EXPECTED IMPLEMENTATION JULY 2014

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620 TRAFFIC CONTROL SIGNAL AND DEVICE INSTALLATION GROUNDING. (REV 1-30-14) (FA 2-4-14) (7-14)

SECTION 620 is deleted and the following substituted:

SECTION 620
GROUNDING AND LIGHTNING PROTECTION

620-1 Description.

Furnish and install grounding and lightning protection to provide personnel and equipment protection against faults, surge currents and lightning transients. Provide a grounding and lightning protection system in accordance with the details shown in the Design Standards unless otherwise shown on the plans.

620-2 Materials.

620-2.1 Ground Rods: Use UL listed ground rods made of copper-clad steel with a nominal diameter of 5/8 inches. Ground rod sections must be a minimum of eight feet in length and manufactured for the sole purpose of providing electrical grounding.

620-2.2 Ground Rod Assembly: Provide a ground rod assembly consisting of one or more ground rods coupled together, such that the total length of the assembly is a minimum of 20 feet, driven into the earth at a single point, without disrupting the electrical continuity of the assembly.

620-2.3 Ground Rod Array: Provide ground rod arrays, as required, consisting of two or more ground rod assemblies, bonded together and spaced a minimum of 40 feet apart.

620-2.4 Grounding Conductors: Use solid copper insulated (green) conductor for electrical or lightning protection ground from the system ground bus or barrier plates to the ground rod assembly. Size equipment grounding conductors according to NEC Section 250.122. Size grounding electrode conductors according to NEC Section 250.66.

620-2.5 Exothermic Grounding Bond: Make all connections to the ground rod assemblies using exothermic welds.

620-2.6 Air Terminals: Use UL listed air terminals.

620-2.7 Surge Protective Devices: Provide surge protective devices (SPDs) to protect electronics from lightning, transient voltage surges, and induced current.

Install SPDs on all power, data, video and any other conductive circuit. SPD requirements for lighting must meet the minimum requirements of Section 992 and the Design Standards. SPDs for traffic control devices, including ITS equipment, must be listed on the Department's Approved Product List (APL).

Provide primary and secondary surge protection on AC power at traffic control device field sites.

620-2.7.1 SPD for 120V or 120/240V Power: Install a SPD at the utility disconnect to the cabinet. Ensure that the SPD at the utility disconnect includes L-N, L-G, and N-G protection and has a maximum surge current rating of 50 kA per phase or greater. Verify that the SPD has been labeled to indicate that the unit is UL 1449, Third Edition listed.

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Ensure an SPD is provided where the supply circuit enters the cabinet. Locate the SPD on the load side of the main disconnect and ahead of any and all electronic devices and connected in parallel with the AC supply. Ensure that the SPD in the cabinet includes L-N, L-G, and N-G protection and has a maximum surge current rating of 50 kA per phase or greater. Verify that the SPD has been labeled to indicate that the unit is UL 1449, Third Edition listed.

Ensure that the SPD has a visual indication system that monitors the weakest link in each mode and shows normal operation or failure status and also provides one set of normally open (NO)/normally closed (NC) Form C contacts for remote alarm monitoring. The enclosure for a SPD shall have a NEMA 4 rating.

620-2.7.2 SPD at Point of Use: Install a SPD at the point the ITS devices receive 120 volt power and connected in series with the circuits. Ensure that these devices comply with the minimum functional requirements shown in Table 1. Ensure that the units are rated at 15 or 20 amps load and are configured with receptacles.

Ensure that these units have internal fuse protection and provide common mode (L+N-G) protection.

620-2.7.3 SPD for Low-Voltage Power, Control, Data and Signal Systems: Install a specialized SPD on all conductive circuits including, but not limited to, data communication cables, coaxial video cables, and low-voltage power cables. Ensure that these devices comply with the minimum functional requirements shown in Table 1 for all available modes (i.e. power L-N, N-G; L-G, data and signal center pin-to-shield, L-L, L-G, and shield-G where appropriate).

