

**City of Duluth  
Energy Efficiency Lighting Project  
Bid Package #1  
Duluth, Minnesota**

**Electrical  
Systems Description  
and Outline Specification**

**Prepared by:**

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Gausman & Moore Project No.: 84493

I hereby certify that these construction documents or reports were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

  
Dave T. Blume \_\_\_\_\_ Reg. No. 24671

July 22, 2016

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## **DIVISIONS 26 – ELECTRICAL**

### **260500 – BASIC ELECTRICAL MATERIALS AND METHODS**

#### **A. Purpose**

1. The purpose of this Outline Specification is to define the scope of work; to serve as a vehicle for Owner bidding.

#### **B. Scope of Work**

1. Provide all labor, materials, equipment and services necessary for the installation and completion of the Electrical Work. In general, this includes but is not limited to the following:
  - a. Luminaire removal.
  - b. Install Owner furnished luminaires.
  - c. Wireless and/or hardwired Network Lighting control system.
2. Do the work in a workmanlike manner by persons experienced and skilled in the trade.

#### **C. Current Characteristics**

1. East First Street- Secondary service at 800 amp, 480Y/277 volts, 3 phase, 4 wire from existing panelboards.
2. Tech Village- Secondary service at 400 amp, 480Y/277 volts, 3 phase, 4 wire from existing panelboards.
3. Fifth Avenue and Michigan Street Ramp- Light fixture replacement associated with city owned/operated parking spaces.
4. Lake Place Plaza- Lighting in this area is served by multiple services/meters.

#### **D. Codes, Permits and Fees**

1. All work shall be done in accordance with the 2014 National Electrical Code, the Minnesota State Building Code, and local codes.
2. The Contractor shall pay for required permits and fees.

#### **E. Identification**

1. Identify lighting control panels/ Gateways.
2. Provide each light fixture with specified ID number/tag indicated in plans.

#### **F. Wiring methods**

1. All wiring (including boxes and conduit) in finished spaces shall be concealed. Wiring in exposed structure parking area may be exposed. Install conduit parallel and perpendicular to structure. Conduit installed in damp and wet locations shall be rigid steel conduit. Conduit installed concealed shall be electric metallic tubing (MC cable will be prohibited). Conduit shall be rigid in damp or wet locations

## 260519 – LOW VOLTAGE POWER CONDUCTORS AND CABLES

- A. Conductors for branch circuits shall be copper. Insulation for #8 and smaller shall be type THHN. Minimum size wire for branch circuits #12.

## 260526 – GROUNDING AND BONDING

- A. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
  - 1. Branch circuits.
  - 2. Lighting control.
  - 3. Flexible raceway runs.

## 260533 – RACEWAYS AND BOXES

- A. Wiring shall be in 3/4" minimum conduit.
- B. Outlet boxes shall be of size and type suitable for their use according to code. They shall be of steel.
- C. Outlet boxes in fire rated walls shall be steel and offset horizontally 24". Outlets shown back-to-back shall be offset 6" minimum.
- D. Securely fasten conduit and raceways with steel straps, clamps, and hangers with suitable fasteners. Tie wires shall not be used.
- E. Raceways shall be concealed in the building construction, except in unfinished space. Exposed raceway when required shall be approved by Owner and painted to match adjacent surface.

## 260943 – NETWORK LIGHTING CONTROLS

### Part I- General

- A. System Description
  - 1. Install a networked lighting control and monitoring system consisting of wireless control modules fixture or pole mounted, communication gateways and software for operating the system. For reduced interference, longer ranges and more reliable communication, devices communicate via 802.15.4, 902-928Mhz radio.

The general operation of lighting and controlled loads shall include:  
Through the use of a photocell input or astronomical time off sets outdoor lighting comes on at dark. At some predetermined, suitable time lighting can be step switched or dimmed to lower levels until motion detector inputs, call button inputs or other adaptive controls return lighting to higher levels. Lighting will operate at lower levels for longer times. Lighting returns to higher levels just before dawn, and fully extinguishes when the photocell threshold is met. Motion detectors can be used to bring lighting from low levels to higher ones upon detection. In parking lot, pathway and area lighting, peer to peer module communication allows for Direction of Travel and Geo-Proximity functions to bring up lighting ahead of pedestrians and vehicles in the area.

