all modifications made over the course

[Insert User name here]

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ofSystem START-UP, and shall accurately represent the System following the completion of a successful System START-UP trial period.

PART 10 — SYSTEM COMMISSIONING

10.1 INTRODUCTION

The process of System COMMISSIONING results in a state where all System functions and capabilities are configured according to User desires. Typical System COMMISSIONING activities include the modification of System software settings.

The following sections contain suggested System COMMISSIONING terms for Components that have been installed and started-up as part of the System.

10.2 RESPONSIBILITY

- A. System COMMISSIONING training shall be performed by:

Instructions: Select ONE

1. ☐ The Vendor
2. ☐ The Vendor or a Vendor-specified agent or representative

Note: For most users, System COMMISSIONING training will be best performed directly by the Vendor.

- B. SYSTEM COMMISSIONING shall be performed by:

Instructions: Select ONE

1. ☐ The Vendor
2. ☐ The Vendor or a Vendor-specified agent or representative
3. ☐ The following 3rd Party: [Instructions: Insert 3rd party name]
4. ☐ The User

Note: For most users, System COMMISSIONING will be best performed by the User, supported by the Vendor or an agent or representative trained by the Vendor.

10.3 SYSTEM COMMISSIONING TRAINING REQUIREMENTS

- A. ☐ Optional: The responsible party shall provide comprehensive System COMMISSIONING training at the User's facility.
1. Training shall be scheduled based on availability of the User's staff.
 2. The responsible party shall provide all necessary instructional equipment to be used during the training sessions for training purposes.
 3. The User may elect to record the training sessions. The recordings shall be the sole property of the User and for the sole use of the User.
 4. Training shall be performed using the User's installed System (not using a remote system or a simulated system).

10.4 SYSTEM COMMISSIONING REQUIREMENTS

- A. ☐ Optional: The responsible party shall identify a manufacturer or manufacturer-authorized representative that will be available to support System COMMISSIONING during the System COMMISSIONING period.
- B. The responsible party shall modify any System software settings as necessary to configure all System functions and capabilities according to User desires.
- C. The responsible party shall successfully demonstrate all that System functions and capabilities are performing according to User desires.
- D. Following User acceptance of a successful demonstration of all System functions and capabilities performing according to User desires, a System COMMISSIONING trial period shall commence.
- E. The System COMMISSIONING trial period shall consist of:

Instructions: Select ONE

- 1. ☐ 7 consecutive calendar days of System operation
- 2. ☐ 14 consecutive calendar days of System operation
- 3. ☐ 21 consecutive calendar days of System operation
- F. Over the course of the System COMMISSIONING trial period, all System functions and capabilities shall operate according to User desires for at least ninety-nine percent (99%) of the time.
- G. The responsible party shall remedy any issues discovered during the System COMMISSIONING trial period.
- H. ☐ Optional: The responsible party shall import asset information from the existing Asset Management System described in Appendix F to the Central Management System.
- I. ☐ Optional: The responsible party shall synchronize asset information between the existing Asset Management System described in Appendix F and the Central Management System.
- J. ☐ Optional: Prior to the completion of System COMMISSIONING, the responsible party shall submit written documentation of all System software settings required to configure all System functions and capabilities according to User desires. Written documentation of all System software settings shall include all modifications made over the course of System COMMISSIONING, and shall accurately represent the System following the completion of a successful System COMMISSIONING trial period.

PART 11 — SYSTEM MAINTENANCE

11.1 INTRODUCTION

The following sections contain suggested terms for the Maintenance of the System.

11.2 RESPONSIBILITY

A. The System shall be maintained by:

Instructions: Select ONE

1. ☐ The Vendor
2. ☐ The following 3rd Party: (Instructions: Insert 3rd party name)
3. ☐ The User

11.3 REQUIREMENTS

A. If the System is Maintained by a 3rd Party or the User:

1. The Vendor shall provide comprehensive maintenance training at the User's facility, covering all aspects of The System.
2. The Vendor shall provide hardware and software maintenance and support according to the warranty terms for the duration of the warranty period. Any Maintenance term shall start following the applicable warranty period.
3. The Vendor shall specify any and all mandatory maintenance required to maintain the terms of the warranty.
4. ☐ Optional: Software and firmware upgrades, maintenance and support shall be provided for one year at no extra cost.
5. ☐ Optional: Software and firmware upgrades, maintenance and support shall be provided for the current version(s) and the next two subsequent major version updates at no extra cost.

