MICHIGAN
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
FOR
GROUNDING, BONDING, LIGHTNING PROTECTION AND SURGE PROTECTION
FOR INTELLIGENT TRANSPORTATION SYSTEM EQUIPMENT

ITS: CLC

1 of 6

APPR: MDW: JVG: 06-08-18
FHWA: APPR: 06-18-18

a. Description. This work consists of providing all labor, materials and equipment required to install functional and unobtrusive grounding and bonding system, lightning protection for all poles and structures that exceed 15 feet in height, and surge protection for all conductors entering or leaving equipment cabinets or camera housings at the specified ITS equipment locations shown on the plans.


2. Adhere to NFPA 780 - Lightning Protection Code as indicated herein.

3. Adhere to Underwriters Laboratory (UL) listings as indicated throughout this document.

4. Comply with the National Electrical Safety Code (NESC)

Identify to the Engineer any conflicts between the requirements of regulatory agencies and the contract for this project.

Submit product data for each type of product used (i.e. “shop drawings”) per the Special Provision for Basic Materials and Methods for Intelligent Transportation Systems Work for approval by the Engineer before work commences.

Submit a system plan, locating air terminals, conductor routing, supports, connectors, ground rods, and connection, mounting, and splicing details. Identify where special means will be incorporated to avoid galvanic reactions due to dissimilar metals.

b. Materials. For each component required in the contract, meet the following requirements:

1. Grounding and Bonding.

   A. Grounding Electrodes (driven rods). Provide ground rods that are 3/4-inch diameter by 10 feet long, made of copper-clad steel with a minimum of 10 mils copper cladding, complying with ANSI/UL 96/96A and ANSI/NEMA GR-1.

   B. Ground Bus Bar Kit. Provide a ground bar kit with screw down terminals sized per grounding and grounding electrode conductors that will be connected. Furnish a ground bar kit with a mounting kit appropriate for intended installation (for example, on an equipment rack in a damp location).
C. Grounding Conductors. Unless noted otherwise, ensure below grade conductors used for bonding grounded systems are bare, stranded #6 American wire gauge (AWG) copper conductors, and ensure bonding conductors routed inside enclosures and cabinets are green insulated #6 AWG conductors.

D. Bonding Kits. Ensure all bonding kits are UL listed and provide adequate surface area for intended application; ensure bonding kits being used as part of a lighting protection system are sized in accordance with NFPA 780. Ensure enclosure ground lugs are furnished and installed by the enclosure manufacturer.

2. Lightning Protection. Ensure all lightning protection materials are UL 96 listed for lightning protection, Class II regardless of structure height.

Do not use a combination of materials that may cause electrolytic coupling of such a nature that corrosion is accelerated. This includes copper in direct contact with aluminum and copper in direct contact with galvanized steel in exterior or other wet locations.


   A. Provide protectors that are UL 497B listed to protect the twisted pair cable that meet or exceed the following minimum requirements:

      (1) Max clamping voltage.

          (a) Common-mode. twice peak signal voltage.

          (b) Differential-mode. 50 volts (V) to ground.

      (2) Technology. two-stage using gas discharge tube and metal-oxide varistor or approval equal.

      (3) Overcurrent protection. integral polymeric positive temperature coefficient (PPTC) device.

      (4) Maintainability. replaceable without tools.

      (5) Protect microwave vehicle detection system (MVDS) and direct current (DC) power cables with grounded metal oxide varistors of appropriate voltages. Provide devices with surge capacity of at least 3,000 Amperes (A). Ensure surge protection for these devices are in accordance with device manufacturer specific guidelines.

      (6) Protect power over Ethernet (POE) devices, with protectors designed for POE applications.

   B. Provide protectors that are IEEE 802.3at and International Electrotechnical Commission (IEC) 61643-21 compliant.

   C. Protect 120/240 volt incoming power service to equipment cabinet with UL 1449 (3rd Edition) listed Type 2 devices. They must meet the following requirements:
(1) Terminals. 12 AWG;

(2) Surge Capacity Rating. Minimum 40 kilo ampere (kA)/mode, 80kA/phase;

(3) Voltage Protection Rating. L-N, L-G, N-G. L-N;

(4) Short Circuit Current Rating. 100 kA;

(5) Nominal discharge current of 20,000A;

(6) Line protection. L-N, L-G, L-L, and N-G;

(7) Indicators. Light-emitting Diode (LED) status indication;

(8) Compatibility. Compatible with the main circuit breaker.

C. Protect coaxial cables for video signals at each end, including the top of the pole, with UL listed surge protection designed for baseband closed-circuit television (CCTV) camera signals that meet or exceed the following minimum requirements:

(1) Surge capacity: 18,000A (8/20 microsecond (µs) pulse);

(2) Turn-on time. 4 nanosecond (ns) for 2 kilovolt per nanosecond (kV/ns);

(3) Voltage Standing Wave Ratio (VSWR). 1.1:1 or less;

(4) Insertion loss. 0.3 decibel (dB) or less;

(5) Frequency range. 0 to 2 Gigahertz (GHz);

(6) Bayonet Neill – Concelman (BNC) connectors;

(7) Operating voltage. 1.5V;

(8) Impedance. 75 Ohms.

c. Construction. Install equipment, materials, and devices in accordance with equipment manufacturer’s written instructions and in compliance with applicable installation standards.

Provide exothermically welded connections below grade and in areas exposed to visible moisture. In locations where damage to existing cable is possible permanent mechanical clamp (listed for wet locations) may be used.

Ensure terminals and connectors are UL listed and sized for the conductors that will be used. Use clips, harnesses, or ties in cabinets to keep grounding electrode conductors and bonding conductors out of the way of service activities.