Software allows the user to assign device ID's, groups and networks at customer sites. Programming of scheduled events, photocell thresholds, control profiles, motion detector enabling and overrides are set by the user. At least one Gateway is required at each site. It will send commands to and receive reports from all devices at the site.

Power metering to revenue grade levels and fixture performance monitoring with automatic fault reporting for improved maintenance are sent to the owner as required.

B. Quality Assurance

1. Manufacturers: Firms regularly engaged in the manufacture of wireless lighting control equipment and ancillary equipment of types used with LED, Induction, LEP and eHID Lighting and other.
2. NEC Compliance: Comply with NEC as applicable to electrical wiring work.
3. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
4. UL Approvals: Products must be listed under UL773 and UL916

C. Submittals

1. Shop Drawings: Submit dimensional drawings of all lighting control system components and accessories.
2. One Line Diagram: Submit a one-line diagram of the proposed system configuration if it differs from that illustrated in the diagrams included in the contract drawings.
3. Typical Wiring Diagrams: Submit typical wiring diagrams for all components including, but not limited to, lighting fixtures, relays, contactors, emergency call buttons, motion detectors, network gateway system and other controls. Diagrams shall include zone schedule and fixture ID as indicated on plans.
4. Product cut and data sheets shall indicate complete and unique catalog numbers for products submitted. All components of catalog number shall be identifiable and options explained. Cut sheets shall include complete specifications for any integral controls, including make/model number.

D. Warranty

1. Control, Monitoring and Communications Hardware.
  - a. Provide a written five year replacement material and workmanship warranty on all hardware.
  - b. Warranty period shall begin on date of commissioning.

## Part 2- Product and System Performance and Requirements

A. Monitoring and Control System Requirements

1. Base Requirements
  - a. System shall have the capability of real-time monitoring and reporting in order to identify and report any occurrence other than the normal operation of the network and monitoring devices.

- b. System shall have the ability to control and schedule parking lot, pathway, street and other types of lighting to save energy by changing light output and/or by turning off lighting completely.
- c. System shall offer nine (8) time based scheduled events for nighttime savings profiles and one for a diagnostic event.
- d. Nodes shall be a one piece, self contained device, externally mounted and providing 0-10Vdc dimming, and bi-level control as well as on and off to luminaires.
- e. System shall provide 0-10Vdc dimming in 1/10th of a volt increments based on LED driver high and low operating range.
- f. System shall not require additional control modules be installed inside fixture to achieve dimming and stepped switching.
- g. System shall ensure nighttime operation of luminaires in the event of a malfunction or loss of communication by defaulting to the next scheduled operation and photocell operation.
- h. System shall include all required equipment to be fully functional and completely operational, with the exception of Owner provided Central Management Server, Ethernet facilities or other owner provided backhaul system.
- i. Nodes and gateway enclosures shall be rated IP66
- j. Peak power use by nodes should be less than two (2) watts
- k. Gateway power use must be twenty (100) watts or less.
- l. The rated life of all devices shall be ten (10) years or more at ambient temperature of 25 C.
- m. Software and Firmware necessary for operation and management of the system shall be provided and if hosted by the owner, the software shall be loaded and configured on their Central Management Server.
- n. System shall be capable of uploading and displaying the Owner's ArcGIS existing street light inventory which may or may not be remotely monitored, and to automatically update the information from the Owner's ArcGIS inventory on a real time or periodic basis.
- o. System shall have the capability to store and retrieve luminaire information such as pole identifier, GPS location, mode of operation, grouping, and product information (make, model, input voltage, wattage and version of components).
- p. All data and logs related to monitoring and control, reporting, and asset inventories shall be maintained and permanently stored on the Central Management Server.
- q. System shall include a graphical user interface that displays network infrastructure, configure monitoring and control devices, upload/download schedules, etc.
- r. The System shall be capable of real-time notification to assigned users and/or groups of luminaire failures or imminent luminaire failure, and/or degradation based upon threshold settings and number of occurrences, including but not limited to active power, power factor, voltage.
- s. System shall be capable of logging data once a day for a period of forty-nine (49) days when communication between the luminaire and CMS is interrupted. System shall automatically transfer data to CMS when communication is restored.
- t. System shall offer the Owner an unlimited number of sites with up to 255 networks per site and up to 255 groups per network. The number of devices per network shall be unlimited.