B. If the System is Maintained by the Vendor:

1. The responsible party shall be responsible for the complete maintenance of the System, ensuring compliance with all terms of the Specification at all times.
2. If the Vendor is hosting the system, Vendor shall provide its comprehensive backup plan for software/system/server services, and data (in database).
3. ☐ Optional: Monthly maintenance records and reports shall be submitted to the User. These shall include (but are not limited to) inspection reports, documentation of maintenance performed, and expected future maintenance requirements.
4. ☐ Optional: The Vendor shall provide a mechanism to allow the User to submit requests for addressing any System malfunctions or maintenance issues.

Appendix A: Existing Central Management System

A1 Description of Central Management Software

Instructions: Describe the specific Central Management Software that other Components are required to be Compatible, Interoperable, or Interchangeable with. See examples below for structure and format.

[Example 1: Vendor Hosted System]

- A1a Central Management Software make: [Make]
- A1b Central Management Software model: [Model]
- A1c Central Management Hardware platform: Cloud

[Example 2: User Hosted System]

- A1d Central Management System make: [Make]
- A1e Central Management System model: [Model]
- A1f Central Management Hardware platform: Server

A2 Description of Central Management Computing Infrastructure

Instructions: Describe the specific Computing Infrastructure that the Central Management Software is intended to be Compatible with. See examples below for structure and format.

[Example 1: Microsoft OS Based System]

- A2a Server make: Dell
- A2b Server model: [Model]
- A2c Server OS make: Microsoft
- A2d Server OS model: Windows Server 2012
- A2e Database make: Microsoft
- A2f Database model: SQL Server 2012

[Example 2: Apple OS Based System]

- A2a Server make: Apple
- A2b Server model: [Model]
- A2c Server OS make: Apple
- A2d Server OS model: X Mountain Lion Server
- A2e Database make: Oracle
- A2f Database model: MySQL Community server 5.5.23

[Example 3: Windows Server with VMWare virtualization]

- A2a Server make: Dell
- A2b Server model: R720
- A2c Server OS make: Microsoft
- A2d Server OS model: Windows 2008 R2 Enterprise Edition
- A2e Database make: Microsoft

[Insert User name here]
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A2f Database model: SQK Server 2012

[Example 4:UNIX Server with Oracle VM Server for SPARC virtualization]

A2a Server make: Oracle

A2b Server model: Oracle SPARC T4 series

A2c Server OS make: Oracle

A2d Server OS model: 64 bit Solaris 10 for SPARC

A2e Database make: Oracle

A2f Database model: Oracle 11g

Appendix B: Existing Backhaul Communication Network(s)

B1 Description(s)

Instructions: Describe the specific Backhaul Communication Network(s) that other Components are required to be Interoperable or Interchangeable with. See examples below for structure and format.

[Example 1:Wired connection to Ethernet]

B1a Physical Layer: RJ45

B1b Data Link Layer: IEEE 802.3

B1c Hardware Make: [Make]

B1d Hardware Model [Model]

[Example 2:Wired connection to Wi-Fi]

B1a Physical Layer: RJ45

B1b Data Link Layer: IEEE 802.11a/b/g/n MAC

B1c Hardware Make: [Make]

B1d Hardware Model [Model]

[Example 3:Wireless connection to Wi-Fi]

B1a Physical Layer: IEEE 802.11a/b/g/n PHY

B1b Data Link Layer: IEEE 802.11a/b/g/n MAC

B1c Hardware Make: [Make]

B1d Hardware Model: [Model]

Appendix C: Existing Field Devices

C1 Description(s)

Instructions: Describe the specific Field Devices that other Components are required to be Interoperable or Interchangeable with. See examples below for structure and format.

[Example 1:Controller]

C1a Controller Make:

C1b Controller Model:

C1c Controller URL:

C1d Controller Catalog Number:

[Example 2:Gateway]

C1a Gateway Make:

C1b Gateway Model:

C1c Gateway URL:

C1d Gateway Catalog Number:

Appendix D: Existing Luminaires

D1 Description(s) of Luminaires at existing Control Points

Instructions: Describe the Luminaire(s) at existing Control Points that Field Devices are intended to be Interoperable with. Enter Reference Codes from Control Point Inventory tables

[Example 1]

D1a Control Point Inventory Reference Code: Cully Boulevard

D2 Description(s) of Uninstalled Luminaires

Instructions: Describe the Luminaire(s) not yet installed at specified Control Points that Field Devices are intended to be Interoperable with. Enter Reference Codes from Luminaire Inventory tables

[Example 1]

D2a Luminaire Inventory Reference Code: 150W HPS

D3 Luminaire Specification(s)

Instructions: Describe the Luminaire(s) not yet purchased that Field Devices are intended to be Interoperable with. Enter items from Section 1.2 Related Documents containing Luminaire specifications.

[Example 1]

D3a MSSLC Specification for LED Roadway Luminaires – Arterial 1

D3b MSSLC Specification for LED Roadway Luminaires – Collector 1

[Insert User name here]
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Control Point Inventory

Instructions: Fill out a table for each luminaire type installed at specified Control Points.