Permanently affix distinct wire numbers or alphanumeric labels to each cable.

1. Grounding and Bonding. Furnish and install insulated and/or bare wire and cables, sized per NEC requirements, as indicated on the plans.
A. Installation.

(1) Bond metallic items, such as poles, towers, horizontal and vertical structures, metal conduit junction boxes, fences, and pad mounted equipment to form a low-impedance ground plane.

(2) Provide equipment grounding conductors and grounding electrode conductors that conform to the NEC. Use of metallic conduit to replace grounding conductors is prohibited. Connection of grounding conductor to neutral (grounded) conductor must only occur at service disconnect.

(3) Bond all metallic conduits, boxes, and cabinets to the grounding system. Provide metallic conduit terminations with grounding bushings. Where not otherwise noted ensure all bonding conductors are green insulated #6 AWG.

(4) Bond electrical grounding conductors to lightning protection system grounding conductors below grade using bare #6 AWG copper conductor.

(5) Drive a grounding electrode through the base of the handholes nearest the electrical racks, poles, and structures to attach to the grounding system as shown on the plans.

B. Testing.

(1) Measure ground grid resistance using 3-point method per IEEE 81 with earth ground test meter. Install additional ground rods and conductors as required and re-measure until resistance to ground is equal to or less than 10 Ohms. Provide documentation to the Engineer of ground grid measurement results for each ITS site location tied to a single grounding system.

(2) Furnish all test equipment required to test the copper cabling in accordance with the parameters specified.

2. Lightning Protection. Install lightning protection system in accordance with the following requirements:

A. Install down conductors, per NFPA 780, in a direct path from air terminals to ground connections free of splices and sharp bends; except when the pole is used as the down conductor or where noted on the plans. No bend of a conductor is to form a final angle of more than 90 degrees nor have a bend radius of less than 8 inches.

B. Conceal and protect down conductors and interior wiring from view at all exterior locations above grade as practical. Concel cable down conductors within structural elements. Cable down conductors may be enclosed within non-metallic conduit for ITS-only installations. Use conduit or guards to protect the conductor to a point 10 feet above grade or as shown on the plans where down conductors are exposed to environmental hazards at grade level.

C. Secure exposed cable conductors to the structure at intervals not exceeding 3 feet. Use fasteners, nails, screws, straps, or bolts for the intended application and of the same
material as the conductor or of electrolytically compatible materials. Galvanized or plated steels are prohibited.

D. Use a grounding electrode for the lightning protection system, located in the dedicated lightning protection handhole(s). Install additional ground rods and conductors as required and re-measure until resistance to ground is equal to or less than 10 Ohms.

E. Bond the lightning protection system to common grounding system underground as shown on the plans.

F. Install air terminals on concrete spun poles as detailed on the plans. Bond the air terminal to the cast-in-place down conductor.

G. Dynamic message sign (DMS) structures are capable of acting as a down conductor per NFPA 780. Install air terminals into the air terminal bases located on the roof of the sign housing and bond the air terminals to the DMS structure, as shown on the plans.

H. Lane Control System (LCS) structures (Type E Truss or Type E Cantilever) are capable of acting as a down conductor per NFPA 870. Install air terminal on the upper cord and bond the air terminals to the LCS structure, as shown on the plans.

I. Install air terminal on traffic signal strain poles, mast arms, wood poles and truss arms as shown on the plans.


A. Install the required number and type of modular surge protector devices, as determined by the number and type of incoming lines.

B. Arrange the equipment and cabinet wiring to minimize leader length to surge protector.

C. Avoid sharp bends in leaders to surge protectors.

4. Warranty. Provide all surge protective devices covered by this special provision with a standard manufacturer’s warranty, transferable to MDOT. All the surge protective devices must carry a warranty (parts and labor) of 3 years from the date of shipment with at least 2 years of warranty remaining at the start of burn-in. Furnish warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to final written acceptance.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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</thead>
<tbody>
<tr>
<td>ITS Grounding, Bonding, and Surge Protection</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Lightning Protection, Pole</td>
<td>Each</td>
</tr>
<tr>
<td>Lightning Protection, Structure, Large DMS</td>
<td>Each</td>
</tr>
<tr>
<td>Lightning Protection, Structure, Small DMS</td>
<td>Each</td>
</tr>
</tbody>
</table>
Lightning Protection, Structure, Type E Truss ............................................ Each
Lightning Protection, Structure, Type E Cantilever ................................. Each

1. **ITS Grounding, Bonding, and Surge Protection** will be measured and paid for as lump sum for all work to ground each ITS component as described by this special provision and as shown on the plans. Partial payments will be made based as shown below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved Equipment Submittals</td>
<td>50%</td>
</tr>
<tr>
<td>Completed Installation</td>
<td>75%</td>
</tr>
<tr>
<td>Inspection by State of Michigan Electrician</td>
<td>100%</td>
</tr>
</tbody>
</table>

2. **Lightning Protection, Pole** will be measured and paid for as each lightning protection system provided for protection of equipment on a pole, mast arm or truss arm with Class II materials.

3. **Lightning Protection, Structure, Large Dynamic Message Sign** and **Lightning Protection, Structure, Small Dynamic Message Sign** will be measured and paid for as each lightning protection system provided for protection of a Dynamic Message Sign, using the structure as a down conductor.

4. **Lightning Protection, Structure, Type E Truss** and **Lightning Protection, Structure, Type E Cantilever** will be measured and paid for as each lightning protection system provided for protection of a Lane Control System on a Type E Truss or Type E Cantilever, using the structure as a down conductor.