- u. Trimming or fine tuning of the luminaire to more accurately match the lighting requirements for sunrise and sunset shall be a standard function. Lighting goes to 50% 30 minutes after sunset and to 100% at full dark. One hour before sunrise, lighting is 100%. Thirty (30) minutes before sunrise lighting turns off.
- v. For enhanced safety, system shall be capable of powering and utilizing direct motion detector inputs and implementing a Predictive Occupancy function illuminating a pathway ahead of travelers or a Geo-Proximity function in parking lots bringing up lighting on nearest poles to initial motion detection.
- w. Nodes or controllers shall include a revenue grade smart metering chipset that measures and logs energy consumption at accuracy levels better than  $\pm 2\%$
- x. System shall provide asset information, current status and malfunctions.
- y. System shall be accessed by user name and password. The system shall be capable of establishing several user access privileges.
- z. Administrator-full access and capability to manage users and groups.
- aa. Operations and Maintenance-monitoring, control configuration and report generation.
- bb. Monitoring and report generation.
- cc. Read-Only monitoring and report generation.
- dd. System shall have user adjustable photocell set points for operation of lighting during low light daytime hours such as in storms and etc.
- ee. System shall utilize a High End 0-10 Level Trim feature allowing the user to limit the maximum light output during normal operation.

## B. Communication Network Requirements

### 1. Base Requirements

- a. Communication network must be designed in accordance with the specifications of the monitoring and control hardware (e.g., controller, gateway etc.) and the backhaul network to ensure optimal performance.
- b. Communication network shall have the capability to be scaled to communicate with an entire street light system should the customer be a municipality, government facility, university or business campus.
- c. For robustness in signal strength, increased range and reduced interference system shall use IEEE 802.15.4 standard, 902-928MHz radio frequency radio adjustable to +24dbm with ranges of 1 mile LOS between nodes and 2 miles LOS between nodes and gateways. Base stations are available that double the RF range stated
- d. If necessary to extend communication range at edges of normal gateway distances, System shall be able to designate any node to become a repeater, re-broadcasting and receiving messages another 1 mile.
- e. Communications network shall be capable of sampling and logging electrical parameters under normal operation including luminaire voltage, current, wattage, power factor and energy consumption.
- f. System shall offer AES 128 encryption or better.
- g. To reduce RF interference, system shall provide up to ten (10) channel and use direct sequence, spread spectrum operation.
- h. System shall be capable of controlling the Owner's irrigation system with simple interface.

C. System Hosting

1. The system shall be capable of being hosted on the Owner's Central Management Server and be independently owned, operated and managed by the Owner or Owner's representative. Data storage and retrieval shall utilize a common database such as SQL. Owner may select to separately contract with others for cellular services and/or set up and hosting of system.

D. Manufacturers

1. The basis of the specified system is the TOP900, manufactured by Echelon Corp.. Any other system to be considered must submit descriptive information 10 days prior to bid. Prior approval does not guarantee final approval by the electrical engineer. The contractor is responsible for providing a system meeting this specification in its entirety. All deviations from this specification must be listed and individually signed off by the engineer.
2. Lumewave system component product numbers:
  - a. TOP900TL(twist lock) and TOP900TN(threaded nipple)
  - b. Gateway
  - c. LumeStar software
  - d. CPD-3000- Power line outdoor lighting controller.
  - e. Base station
  - f. EMB900 wireless indoor lighting module
  - g. EW-205-12-LU outdoor motion sensor (parking ramp)
  - h. FS-305-LU indoor/outdoor motion sensor (parking ramp)