Reference Code	[Insert suitable reference e.g. "Cully Boulevard"]		
Technology	☐ LED ☐ Induction ☐ CMH ☐ MH ☐ HPS ☐ LPS		
Control Point	Number of Instances		
	Pole Height		
	GPS Coordinates	[Insert reference to Related Document]	
	GIS File	[Insert reference to Related Document]	
Luminaire	Make		
	Model		
	Catalog Number		
	Controller Integration	☐ NEMA C136.10 ☐ NEMA C136.41 ☐ Internal Cavity	
	Rated Input Power		Watts
	Power Factor		At Rated Input Power
	Other Notes		
Ballast/Driver	Control Signal	☐ 0-10V ☐ DALI ☐ Other _____ ☐ Not dimmable	
	Make		
	Model		
	Catalog Number		
	AC Input (RMS Volts)	☐ 120 ☐ 208 ☐ 240 ☐ 277 ☐ 347 ☐ 480 ☐ 120-277 ☐ 347-480 ☐ Other _____	
	Other Notes		

[Insert User name here]
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Luminaire Inventory

Instructions: Fill out a table for each luminaire type.

Reference Code	[Insert suitable reference e.g. "150W HPS"]	
Technology	☐ LED ☐ Induction ☐ CMH ☐ MH ☐ HPS ☐ LPS	
Luminaire	Number of Instances	
	Make	
	Model	
	Catalog Number	
	Controller Integration	☐ NEMA C136.10 ☐ NEMA C136.41 ☐ Internal Cavity
	Rated Input Power	Watts
	Power Factor	At Rated Input Power
	Other Notes	
Ballast/Driver	Control Signal	☐ 0-10V ☐ DALI ☐ Other _____ ☐ Not dimmable
	Make	
	Model	
	Catalog Number	
	AC Input (RMS Volts)	☐ 120 ☐ 208 ☐ 240 ☐ 277 ☐ 347 ☐ 480 ☐ 120-277 ☐ 347-480 ☐ Other _____
	Other Notes	

Appendix E: Existing Sensor(s)

E1 Description(s)

Instructions: Describe the specific Sensor(s) that Field Devices are intended to be Interoperable with. See examples below for structure and format.

[Example 1]

E1a Photoelectric Sensor Make:

E1b Photoelectric Sensor Model:

E1c Photoelectric Sensor URL:

E1d Photoelectric Sensor Catalog Number:

[Example 2]

E1a Occupancy Sensor Make:

E1b Occupancy Sensor Model:

E1c Occupancy Sensor URL:

E1d Occupancy Sensor Catalog Number:

Appendix F: Existing Asset Management System(s)

F1 Description(s)

Instructions: Describe the specific Asset Management System(s) that the Central Management System is intended to be Interoperable with. See examples below for structure and format.

[Example 1:User created and managed spreadsheet]

F1a Software make: Microsoft

F1b Software model: Excel 2010

F1c Software URL: <http://office.microsoft.com/en-us/excel/>

[Example 2:Generic Description: ArcGIS]

F1a Software make: Esri

F1b Software model: ArcGIS 10

F1c Software URL: <http://www.esri.com/software/arcgis/arcgis10/index.html>

[Example 3:Work and Asset Management]

F1a Software make: Oracle

F1b Software model: WAM 9.x

F1c Software URL: <http://www.oracle.com/us/products/applications/utilities/business-solutions/work-asset-management/overview/index.html>

[Example 4:Service Orientated Architecture Bus]

F1a Software make: Oracle

F1b Software model: SOA Suite 11

F1c Software URL: <http://www.oracle.com/us/products/middleware/soa/suite/overview/index.html?origref=http://www.oracle.com/us/industries/utilities/solutions/index.html>

[Example 5: Google Earth/Maps/MapsGL based system]

F1a Software make: [Make]

F1b Software model: [Model]

F1c Software URL: <http://www.google.com/mapmaker>

[Example 6: OpenGIS based [system](#)]

F1a Software make: [Make]

F1b Software model: [Model]

F1c Software URL: <http://www.opengeospatial.org/>

Appendix G: Existing Intelligent Traffic System(s)

G1 Description(s)

Instructions: Describe the specific Intelligent Traffic System(s) that the Central Management System is intended to be Interoperable with. See examples below for structure and format.

[Example 1]

G1a Traffic Signal System Make:

G1b Traffic Signal System Model:

G1c Traffic Signal System URL:

G1d Traffic Signal System Catalog Number:

[Example 2]

G1a Traffic Signal System Make:

G1b Traffic Signal System Model:

G1c Traffic Signal System URL:

G1d Traffic Signal System Catalog Number