Table 1

SPD Minimum Requirements

Circuit Description	Clamping Voltage	Data Rate	Surge Capacity	Maximum Let-Through Voltage
12 VDC	15-20 V	N/A	5kA per mode (8x20 µs)	<150 Vpk
24 VAC	30-55 V	N/A	5kA per mode (8x20 µs)	<175 Vpk
48 VDC	60-85 V	N/A	5kA per mode (8x20 µs)	<200 Vpk
120 VAC at POU	150-200 V	N/A	20kA per mode (8x20 µs)	<550 Vpk
Coaxial Composite Video	4-8 V	N/A	10kA per mode (8x20 µs)	<65 Vpk (8x20 µs/1.2x50µs; 6kV, 3kA)
RS422/RS485	8-15 V	Up to 10 Mbps	10kA per mode (8x20 µs)	<30 Vpk
T1	13-30 V	Up to 10 Mbps	10kA per mode (8x20 µs)	<30 Vpk

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Table 1				
SPD Minimum Requirements				
Circuit Description	Clamping Voltage	Data Rate	Surge Capacity	Maximum Let-Through Voltage
Ethernet Data	7-12 V	Up to 1 Gbps	1kA per mode (10x1000 µs)	<30 Vpk
POE	60-70 V	Up to 1 Gbps	5kA per mode (8x20 µs	<200Vpk (100kHz 0.5µs; 6kV, 500A)

Ensure that SPDs are listed and meet the requirements of UL 497B or UL 497C, as applicable.

620-2.7.4 Mechanical Specifications: Ensure equipment is permanently marked with manufacturer name or trademark, part number, and date of manufacture or serial number.

All parts must be made of corrosion-resistant materials, such as plastic, stainless steel, anodized aluminum, brass, or gold-plated metal.

620-2.7.5 Environmental Specifications: Ensure that SPDs operate properly during and after being subjected to the temperature and humidity test described in NEMA TS 2, Section 2.2.7, and the vibration and shock tests described in NEMA TS 2, Sections 2.2.8., and 2.2.9.

620-2.7.6 Manufacturer's Warranty: Ensure that the SPD has a manufacturer's warranty covering failures for a minimum of 10 years from the date of final acceptance by the Engineer in accordance with 5-11 and Section 608.

The term "failure" for warranty replacement is defined as follows:

Parallel-connected, power-rated SPD units are considered in failure mode when any of the visual indicators shows failure mode when power is applied to the terminals at the unit's rated voltage, or the properly functioning over-current protective device will not reset after tripping.

Series-connected, low-voltage power, data, or signal units are considered in the failure mode when an open circuit condition is created and no data/signal will pass through the SPD device or a signal lead is permanently connected to ground.

In the event that the SPD, including any component of the unit, should fail during the warranty period, the entire SPD shall be replaced by the manufacturer at no cost to the Department or maintaining agency.

620-3 Installation.

620-3.1 General: Construct a single-point grounding system. Install the primary ground rod assembly in an electrical pull box so that the top four inches are accessible for inspection, resistance testing, and maintenance. The primary ground rod assembly and electrical pull box shall be installed between 12 inches to 36 inches from the element being grounded. The top of all other ground rod assemblies connected to the primary ground rod assembly in an array must be buried a minimum of 18 inches below grade. Direct bury grounding conductors used to connect ground rod assemblies a minimum of 18 inches below finished grade.

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Bond all ground rod assemblies and ground rod arrays together with solid bare tinned copper wire unless otherwise shown on the plans. Install grounding conductors in a straight path.

Make all bonds between ground wires and ground rod assemblies and ground rod arrays with an exothermic bond with the following exception: do not exothermically bond sections of ground rods to create the ground rod assembly and do not exothermically bond connections within a cabinet. Apply an anti-oxidant compound to all mechanical connections.

Connect primary surge protection for power at the service entrance or main disconnect. Connect secondary surge protection at point of use, unless otherwise shown in the plans.

Ensure that lightning protection systems conform to the requirements of the National Fire Protection Association (NFPA) Code NFPA 780, Standard for the Installation of Lightning Protection Systems. Install SPDs that have an operating voltage appropriate for the characteristics of the circuits they protect.

