LED SITE LIGHTING PERFORMANCE SPECIFICATION

PART 1 – GENERAL

1.1 REFERENCES

A. 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.

B. American National Standards Institute (ANSI)

1. ANSI C62.41.1-2002 – IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits

2. ANSI C62.41.2-2002 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000W and less) AC Power Circuits

3. ANSI C82.SSL1 – SSL Drivers (in ANSI development)

4. ANSI C136.31-2001 – American National Standard for Roadway Lighting Equipment – Luminaire Vibration

C. American Society for Testing and Materials International (ASTM)

1. ASTM B117-97 – Standard Practice for Operating Salt Spray (Fog) Apparatus

2. ASTM G53 – Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV – Condensation Type) for Exposure of Nonmetallic Materials

D. Illuminating Engineering Society of North America (IESNA)

1. DG-13-98, Guide for the Selection of Photocontrols for Outdoor Lighting Applications

2. G-1-03, Guidelines for Security Lighting

3. LM-10-10, Photometric Testing of Outdoor Fluorescent Luminaires

4. LM-31-95, Photometric Testing of Roadway Luminaires Using Incandescent Filament and HID Lamps

5. LM-64-01, Photometric Measurements of Parking Areas

6. LM-69-95 (R2002), Interpretation of Roadway Luminaire Photometric Reports

7. LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products

8. LM-80-08, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources

9. RP-20-98, Recommended Practice for Lighting Parking Facilities

10. RP-33-99, Recommended Practice for Lighting for Exterior Environments

11. TM-15-07 (Revised), Luminaire Classification System for Outdoor Luminaires

E. International Electrotechnical Commission (IEC)

1. IEC 60529 – Degrees of Protection provided by enclosures (IPCode)

F. National Electrical Manufacturers Association (NEMA)

1. ANSI/NEMA/ANSLG C78.377-2008 – American National Standard for the Chromaticity of Solid State Lighting Products

2. WD 7-2000 NEMA Guide Publication: *Occupancy Motion Sensors*

G. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code (NEC)

1.2 RELATED DOCUMENTS

Contract Drawings and conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specifications Sections and all other Contract Documents) apply to the work of this section.

1.3 QUALITY ASSURANCE

A. Site Owner may request standard production model luminaire samples identical (including LED package) to product proposed to be installed for inspection. Owner may request independent testing of sample luminaires to verify luminaire performance and compliance with the specifications. Conduct testing per the applicable IESNA and ANSI approved methods for products using Solid-State Lighting (SSL) sources. Test laboratories must be either National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program or one of the qualified labs listed on the DOE SSL web site (http://www1.eere.energy.gov/buildings/ssl/test_labs.html).

B. If luminaires are believed to be underperforming in early life, the Site Owner may choose to take field measurements between 2,000 and 3,000 operating hours of the completion of installation to confirm that lighting levels are in accordance with the site-specific photometric requirements in this specification. If uniformity is more than 15% worse or average light levels are more than 15% below the **DAY 1** submittal (see 1.7.A.1) and the luminaire locations in the field are as designed, the luminaire manufacturer must provide additional luminaires to achieve the specified light levels and uniformity. Variance from specified tolerances may be allowed provided prior approval by Owner.

C. Guidance for pre and post-installation field measurements (Measurement & Verification (M&V) Plan) can be found at http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/lighting_measurement_evaluation_protocol.pdf

1.4 SITE LIGHTING SYSTEM PERFORMANCE

A. Energy Conservation:

1. Site lighting must meet the following lighting power density (LPD) requirements (paved area of site defines the applicable area) based on the exterior zone location for the project (see Appendix B for zone definitions):

a. LZ2 –LPD maximum of 0.05 W/SF

b. LZ3 –LPD maximum of 0.06 W/SF

c. LZ4 –LPD maximum of 0.08 W/SF

B. Light Loss Factors:

1. Assume Lamp Lumen Depreciation (LLD): 0.70. An alternate value may be used based on the use of the Site defined performance method if allowed by site Owner. See Section 2.4 D for calculation.