E. TOP900 WIRELESS CONTROL MODULE

1. Description
  - a. Replaces existing photocell and receptacle
  - b. All wiring routed through ½" threaded nipple for universal mounting or through 3 blade twist lock with low voltage pass-through for control wiring.
  - c. Operation and control 100-277Vac, 1000watt
  - d. Motion detector and call button inputs
  - e. Up to 9 time based scheduled actions per day
  - f. Stepped switching and 0-10Vdc dimming in 1/10th volt increments
  - g. IP66, UL listed
  - h. Adjustable photocell thresholds
  - i. Data logging
  - j. Revenue Grade power metering with accuracy of better than +-2%
  - k. Failure and performance reporting
  - l. Demand responsive to real time inputs from customer systems and utilities
  - m. DOT (Direction of Travel) capable for use with motion detectors for illuminating pathways ahead of foot/biking traffic
  - n. Peer to peer communication to provide group activation by single motion detector inputs
  - o. 900 MHz radio with 1 mile range between devices, 2 miles between Gateways and devices.
  - p. Over the air flashing for program updates.
  - q. No additional components for control are to be installed inside the fixture housing.

2. Gateways (one required per site):
  - a. USB
  - b. Ethernet
  - c. Wi-Fi
  - d. Cellular
  - e. 2 mile LOS range from Gateways to TOP900 modules. Base station configuration will double RF Range
  - f. Requires 120-240 volts and an Ethernet Connection
  - g. Install Antenna in Free Air
  - h. Requires customer provided Static IP address for access to LAN
3. Wireless Specifications
  - a. 902-928mHz, IEEE 802.15.4 standard
  - b. Spread Spectrum: Direct Sequence
  - c. 10 Channels
  - d. RF Adjustable to +24dbm
  - e. Any TOP module can operate as a repeater for extending range
  - f. AES128 Encryption
4. Unit Costs
  - a. TOP900TLX \$190/ Unit
  - b. CPD-3000-\$135/ Unit
  - c. Lumewave Gateway- \$2850/ Unit
  - d. Lumewave Base Station- \$2850/ unit
  - e. EW-205-12-LU-\$90/ Unit
  - f. FS-305-LU- \$90/ Unit
  - g. System start-up- \$4600.00
5. CPD-3000
  - a. Replaces existing photocell and receptacle
  - b. All wiring routed through ½" threaded nipple for universal mounting or through 3 blade twist lock with low voltage pass-through for control wiring.
  - c. Operation and control 100-277Vac, 1000watt
  - d. Motion detector and call button inputs
  - e. Up to 9 time based scheduled actions per day
  - f. Stepped switching and 0-10Vdc dimming in 1/10th volt increments
  - g. IP66, UL listed
  - h. Adjustable photocell thresholds
  - i. Data logging
  - j. Revenue Grade power metering with accuracy of better than +-2%
  - k. Failure and performance reporting
  - l. Demand responsive to real time inputs from customer systems and utilities
  - m. DOT (Direction of Travel) capable for use with motion detectors for illuminating pathways ahead of foot/biking traffic
  - n. Peer to peer communication to provide group activation by single motion detector inputs
  - o. 900 MHz radio with 1 mile range between devices, 2 miles between Gateways and devices.
  - p. Over the air flashing for program updates.
  - q. No additional components for control are to be installed inside the fixture housing.



6. Base Station
  - a. USB
  - b. Ethernet
  - c. Wi-Fi
  - d. Cellular
  - e. 2 mile LOS range from Gateways to TOP900 modules. Base station configuration will double RF Range
  - f. Requires 120-240 volts and an Ethernet Connection
  - g. Install Antenna in Free Air
  - h. Requires customer provided Static IP address for access to LAN
  