620-3.2 Minimum Grounding Resistance: Obtain a resistance to ground of 5 ohms or less for the following elements. Install multiple ground rod assemblies totaling a maximum length of up to 80 feet, as required to achieve minimum grounding resistance.

a. Power service for traffic control devices
b. Signal and ITS cabinets
c. ITS Poles/Structures with electronic equipment
d. DMS and DMS structures
e. Equipment Shelters and fencing
f. Communication Towers

Install a single ground rod assembly for these elements.

a. Conventional lighting
b. External lighting for signs
c. Signal cable & span wire
d. Aerial interconnect messenger wire
e. Pedestals for pedestrian signals
f. Pull boxes with metal covers when 120V (or greater) AC power is present
g. Splice vaults with wire grounding units

Install a minimum of one primary ground rod assembly. If a grounding and lightning protection system using a single ground rod assembly does not achieve the required resistance to ground, extend the length of the ground rod assembly an additional 20 feet or install an additional ground rod assembly 40 feet away and connect it to the main ground rod assembly to create a ground rod array. Continue installing ground rod assemblies connected in an array until the required resistance is obtained or until the maximum required total length of ground rod is installed.

Grounding systems formed from horizontally constructed conductive radials are permitted if site conditions prohibit the use of vertically driven rods as permitted by the NEC Article 250.53(G). A grounding system consisting of the maximum total length of ground rod required is acceptable in cases where soil conditions prevent the grounding system from achieving the required resistance to ground. Submit the site resistance measurement to the Engineer.

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620-3.3 Grounding Traffic Control Systems at Signalized Intersections: Ensure that all separately grounded elements at an intersection (signal cabinet, power service, mast arms or strain poles, etc.) are bonded together to form an intersection grounding network array.

For traffic signal poles, including pedestals for pedestrian signals, accommodate the ground connection from signal heads and electrically powered signs through span wires to the ground rod assembly or array located at the pole base in accordance with the details in the Design Standards.

For span wire assemblies, use the span wire to connect the ground rod assemblies or arrays of the poles. Do not use guy wires for grounding purposes, however bond any guy wire to the span wire as part of the intersection grounding network.

620-3.4 Grounding Traffic Control Systems on Highways: Install the primary ground rod assembly at the base of the traffic control device supporting structure. Bond all metal components of the system (such as cabinets, steel poles, and concrete pole grounding wire) to the grounding system using a mechanical connection on the equipment side and an exothermically welded connection at the down cable. Do not use split bolts for grounding system connections.

Connect all ground rod assemblies and any associated grounded electrical system within a 100 foot radius (but not beyond the edge of the roadway) of the primary ground rod assembly. Connect the primary ground rod assembly to a single point main grounding bar inside the equipment cabinet or mount it to the base of the traffic control device supporting structure unless otherwise shown on the plans.

Place multiple ground rod assemblies, as required, in a ground rod array as depicted in the Design Standards unless otherwise shown on the Plans. If a required array cannot be placed in the right of way, submit an alternate placement detail for approval.

620-3.5 Grounding Highway Lighting Systems: Ground each metal light pole.

For poles on bridge structures, bring the grounding conductors out to a pull box at each end of the structure and connect them to driven ground rods 20 feet in length.

Ground all high mast poles in accordance with the details for grounding in the Design Standards, Index No. 17502.

620-3.6 Grounding Equipment Shelters: Install all grounds for the equipment shelter on the side of the building that utilities, communication cables, and fiber enter. Connect all earth grounds to this point, including the grounding system for SPDs. Make all connections to SPDs according to the manufacturer's recommendations.

Ensure that communication cables, AC power, emergency generator, and equipment frames are connected by the shortest practical route to the grounding system. Protect the lead lengths from each device to the SPD.

Use compression type connection for all interior connections to bond grounding conductors to equipment in the shelter. For connections to bus bars, use mechanical connections having two bolts on a double-lug connector. Install star washers, or another means that accommodates the fasteners used and achieves reliable electrical connections that will not deteriorate. Crimp and solder all wires connected to lugs or clamps. Verify electrical continuity of all connections. Remove all non-conducting surface coatings before each connection is made.

Ensure that ground conductors are downward coursing, vertical, and as short and straight as possible. Ensure that the minimum bending radius for interior equipment shelter grounds is eight inches. Avoid sharp bends and multiple bends in grounding conductors.

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620-3.6.1 Interior Grounding: Install a No. 2 AWG solid bare copper wire approximately one foot below the ceiling on each wall and mount it using insulated standoffs. Ensure that the wire encircles the equipment room, forming a ring or continuous loop. Mechanically connect the cable trays to the interior perimeter ground using stranded copper wires with green insulation and bolted terminal connectors at the cable tray ends. Make all points where cable tray sections meet electrically continuous by use of a short jumper wire with terminals attached at each end.