2. Assume Luminaire Dirt Depreciation (LDD): 0.90 for all luminaires.

C. Site Lighting Requirements – Main Parking Area

1. Defined as the group(s) of parking spots comprising the majority of the site. The zone starts from the edge of the front aisle and extends to the center of the outermost driving lane. See Appendix A for diagram of exterior areas.

2. Illuminance requirements of area:

Table 1. Main Parking Area

	Minimum Horizontal Illuminance	Uniformity Maximum:Minimum	Minimum Vertical Illuminance
Lighting Zone 0	N/A	N/A	N/A
Lighting Zone 1	N/A	N/A	N/A
Lighting Zone 2	0.50 fc	10:1	0.25 fc
Lighting Zone 3	0.75 fc	10:1	0.40 fc
Lighting Zone 4	1.00 fc	10:1	0.50 fc

3. Horizontal illuminance measurements must be taken at finished grade. Vertical illuminance in the center of Main Parking Area must be taken at 5’ above parking surface at the point of lowest horizontal illuminance, excluding facing outward along boundaries.

4. Site Lighting Requirements – Perimeter Parking Areas

5. Defined as the group(s) of parking spots on the perimeter of the site. The zone starts on the center of the outermost driving lane and goes to the boundary of the paved area. See Appendix A for diagram of exterior areas.

6. Illuminance requirements of area:

Table 2. Perimeter Parking Area

	Minimum Horizontal Illuminance	Uniformity Maximum:Minimum
Lighting Zone 0	N/A	N/A
Lighting Zone 1	N/A	N/A
Lighting Zone 2	0.20 fc	10:1

Lighting Zone 3	0.40 fc	10:1
Lighting Zone 4	0.50 fc	10:1

D. Site Lighting Requirements – Front Aisle

1. Defined as the driving/walking area from the façade of the building through the nearest set of drive lanes. See Appendix A for diagram of exterior areas.

2. Illuminance requirements of area:

Table 3. Front Aisle

	Minimum Horizontal Illuminance	Uniformity Maximum:Minimum
Lighting Zone 0	N/A	N/A
Lighting Zone 1	N/A	N/A
Lighting Zone 2	1.00 fc	10:1
Lighting Zone 3	1.50 fc	10:1
Lighting Zone 4	2.00 fc	10:1

E. Site Lighting Requirements – Entry Drives, Bale and Loading Areas, Rear Drives

1. Entry drive defined as the roadway for entering and leaving the parking lot. The zone starts at the end of the public road and ends where the perimeter parking zone starts. See Appendix A for diagram of exterior areas.

2. Loading area defined as the roadway along the façade where loading and unloading for the building occur. See Appendix A for diagram of exterior areas.

3. Rear drive defined as the roadway behind the building, where customer parking does not occur, and extends from the façade of the building to the boundary of the paved area. See Appendix A for diagram of exterior areas.

4. Illuminance requirements of area:

Table 4. Entry Drives, Loading Areas, Rear Drives

	Minimum Horizontal Illuminance	Uniformity Maximum:Minimum
Lighting Zone 0	N/A	N/A
Lighting Zone 1	N/A	N/A
Lighting Zone 2	0.20 fc	10:1
Lighting Zone 3	0.40 fc	10:1
Lighting Zone 4	0.50 fc	10:1

F. Site Lighting Requirements – Spill Light Control (Light Trespass)

1. The Lighting System must produce less than the vertical illuminance listed in the table below at any point 5’ AFG along the site boundary (normal to the boundary and facing the site):

Table 5. Site Lighting Trespass Maximum Vertical Illuminance Values

Lighting Zone	Maximum Illuminance
LZ0	0.05 fc
LZ1	0.10 fc
LZ2	0.30 fc
LZ3	0.80 fc
LZ4	1.50 fc

G. When Security is an issue – Note that increased light levels are not the only or necessarily the best way to improve security in parking lots. Considerations include improved security camera equipment and placement, use of motion detectors to trigger increased light levels, increased lighting uniformity, etc. However when specific security issues requiring light levels exceeding recommendations in A through F above are identified by the site Owner, reference IESNA document G-1-03, section 4. If all the requirements are met in G-1-03, use an LPD multiplier of 1.50 for each of the Lighting Zones (LZ).

