DERRY-LONDONDERRY EXIT 4A
13065

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SPECIAL PROVISION

SECTION 677 – INTELLIGENT TRANSPORTATION SYSTEMS (ITS) EQUIPMENT

ITS CABINET SPECIFICATION

This special provision provides for installation of ITS equipment cabinets, related network equipment, power supplies, power service, and all associated equipment necessary to provide a working ITS device site. All provisions of Special Provision to Section 677 - Intelligent Transportation Systems (ITS) Equipment – Base Specification, except as modified or changed below, shall apply.

Add to Description (Special Provision to Section 677 - Intelligent Transportation Systems (ITS) Equipment – Base Specification):

1.4 ITS Cabinet Equipment and Communications. This work shall consist of furnishing, installing, wiring and testing, ITS Equipment Cabinets, Fiber Optic Patch Panels and Distribution Enclosures, Ethernet Switches and all ancillary equipment necessary to provide a complete working system as shown on the plans or as ordered.

1.5 ITS Equipment Power. This work shall consist of furnishing, installing, wiring, and testing Meter and Disconnect Pedestals, Uninterruptible Power Supplies (UPS), Service Wires and all ancillary equipment necessary to provide a complete power supply system as shown on the plans or as ordered.

Add to Materials (Special Provision to Section 677 - Intelligent Transportation Systems (ITS) Equipment – Base Specification):

2.6 ITS Cabinets and Equipment.

2.6.1 Ground Mounted ITS Equipment Cabinet shall be 66”H x 24”W x 30”D. The cabinet shall have two locking doors located on opposite sides of the cabinet. All equipment housed in the cabinet shall be rack mountable.

2.6.2 The cabinet shall contain a full-height standard EIA 19-inch rack. The rack shall be secured within the cabinet by mounts at the top and bottom.

2.6.3 Concrete work pad for cabinets shall meet the requirements of Section 608 for Concrete Sidewalks.

2.6.4 Granular material under concrete work pad shall meet requirements of Section 209.

2.6.5 The cabinet shall protect all equipment against sustained winds of 90 miles per hour (MPH), with 120 MPH wind gusts, blowing sand and dust, roadside pollutants from vehicle exhausts, blowing rain and snow, and heavy ice accumulations.

2.6.6 The cabinet shall be weatherproof with the top of the enclosure crowned or slanted to prevent standing water. The field cabinet shall also provide protection against vandalism and theft of equipment. Each cabinet door shall be supplied and installed with Corbin 1548-1 locks for access by #2 keys.

2.6.7 The cabinet and doors shall be constructed from sheet aluminum, which has a minimum thickness of 0.125 inches. All welds shall be neatly formatted and free of cracks, blowholes and other irregularities.

2.6.8 The cabinet shall be supplied with a captive door restraint bar. The bar shall allow the door to be kept open at a minimum of two different angles, with one at 90° and the other in the fully open position. The door restraint bar shall be supplied and installed such that the door is held in place during a 40 MPH wind without the restraint bar being bent. The door restraint bar shall be provided to prevent door movement when open in windy conditions.

2.6.9 Door hinges shall be continuous and bolted to the cabinet and door utilizing steel carriage bolts and nylock nuts. The hinges shall be made of a minimum 0.083-inch thick aluminum and shall have a minimum 0.250-inch diameter stainless steel hinge pin. The hinge pin shall be capped at the top and bottom by a weld to prevent removal.

2.6.10 The top and bottom of the latching pushrods shall contain nylon rollers to promote secure door closure.

2.6.11 The door handle shall be stainless steel. The latching handle shall have provisions for padlocking in the closed position.

2.6.12 The cabinet shall contain a power panel, sized for the required current and the required number of circuit breakers. The panel shall also contain a single phase filtering surge protector, designed for use within traffic equipment cabinets, to absorb power line noise and switching transients. The cabinet shall also be supplied with electrical neutral and ground terminal busses.

2.6.13 A generator anchoring system provided at each cabinet shall consist of a ½-inch x 13 tpi galvanized wrought eyebolt with a thread length of 1 5/8 inches. Epoxy compound for anchoring the eyebolt to the ITS cabinet foundation shall be a product as included on the Department's Qualified Products List (QPL).