7. EW-205-12-LU and FS-305-LU (Parking Garages)
  - a. Replaces existing photocell, wireless controller and/or receptacle
  - b. All wiring routed through ½" threaded nipple for universal mounting or through 3 blade twist lock with low voltage pass-through for control wiring.
  - c. Operation and control 100-277Vac, 1000watt
  - d. Motion detector and call button inputs
  - e. Up to 9 time based scheduled actions per day
  - f. Stepped switching and 0-10Vdc dimming in 1/10th volt increments
  - g. IP66, UL listed
  - h. Adjustable photocell thresholds
  - i. Data logging
  - j. Revenue Grade power metering with accuracy of better than +-2%
  - k. Failure and performance reporting
  - l. Demand responsive to real time inputs from customer systems and utilities
  - m. DOT (Direction of Travel) capable for use with motion detectors for illuminating pathways ahead of foot/biking traffic
  - n. Peer to peer communication to provide group activation by single motion detector inputs
  - o. 900 MHz radio with 1 mile range between devices, 2 miles between Gateways and devices.
  - p. Over the air flashing for program updates.
  - q. No additional components for control are to be installed inside the fixture housing.

### Part 3-Execution and support services

#### A. Installation

1. Lumewave TOP 900 wireless control modules require installation on fixture and commissioning of TOP900's for the customers wireless lighting control network. All equipment and wiring shall be installed as per manufacturer's instructions, configured and operationally field tested.
  
2. There are 3 ways to commission the TOP900 series products on the customers' wireless lighting control network:
  - A. Contractor captures the peel-off label on the box then installs the TOP900 and connects control wiring on/in fixture:
 

VERY IMPORTANT!

    - 1) Contractor removes peel-off label on TOP900 box and stick on plan next to pole the TOP900 was installed on.
    - 2) Contractor returns the plan with the stickers to customer
    - 3) Customer scans label into system
    - 4) Commissioning is done over the air

- B. Contractor delivers the TOP900 control modules to customer for commissioning:
  - 1) Customer commissions the TOP900 module and returns to contractor with identification of the pole to mount the TOP900 on.
  - 2) Contractor installs the TOP900 and connects control wiring as required based on/in fixture and unit immediately begins to control the fixture based on its control schedule
- C. Contractor delivers the TOP900 units "in its box" to the customer
  - 1) Customer scans the ID on the box into the system and writes the ID of the pole the contractor is to install the unit on
  - 2) Contractor simply installs the unit. When unit is installed and powered-up, commissioning takes place over the air.
- 3. All pertinent installation and startup instructions shall be provided.

B. Final Testing

- 1. Final testing of installation of the monitor and control system, wireless communications system, and luminaires shall begin upon completion of all software and hardware installations and successful demonstration of all system functions.
- 2. Testing period will be comprised of thirty (30) day calendar days of live continuous operation of the system. Commencement of final acceptance testing shall be scheduled by the owner.
- 3. All components of the monitoring and control system and communications network must be available and operational for at least 99% of the time during this period to constitute a valid test.

C. Factory Commissioning

- 1. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will commission communication nodes, program schedules and system operation to ensure a trouble-free wireless outdoor monitoring and control system.
- 2. The electrical contractor and owner shall provide both the manufacturer and the electrical engineer with ten working days written notice of the scheduled commissioning date.

D. Manufacturer Services

- 1. Provide installation and troubleshooting support via telephone and internet.
- 2. Software/firmware maintenance may be acquired at the option of the Owner, and include all publicly available additions and improvements to the functionality, as well as new upgraded functions of the software.

3. Maintenance shall include the detection and correction of any error in the software/firmware and the implementation of all updates, upgrades, and installation of additional programs to the software/firmware to remedy such errors. Software and firmware upgrades shall be installed onto the target hardware.
4. Provide maintenance and support for the current release and the two immediately subsequent releases of the software at no extra cost to the Owner above and beyond the maintenance or license fee. The Maintenance Term will initially be one year and may be renewed at the Owner's discretion. Maintenance terms begin after the Acceptance Period.

#### 262726 – WIRING DEVICES

- A. Devices shall be specification grade. All exterior receptacles and receptacles located near sinks shall be GFCI type. All exterior devices shall be gray with cast aluminum, spring-loaded lift cover and listed for “wet locations” cover.
- B. All internal receptacles shall be gray with stainless steel coverplates.