1.5 SUBMITTALS

A. Performance Reports – Submit the following for approval when required by the Site Owner:

1. Computer generated photometric analysis of proposed **DAY 1** (defined as the initial illuminance values), of the lighting installation. Submittal should include the following requirements:

a. Provide horizontal illuminance measurements per section 1.6-C. Spacing between computer calculation points must be 10’

b. Provide vertical illuminance measurements per section 1.6-G

c. Computer calculation must use the following applicable LLF values: 1.0 LLD and 1.0 LDD.

2. Computer generated photometric analysis of End-of-useful life date **(see 2.4 D**) of the lighting installation, submittal should include the following requirements:

a. Provide horizontal illuminance measurements per section 1.6-C-3. Spacing between computer calculation points must be 10’

b. Provide vertical illuminance measurements per section 1.6-C-4

c. Computer calculation must use the LLF values specified in Section 1.6.B.

3. Luminaire photometric reports per IESNA LM-79-08 including: laboratory name, report number, date, luminaire catalog number, and luminaire / light source specifications. Report must contain lumen values in BUG zones per IESNA TM-15-07 and Roadway Type classifications, luminous Intensity, zonal lumen summary, and an iso-footcandle diagram per LM-31as well as documentation that specified standards and test methods were followed.

4. Provide documentation of the expected useful life as defined in Section 2.4 D including the testing and calculation of useful life and verification of site lighting performance at that life. If the Site defined performance method is used,

document the use of LM-80 test data, the specific extrapolation procedure used, the interpolation between the three sets of LM-80 data, and all calculations applied in deriving the proposed LLD and useful life.

5. Provide safety certification and file number as required for the luminaire family that must be listed, labeled, or identified per the National Electric Code (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

1.6 WARRANTY

A. Standard Warranty – Note: Life of LED parking lot lighting (primarily the luminaire) is not yet well understood given the relative newness of the technology for this application. Projected life of LED luminaires is a key component to payback scenarios in buyers' purchase evaluations, therefore prospective buyers are looking for ways help assure products perform as anticipated. Since life claims provided by suppliers is typically 50,000 hours or greater and the first cost of LED parking lot luminaires can be significant, site Owners are looking for assurances that the product will perform as claimed in terms of life.

1. Provide a written **five year** on-site replacement material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products. Finish warranty must include warranty against failure or substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

2. Provide a written **five year** replacement material warranty for defective or non-starting LED source assemblies.

3. Provide a written **five-year** replacement material warranty on all power supply units (PSUs).

4. Provide a written **five year** replacement warranty for luminaires producing inadequately-maintained illuminance levels at end of warranty period, as prorated from levels expected at end of useful life. For example, a luminaire expected to produce 70% of initial lumens at 100,000 hours would be expected to last over 11 years (continuous operation), so levels would be expected to be at 87% of initial at end of five-year warranty period. Warranty must cover all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor. If the expected useful life of the luminaire system as defined in Section 2.4 D is not maintained, then the manufacturer must replace the light source(s) or luminaire as needed.

5. Owner may request an optional **ten year** replacement warranty for inadequately-maintained illuminance levels, finish of luminaire, power-supply unit (PSU), or defective LED source assemblies. The terms of the extended warranty will be negotiated by the Owner and the luminaire manufacturer for an additional cost.

6. Warranty period must begin on date of possession. The supplier will provide the site Owner with appropriate signed warranty certificates. The site Owner must receive certificates prior to final payment.