2.6.14 Generator transfer switch shall be an external manual 30-amp, 125-volt switch with a confirmation pilot light.

2.6.15 The cabinet shall be equipped with a slide out metal drawer, constructed and installed such that it is capable of holding a 15-pound notebook computer, and mounted at a suitable height for a technician to use as a computer workstation.

2.6.16 The current rating of all duplex outlets shall be 15 amperes, with at least one being a GFCI outlet.

2.6.17 Thermostats for controlling electric cooling fans shall have the capability of being field adjusted from 50°F to 120°F.

2.6.18 The cabinet shall be supplied with a 120 VAC, 200 watt radiant heater. The radiant heater shall be a self-contained device designed to provide heat for an outdoor metal enclosure. The heater shall have an on/off switch, along with an adjustable thermostat with a minimum turn on range of 10°F to 60°F.

2.6.19 The air filters shall have an average rated efficiency of 30% and an arrestance of 90% when tested in accordance with ASHRAE 52.1-1992 Test Standard. The filter shall be listed and rated Class 2 by the Underwriters Laboratories. Filters shall have a metal structure; paper or paper-based filters shall be prohibited.

2.6.20 All intake and exhaust vents shall meet NEMA 3R requirements with and without powering the air venting arrangements.

2.7 Pole Mounted ITS Equipment Cabinet shall meet all requirements of the ground mounted ITS equipment cabinet, except as indicated below.

2.7.1 The pole mounted ITS equipment cabinet shall be 46”H x 24”W x 20”D. The cabinet shall have two locking doors.

2.7.2 Generator anchoring system will not be required at pole mounted cabinet locations, provided a generator can be secured by a padlocked chain wrapped around the pole.

2.8 ITS Cables.

2.8.1 All equipment shall be supplied with the Manufacturer’s recommended cables.

2.8.2 All Ethernet cable shall be weatherproof Category 6.

2.8.2.1 Ethernet cable not installed within a cabinet, conduit, or other enclosed space shall be UV protected and weatherproof.

2.8.2.2 All free-hanging Ethernet cable shall be plenum type.

2.8.2.3 When required for rodent control or underground burial, Ethernet cable shall be armored, ruggedized, and/or gel filled.

2.9 Rack Mounted Fiber Optic Distribution Enclosure.

2.9.1 The Rack Mounted Fiber Optic Distribution Enclosure shall be a stand-alone unit manufactured for mounting in EIA 19-inch racks.

2.9.2 The Rack Mounted Fiber Optic Distribution Enclosure shall include and be capable of accommodating a minimum of 96 SC type connector sleeves, or as shown in the Plans, whichever is greater.

2.9.3 The Rack Mounted Fiber Optic Distribution Enclosure shall include and be capable of terminating up to 36 connectorized pigtails.

2.9.4 The Rack Mounted Fiber Optic Distribution Enclosure shall incorporate a hinged access door.

2.9.5 The Rack Mounted Fiber Optic Distribution Enclosure shall include a number of splice trays capable of holding a total minimum of 36 splices or as shown in the plans. Splice trays shall meet the following requirements:

2.9.5.1 Each splice tray shall be capable of holding 12 splices.

2.9.5.2 Each splice tray shall incorporate a system to retain and provide strain relief to the fiber optic buffer tubes and connector pigtails.

2.9.5.3 Each splice tray shall incorporate grooves where the fiber optic splices can be held in place.

2.9.5.4 Each splice tray shall incorporate a clear snap-on lid.

2.9.6 The Rack Mounted Fiber Optic Distribution Enclosure shall include a restraining system to hold the splice trays securely in place.

2.9.7 The Rack Mounted Fiber Optic Distribution Enclosure shall incorporate cable guides that maintain fiber strands and fiber buffer tubes bending radius greater than the minimum allowed by the fiber optic cable manufacturer.