Directly bond all other metallic objects, such as door frames and doors, air conditioners, alarm systems, wall-mounted communication equipment, etc., to the closest interior perimeter ground with the shortest possible stranded copper wire with green insulation. Bond the door to the doorframe using flexible welding cable.

620-3.6.2 Exterior Grounding: Install an exterior grounding system consisting of multiple ground rod assemblies around the exterior perimeter of the equipment shelter. Place the ground rod assemblies a minimum of two feet from the building foundation in a suitable access point. Bond the following items to the shelter's grounding system:

1. Metal building parts such as downspouts and siding.
2. Ground rods provided by power or telephone utilities for grounding of AC power or surge protection devices, as permitted by local codes.
3. Shelter support skids, bases, or foundations, if applicable.
4. Any metal object larger than four square feet.
5. External metal fencing.

620-3.6.3 Punch Block SPD Grounding: Ground Type 66 punchdown blocks in accordance with the manufacturer's recommendations and mechanically connect them to the shelter's interior perimeter ground.

620-3.6.4. Equipment Shelter Fence Grounding: Ensure that the metal Type B fence is grounded to fence perimeter grounding conductors consisting of No. 2 AWG solid bare tinned copper wires that encircle the entire compound to achieve required resistance to ground required in 620-3.2.

Exothermically bond any splices in the grounding conductors. Bury the fence perimeter grounding conductor a minimum of 2.5 feet below finished grade. Bond all fence posts to the fence perimeter ground wire using No. 2 AWG solid bare tinned copper wire. Bond the gate and gatepost together with a flexible ground, such as welding cable wires. Ground the gatepost to the fence perimeter ground wire using No. 2 AWG solid bare tinned copper wire. Exothermically bond all connections to the fence perimeter ground wire.

Connect the fence's top rail to each corner post and in the middle of each side. Ground the fence fabric with No. 2 AWG solid bare tinned copper wire connected to the fence posts. Connect the fence perimeter wires to the ground rod assemblies of the equipment shelter's ground system with No. 2 AWG solid bare tinned copper wire, as shown in the plans.

Ensure that all ground leads are No. 2 AWG solid bare tinned copper wires for all above- and underground grounding wire installations. Ensure that all exothermic bonds are appropriate for the application. Do not use welding or other forms of bonding without prior written approval.

620-4 Ground Resistance Testing and Inspection.

620-4.1 Testing: Measure the ground resistance with an instrument designed specifically

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to measure and document earth/ground resistance, soil resistivity, and current flow. Conduct the test by using the fall-of-potential method as described in the Institute of Electronic and Electrical Engineers (IEEE) Standard 81.If fall-of-potential tests cannot be performed, it is acceptable to measure resistance at each accessible ground rod using a clamp-on ground resistance tester. Provide the Engineer with written, certified test results for each testing location. Illegible hand-written results are not acceptable. Provide the following information on the test results:

1. The formal name or ID for the location where the test was performed
2. The GPS latitude and longitude for the location where the test was performed
3. The date on which the test was performed
4. The make and model number, serial number, and last date of calibration (by an independent testing facility within the previous 12 months) for the grounding resistance testing device used
5. Contact information (including name, signature, and employer name) for each person conducting, witnessing, or certifying the test
6. Description of the local environmental and soil conditions at the time of testing
7. A rough sketch of the site grounding system; along with the corresponding measured data points
8. Page numbering showing the current page number and total page count (e.g., Page 1 of 3)

620-4.2 Inspection: Do not backfill below-grade grounding installations and grounding connections until inspected and approved. The Engineer will inspect the installation for proper connection types, tightness, workmanship, and conformance to plans. Replace any exothermic bonds that are deemed unsatisfactory with new exothermic bonds. Repair or replace any mechanical connections that are deemed unsatisfactory. Measure the resistance at each accessible ground rod using a clamp-on earth tester. The measurement at any individual rod is the cumulative resistance of all rods in a parallel circuit.

For grounding system inspections, notify the Engineer at least five days prior to completion of the installation. Record all test results in a standardized format approved by the Engineer prior to testing. All recorded test report data shall be dated, witnessed, and signed by at least one representative of the Department and the Contractor. Remedy all deficiencies at no cost to the Department.

620-5 Basis of Payment.

The work specified in this Section will not be paid for directly, but will be considered as incidental work.