PART 2 – PRODUCTS

2.1 GENERAL

A. Luminaires must be the type indicated on Drawings and as specified. Fixtures of the same type must be provided by one manufacturer.

B. Luminaires must be of the types and manufacturers described in the LUMINAIRE REQUIREMENTS section below, with light source, wattage and voltage as indicated on Drawings. Specific manufacturer and model number references are indicated as a standard of performance and quality. Other manufacturers' models may be supplied provided the product meets or exceeds the specifications. The alternate fixtures must achieve the same photometric levels and uniformity ratios.

C. All housing finishes must be baked-on enamel, anodized, or powder-coated, unless otherwise specified in subsections below.

2.2 LIGHT SOURCE REQUIREMENTS

A. LED sources must meet the following requirements:

1. Luminaires must be rated for -40°C to +50°C operation

2. Correlated Color Temperature (CCT) shall be one of the following, as selected by Owner:

a. Nominal CCT: 2700 K (2725 ± 145)

b. Nominal CCT: 3000 K (3045 ± 175)

c. Nominal CCT: 3500 K (3465 ± 245)

d. Nominal CCT: 4000 K (3985 ± 275)

e. Nominal CCT: 4500 K (4503 ± 243)

f. Nominal CCT: 5000 K (5028 ± 283)

g. Nominal CCT: 5700 K (5665 ± 355)

h. Nominal CCT: 6500 K (6530 ± 510)

3. D_{uv} tolerance of 0.001 ± 0.006

4. Color Rendering Index (CRI): ≥ 65

5. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:

a. High Temperature Operating Life (HTOL)

b. Room Temperature Operating Life (RTOL)

c. Low Temperature Operating Life (LTOL)

d. Powered Temperature Cycle (PTMCL)

e. Non-Operating Thermal Shock (TMSK)

f. Mechanical Shock

g. Variable Vibration Frequency

h. Solder Heat Resistance (SHR)

2.3 DRIVER REQUIREMENTS

A. Power Supply Units (PSUs) including drivers must meet the following requirements:

1. Must have a minimum efficiency of 85%

2. Must be rated to operate between -40°C to +50°C

3. Input Voltage: capable of 120 to 480 (±10%) volt, single phase as required by the site

4. Power supplies can be UL Class I or II output

5. Operating frequency must be 50/60 Hz

6. Drivers must have a Power Factor (PF) of: ≥ 0.90

7. Drivers must have a Total Harmonic Distortion (THD) of: ≤ 20%

8. Drivers must comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards

9. Drivers must be Reduction of Hazardous Substances (RoHS) compliant. (see http://www.rohs.eu/english/index.html)

2.4 LUMINAIRE REQUIREMENTS

A. General Requirements

1. Luminaire must be UL-listed for wet locations and wiring cavity must be field accessible for service or repair needs.

2. Optical cavity must be a minimum IEC 60529/IP65.

3. Fully assemble and electrically test luminaires before shipment from factory.

4. The coating must be capable of surviving ASTM B117 Salt Fog environment for 500 hrs minimum without blistering or peeling. The coating must demonstrate gloss retention of greater than or equal to 90% for 500 hrs exposure QUV test per ASTM G53 UVB313, 4 hr UV-B 60 ˚C/4 hr Condensation 50 ˚C.

5. Luminaire arm bolts must be 304 stainless steel or zinc plated steel and Grade 8.

6. Luminaires must have locality-appropriate governing mark and certification.

7. Color of the luminaire must be as specified by the site Owner.

8. If a lens not integral to the LED is used, construct the luminaire optical enclosure (lens/window) of clear and UV-resistant polycarbonate, acrylic or glass.

9. 80% of the luminaire material by weight should be recyclable at end of life. Design luminaire for ease of component replacement and end-of-life disassembly.