#### 265100 – INTERIOR LIGHTING

- A. Install wireless lighting control system (WLCS) component on and/or within the housing of the light fixtures.
- B. Light fixtures damaged during the WLCS component installation shall be repaired or replaced at the contractor's expense.
- C. To limit light pollution (dark sky compliance), enhance or maintain public safety and ensure appropriate aesthetic lighting qualities in public spaces as most appropriate in each individual lighting application.

#### 265600 - EXTERIOR LIGHTING

##### A. Related documents

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

##### B. Summary

1. Section Includes:
  - a. Owner furnished.

##### C. Manufacturers

1. Manufacturers: Exterior luminaires will be furnished by the Owner. Compliance with requirements, provide products by one of the manufacturers.
2. To limit light pollution (dark sky compliance), enhance or maintain public safety and ensure appropriate aesthetic lighting qualities in public spaces as most appropriate in each individual lighting application.

#### D. Light emitting diode luminaires and drivers

1. LED Light Engine: The LED light engine shall as a minimum meet the following characteristics:
  - a. Cast aluminum heat sink integrated with the housing to provide superior thermal management.
  - b. Incorporate a replaceable PC board with quick connector mounts to heat sink.
  - c. Use latest generation of high lumen output LEDs binned to Energy Star standards and be of color temperatures of 3000K, 3500K, or 4100K.
2. LED Driver:
  - a. LED light fixture shall be designed and tested by an accredited independent laboratory in accordance with IESNA LM-79-2008 and IESNA LM-80-2008, have an L70 rated life (operating time from inception the luminaire delivers 70% of initial rated lumens) of 50,000 hours.
  - b. Thermal losses shall be less than 10% when operated at a steady state ambient operating temperature of 77 degrees F (25 degrees C) and optical losses shall be less than 15%.
  - c. Lumens per watts shall be a minimum of 90.

#### E. Poles and support components, general requirements

1. Provide 6" aluminum-nipple welded to fixture arm, painted to match fixture, as manufactured by Duluth Steel Fabricators, Inc. Contact Mark Youngren, 218-624-5793. This applies to pole mounted light fixtures. Verify exact quantity with city prior to order. Aluminum arm welding scope with Duluth Steel Fabricators will include a minimum of 10 arms per each work order package.
2. Structural Characteristics: Comply with AASHTO LTS-4.
3. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - a. Materials: Shall not cause galvanic action at contact points.
  - b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
  - c. Anchor-Bolt Template: Plywood or steel.

4. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Use 3000 psig (20.7 MPa) strength, 28-day concrete.
5. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
6. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

F. Luminaire installation

1. Install Owner furnished LED light fixtures in existing location unless noted otherwise. Contractor to coordinate delivery to site as directed by Owner. Protect fixtures from damage as required by means recommended by manufacturer and approved by the city. Connect to existing branch circuit made available by demolition of existing light fixture.
2. Fasten luminaire to indicated structural supports.
3. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.
4. Install lock-tight substance furnished with light fixtures per manufacturers requirements and/or recommendations.
5. Replace light fixture branch circuit wiring within pole, no splices allowed.

G. Corrosion prevention

1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
2. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

H. Grounding

1. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - a. Install 10-foot (3-m) grounding electrode for each pole.
  - b. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

2. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - a. Install 10-foot (3-m) grounding electrode for each pole.
  - b. Install #6 AWG grounding conductor and conductor protector.
  - c. Ground metallic components of pole accessories and foundations.

G. Field quality control

1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
2. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
  - a. Verify operation of photoelectric controls.
3. Tests and Observations: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:
  - a. Photometric Tests: Measure light intensities at night at locations where specific illumination performance is indicated. Use photometers with calibration referenced to National Institute of Standards and Technology (NIST) standards.
  - b. Check for intensity of illumination.
  - c. Check for uniformity of illumination.
  - d. Check for excessively noisy ballasts.
4. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

H. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF DIVISION 26

END OF ELECTRICAL  
OUTLINE SPECIFICATION