B. Luminaire Distribution

1. Luminaires must produce no more than the following lumens in the various vertical regions as defined by IESNA TM-15-07 Section 4.0 Luminaire Classification System (LCS):

Table 6. Maximum Allowed Lumens in the Uplight Zone for Luminaires

Lighting Zone	Uplight Low (90° – 100°)	Uplight High (100° – 180°)
LZ0	0 lumens (U0)	0 lumens (U0)
LZ1	10 lumens (U1)	10 lumens (U1)
LZ2	100 lumens (U2)	100 lumens (U2)
LZ3	500 lumens (U3)	500 lumens (U3)
LZ4	1000 lumens (U4)	1000 lumens (U4)

Table 7. Maximum Allowed Lumens in the Glare Zone for Asymmetric Luminaires

	Forward High (60° – 80°)	Forward Very High (80° – 90°)	Back High (60° – 80°)	Back Very High (80° – 90°)
LZ0	660 lumens (G0)	10 lumens (G0)	110 lumens (G0)	10 lumens (G0)
LZ1	1800 lumens (G1)	250 lumens (G1)	500 lumens (G1)	250 lumens (G1)
LZ2	5000 lumens (G2)	375 lumens (G2)	1000 lumens (G2)	375 lumens (G2)
LZ3	7500 lumens (G3)	500 lumens (G3)	2500 lumens (G3)	500 lumens (G3)
LZ4	12000 lumens (G4)	750 lumens (G4)	5000 lumens (G4)	750 lumens (G4)

Table 8. Maximum Allowed Lumens in the Glare Zone for Bilaterally Symmetric Luminaires

	Forward High (60° – 80°)	Forward Very High (80° – 90°)	Back High (60° – 80°)	Back Very High (80° – 90°)
LZ0	660 lumens (G0)	10 lumens (G0)	660 lumens (G0)	10 lumens (G0)
LZ1	1800 lumens (G1)	250 lumens (G1)	1800 lumens (G1)	250 lumens (G1)
LZ2	5000 lumens (G2)	375 lumens (G2)	5000 lumens (G2)	375 lumens (G2)
LZ3	7500 lumens (G3)	500 lumens (G3)	7500 lumens (G3)	500 lumens (G3)
LZ4	12000 lumens (G4)	750 lumens (G4)	12000 lumens (G4)	750 lumens (G4)

C. Mechanical Vibration

1. The luminaire must be subjected to 100,000 cycles of 2 Gs at the resonant frequency of the luminaire (between 5 and 30 Hz) applied at the center of gravity of the luminaire on 3 primary axes per ANSI C136.31 without damage to the luminaire. The luminaire must be fully functional upon completing the test.

D. Expected Useful Life (Light Output) and Depreciation

1. Useful Life Requirement: The useful life of the luminaire in terms of lumen output must be as specified by one of the following two methods:

a. Simplified L_{70} threshold: A minimum of 50,000 operating hours before reaching the L_{70} lumen output degradation point with no catastrophic

failures. The L_{70} lumen output must be capable of providing the illuminance levels and uniformity specified in Section 1.6.

b. Site performance method: A lifetime (in hours) specified by the Owner based on expected Site lighting use and planned replacement where the output at the specified useful life must be capable of providing the illuminance levels and uniformity specified in Section 1.6.

2. Useful Life Testing and Verification Procedure:

a. Simplified L_{70} threshold: Perform LM-79-08 testing on the luminaire at both time intervals of 0 hours and ≥ 6,000 hours. The luminaire must be operated continuously in the appropriate UL 1598/153 environment except when it is removed to perform the LM-79 light output tests. If the light output determined at ≥ 6,000 hours is ≥ 96% of the light output determined at 0 hours, the luminaire meets the simplified L_{70} threshold for useful life.

1. To demonstrate compliance a test report shall be issued showing measurement results at T=0, measurement results at T≥ 6000 hours and a summary table showing percent lumen output change and percent input power change.

b. Site defined performance method:

1. Perform lumen maintenance testing per LM-80-08 on the light source(s) (module/array) for a minimum of 6000 hours (longer testing period is encouraged). Per LM-80-08, identify the case temperature measurement point (T_s) that is accessible to allow temporary attachment of a thermocouple for measurement of the LED temperature when installed in the luminaire. Access via a temporary hole in the housing, tightly resealed during testing with putty or other flexible sealant is allowable.
2. Use the LM-80-08 test data to extrapolate the lumen depreciation of the LED module/array (lumen degradation at three temperatures) using a standard exponential decay curve fit as described in Appendix C.
3. Identify the installed (in luminaire) operating temperature of the LED using the T_s point under operating conditions as described in LM-79-08. Use this in-luminaire LED module/array temperature to interpolate a decay curve between the three extrapolated degradation curves derived from LM-80 and exponential decay curve fitting.
4. From this interpolated curve, determine the lamp lumen depreciation (LLD) value and useful life that meets the needs of the Owner defined hours of operation to end of useful life as well as the illuminance levels and uniformity specified in Section 1.6. for the useful life of the luminaire. Document the use of LM-80 test data, the specific extrapolation procedure used, the interpolation between the three sets of LM-80 data, and all calculations applied in deriving the proposed LLD and useful life.

E. Electrical System Requirements

1. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low – 6kV/1.2 x 50 μs, 10kA/8 x 20 μs) waveforms at 1 minute intervals with

less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C

2. Primary Fuse Protection: Provide double fusing with fuse holder appropriately sized to the current. Fuse voltage must be ≥ than the voltage indicated in section 2.3.A.3.

3. Under voltage protection via shutoff and short circuit protection via current limitation

4. Internal luminaire design must incorporate modular electrical connections

F. Other Tests

1. At time of order, Site Owner can request additional tests per extreme environmental condition (e.g. sea salt near water, extreme cold weather operation in Alaska, etc…) if site is located in adverse locations.

2.5 CONTROL REQUIREMENTS

A. Daylighting Controls

1. All exterior parking lot, drive, and front aisle areas must be controlled with a combination Photocell plus Time Switch control system that allows automatic on and off based on daylighting plus timed off after expected parking lot activity ends. Photosensor is used to energize all luminaires at dusk, and to switch-off any security lighting left on overnight by Time Switch.

2. Furnish switches or relays in NEMA I General purpose enclosure unless noted otherwise. Switches located on the exterior or in "wet" locations must have NEMA 3R, 4, or 4X enclosures as noted or required.

3. The Photocell plus Timeswitch control system must have the following characteristics:

a. 15 to 30 second built-in time delay to prevent response to momentary lightning flashes, car headlights or cloud movements.

b. Settings to energize the lighting system when the north sky light decreases to approximately XX footcandles, and maintains the system energized until the north sky light increases to approximately XX footcandles.
Note: XX values to be supplied by Site Owner. Actual value will depend on the lighting zone/required illuminance as specified in section 1.6. A TURN-ON/TURN-OFF ratio ≤ 5:1 (the lights either turn on or off when the photocell measures 5x the required illuminance) should be used.

c. Mounted in an un-obscured location for measuring the available north sky daylight with a separate control/calibration module mounted separately and in an accessible location and shield the sensor from direct sunlight

d. Use relays that are UL 773 or UL 773A listed and designed to fail in the on position.

4. The time switch(s) must control specific circuit "off" functions during dark hours and be:

a. Digital microprocessor-based with battery backup capable of retaining programmed settings for at least 10 hours.

b. 7-day, 24-hour astronomic capable.

B. Optional Controls

Optional controls installed in addition to the Photocell plus Time Switch control system may include but are not limited to:

1. After hours dimming control – dims light levels to X% *[site Owner must specify between 10% – 50% of full lumen output]* after expected parking lot activity ends (a.k.a. “curfew” control)

2. After hours switching control – turns off or reduces light levels after expected parking lot activity ends (a.k.a. “curfew” control)

a. Specific areas turned off after expected parking lot activity ends

b. Overall reduction of light level after expected parking lot activity ends

3. Lumen maintenance – Luminaires are initially dimmed to 70% of full output, with input power then gradually (and automatically) increased over time to compensate for LLD.

4. Occupancy Sensor Controls

a. Install and aim sensors in locations to achieve coverage of areas indicated. Coverage patterns shall be derated as recommended by manufacturer based on mounting height of sensor and tree locations. Do not simply use gross rated coverage in manufacturer’s product literature.

b. Occupancy/vacancy sensors shall comply with NEMA Standard WD 7-2000 which provides for testing requirements on the issues of performance sensitivity.

c. Infrared: Integral to the luminaire. Detect occupancy by changed in infrared energy within a coverage area and must be capable of operating between -40°C to +50°C and be wet-location rated.

d. Sensors shall be located or shielded or controlled by software to adjust sensitivity based on ambient temperature or air temperature variations.

e. Sensor must incorporate a failsafe feature such that lamps fail “on” in the event of sensor failure.

f. If sensors are to be installed integral to the luminaire, installation must be performed by luminaire manufacturer.

5. End-of-Life

a. Provide End-of-Life mechanism into the luminaire. When the LED die output has reached end of useful life, the luminaire should enter a visible “failure mode”, e.g. intermittent flashing or flickering.

2.6 PRODUCT MANUFACTURERS

A. Substitution Limitations: Any manufacturer who offers products that comply with the required product performance and operation criteria may be considered.

B. Product Options:

1. The above product description, performance and operation requirements must be followed.

2. Other mutually exclusive product options offered by qualified manufacturers such as housing color or lamp type are to be determined by the customer/project manager prior to selection and installation of the product.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Disconnect all power sources prior to installation.

B. Follow manufacturers' recommended installation procedures.
Mounting Height: range of 12-45 feet, as per luminaire schedule

3.2 TESTING & COMMISSIONING

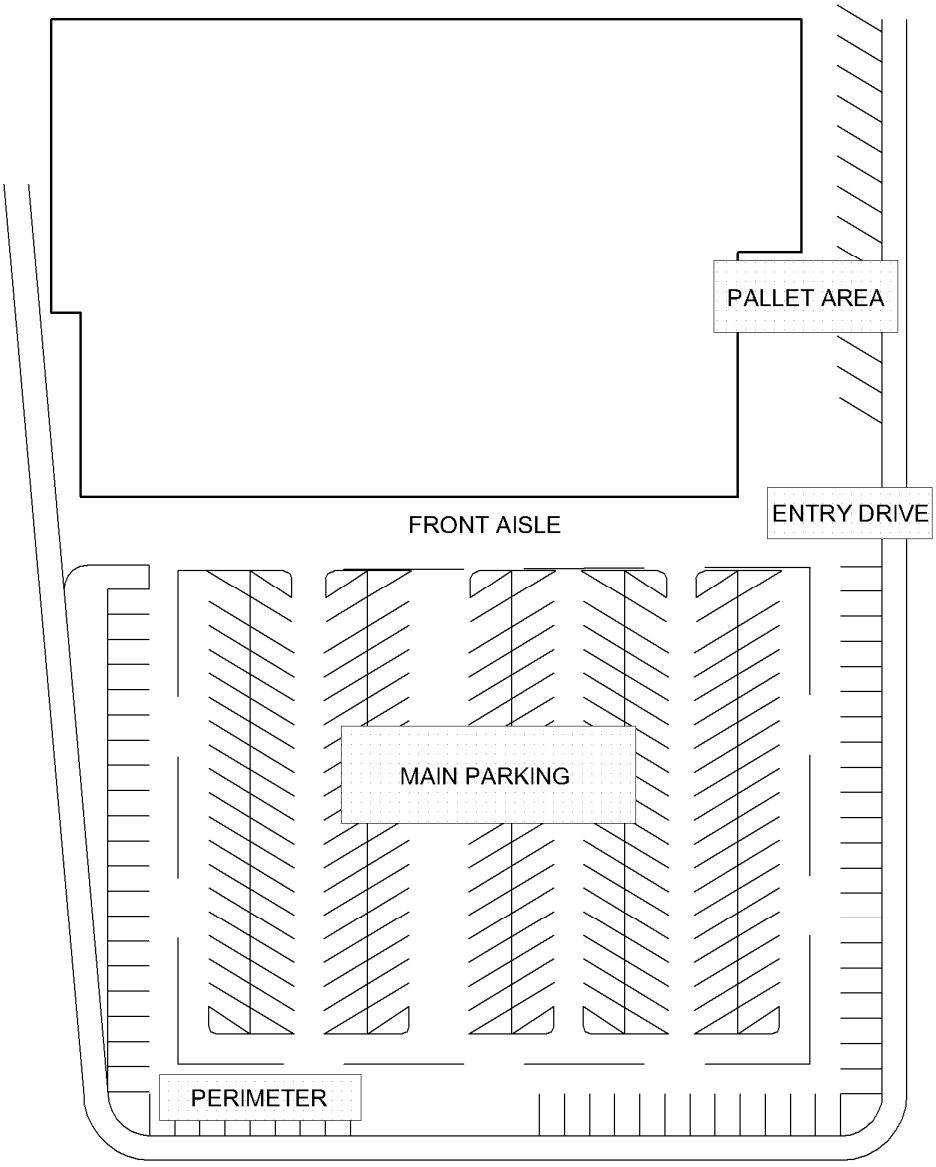
A. Set appropriate time delay. Adjust sensitivity setting as necessary.

3.3 MANUFACTURER SERVICES

Manufacturers must provide installation and troubleshooting support via telephone.

END OF SECTION

Appendix A – Diagram of Parking Areas Identified in This Specification



Appendix B – Definitions and Related Terms

Lighting Zones:

1. To provide as much information about the lighting zone, both the ASHRAE/IESNA Std. 90.1 and IESNA RP-33 exterior lighting zone definitions are combined below for zones where area lighting is expected to be applied. Lighting Zone (LZ0) is not expected to include area lighting as described in this specification but is described here for reference. Lighting Zone (LZ0) –Areas where the natural environment will be seriously and adversely affected by lighting. Impacts include disturbing the biological cycles of flora and fauna and/pr detracting from human enjoyment and appreciation of the natural environment. Human activity is subordinate in importance to nature. The vision of human residents and users is adapted to the total darkness, and they expect to see little or no lighting. When not needed, lighting should be extinguished.
2. Lighting Zone (LZ1) – Developed areas of National Parks, State Parks, Forest Land, and Rural areas. Areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety and convenience but it is not necessarily uniform or continuous. After curfew, most lighting should be extinguished or reduced as activity levels decline.
3. Lighting Zone (LZ2) – Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas. Lighting may typically be used for safety and convenience but it is not necessarily uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.
4. Lighting Zone (LZ3) – Areas not classifiable under the other four Lighting Zones. Areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience and it is often uniform and/or continuous. After curfew, lighting may be extinguished or reduced in most areas as activity levels decline.
5. Lighting Zone (LZ4) – High activity commercial districts in major metropolitan areas as designated by the local jurisdiction. Areas of human activity where the vision of human residents and users is adapted to high light levels. Lighting is generally considered necessary for safety, security and/or convenience and it is mostly uniform and/or continuous. After curfew, lighting may be extinguished or reduced in some areas as activity levels decline.

Appendix C – Lamp Lumen Depreciation Calculations Standard Exponential decay curve fit process

A. A standard exponential decay function (e.g.,) must be used to estimate the lumen degradation of the LED module/array. The LM-80-08 data must be graphed per temperature to determine the exponential decay of the data. This can be done in various software programs and must take the form of:

$$L=L_0e^{-\alpha t}$$

Where:

1. L = light output at "t" hours

2. L_0 = % of initial light output at 1000 hours

3. e = natural logarithm

4. $-\alpha$ = a solved constant.

5. t = time of data point