2.9.8 The Rack Mounted Fiber Optic Distribution Enclosure shall include connectorized pigtails to connect the fiber optic cable to the Rack Mounted Fiber Optic Distribution Enclosure front panel. The connectorized pigtails shall meet the following requirements:

2.9.8.1 All fiber optic connectors shall be SC type with a physical contact 2.5 mm ceramic ferrule.

2.9.8.2 The connector mean insertion loss shall be 0.3 dB and maximum 0.5 dB.

2.9.8.3 The connector mean return loss shall be less than -59 dB and maximum of -55 dB.

2.9.8.4 All SC connectors shall have a durability rate of less than 0.2 dB change over 500 rematings.

2.9.8.5 Connectors shall meet ANSI/TIA EIA-604-3A requirements.

2.9.8.6 The fiber optic strand of the connectorized pigtail shall have matching optical properties as the fiber optic strand used on the fiber optic cable.

2.9.9 The Rack Mounted Fiber Optic Distribution Enclosure shall incorporate a restraining mechanism to hold the fiber optic cable central member and outside jacket.

2.10 Fiber Optic Patch Panel.

2.10.1 The Fiber Optic Patch Panel shall be supplied with the number of positions indicated in the Contract Documents.

2.10.2 The Fiber Optic Patch Panel shall meet all of the requirements of the Rack Mounted Fiber Optic Distribution Enclosure, except as follows:

2.10.2.1 The Fiber Optic Patch Panel shall be a stand-alone unit manufactured for use in outdoor field cabinets and mounted in EIA 19 inch racks, wall mounted, or shelf mounted, as required by the application.

2.10.2.2 The Fiber Optic Patch Panel shall be one rack unit in height for the 12-position and a maximum of two rack units in height for the 24-position.

2.10.2.3 The 12-Position Fiber Optic Patch Panel shall include and be capable of accommodating a minimum of 12 SC type connector sleeves. The 24-Position Fiber Optic Patch Panel shall include and be capable of accommodating a minimum of 24 SC type connector sleeves.

2.10.2.4 The Fiber Optic Patch Panel shall incorporate a hinged access door.

2.10.2.5 The 12-Position Fiber Optic Patch Panel shall include a splice tray capable of holding 12 splices. The 24-Position Fiber Optic Patch Panel shall include two splice trays, each capable of holding 12 splices.

2.10.2.6 The 12-Position Fiber Optic Patch Panel shall include 12 connectorized pigtails, and the 24-Position Fiber Optic Patch Panel shall include 24 connectorized pigtails.

2.11 Ethernet Switch may be 100 Mbps or 1 Gbps containing Ethernet ports of the quantity indicated in the Contract Documents, and shall meet the following requirements:

2.11.1 Ethernet Switch shall be a self-contained unit capable of 24-hour per day unattended operation, manufactured by Cisco, RuggedCom, Etherwan, or approved equal. Ethernet Switch shall be of rugged design and suitable for reliable operation. Ethernet Switch shall be configured for minimum maintenance and need for adjustment after initial setup.

2.11.2 Ethernet Switch shall allow for remote configuration and status using web based tools via the most current version of Internet Explorer.

2.11.3 Ethernet Switch shall allow for remote configuration and status using Command Line Interface (CLI) via a local console (RS-232).

2.11.4 Ethernet Switch shall support remote configuration and status over Ethernet using SSH port 22.

2.11.5 Ethernet Switch shall support HTTPS (hypertext transfer protocol secure) using port 443.

2.11.6 Ethernet Switch shall include LED indicators for each Ethernet port to provide port status. Indicators shall be for:

(a) Power

(b) Collisions (1 LED for 10Mb, or 100Mb)

(c) LK (steady on when twisted pair link is operational)

(d) RX (Activity, flashing when port is receiving data)

2.11.7 Ethernet Switch shall enforce partitioning enforced after 32 consecutive collisions.

2.11.8 Ethernet Switch shall enforce partitioning enforced after 32 consecutive collisions.

2.11.9 Ethernet Switch shall auto-reconnect after one packet of error free transmission.

2.11.10 Ethernet Switch shall be a managed Ethernet layer 2 device.

2.11.11 Ethernet Switch shall have a switching method of store and forward.

2.11.12 Ethernet Switch shall support the following protocols:

(a) RTP/I

(b) TCP/IP

(c) DNS

(d) DHCP

2.11.13 Ethernet Switch shall support the following network management protocols and be interoperable and compatible with the proposed communication system:

(a) SNMP V2c

(b) RMON for Ethernet agent

(c) Telnet/TFTP

(d) ICMP

2.11.14 Ethernet Switch interface shall include a Port Note Description field to identify connected devices.

2.11.15 Ethernet Switch shall be rack and shelf mountable.

2.11.16 Ethernet Switch shall be UL listed.

2.11.17 Ethernet Switch shall be field hardened and rated by its manufacturer in accordance with the operating temperature, storage temperature, and relative humidity requirements of the NEMA TS2 Standard. The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome effects due to temperature in the specified environmental range.

2.11.18 100 Mbps Ethernet Switch shall have dual speed 10/100 Mbps Ethernet ports with RJ45 connectors. The Design-Build Team shall determine the number of ports required for the specific project installation and provide a switch with the required number of ports, plus a minimum of 4 spare Ethernet ports with RJ45 connectors, or a minimum of 12 total dual speed 10/100 Mbps Ethernet ports, whichever is greater.

2.11.19 The 10/100 Mbps Ethernet ports shall support the following network:

(a) IEEE.802.3 10 Base-T

(b) IEEE.802.3u 100 Base-T

(c) IEEE.802.1d Spanning Tree

(d) IEEE.802.1w Rapid Spanning Tree

(e) IEEE.802.1q VLAN

(f) IEEE.802.1p Class of service (CoS)

(g) Support for IGMP Multicast

2.11.20 In addition to the requirements described above, 1 Gbps Ethernet Switches shall also meet the following requirements:

2.11.20.1 1 Gbps Ethernet Switch shall have multi-speed 10/100/1000 Mbps Ethernet ports with RJ45 connectors. The Design-Build Team shall determine the number of ports required for the specific project installation and provide a switch with the required number of ports, plus a minimum of 2 spare Ethernet ports with RJ45 connectors, and 2 spare Small Form Factor Pluggable (SFP) ports.

2.11.20.2 The 10/100/1000 Mbps Ethernet ports shall support the following network standards:

(a) IEEE.802.3 10 Base-T

(b) IEEE.802.3u 100 Base-T

(c) IEEE.802.3ab 1000 Base-T

(d) IEEE.802.1d Spanning Tree

(e) IEEE.802.1w Rapid Spanning Tree

(f) IEEE.802.1q VLAN

(g) IEEE.802.1p Class of service (CoS)

(h) Support for IGMP Multicast

2.12 Fiber Ethernet Switch. Fiber Ethernet switches may be either 100 Mbps or 1 Gbps as indicated in the contract documents. 100 Mbps Fiber Ethernet Switch shall meet all of the requirements of the 100 Mbps Ethernet switch described above, and shall also meet the following requirements:

2.12.1 Fiber Ethernet Switch shall be a self-contained unit capable of 24-hour per day unattended operation, manufactured by Cisco, RuggedCom, Etherwan, or approved equal. Fiber Ethernet Switch shall be of rugged design and suitable for reliable operation. Fiber Ethernet Switch shall be configured for minimum maintenance and need for adjustment after initial setup.

2.12.2 The 100 Mbps Fiber Ethernet Switch shall include a minimum of four spare single mode fiber optic patch cords. All spare patch cords shall be the length required to establish fiber connections to any device placed in the cabinet, or minimally three feet long, whichever is greater. The fiber patch cords shall be terminated on both ends with one type SC and one type LC single mode connector.

2.12.3 The 100 Mbps Fiber Ethernet Switch shall have two (2) or more single mode fiber optic ports. Each port shall have two (2) type SC connectors.

2.12.4 Single mode fiber optic ports shall meet the following requirements:

(a) Optical emitters shall be laser diode type

(b) Fiber optic ports shall have an operating wavelength of 1310 nm, single mode, and/or 1550 nm, single mode

(c) Fiber optic ports shall each have an optical power budget of 13dB, minimum

(d) Optical emitters shall have a transmit power of -15dBm, minimum

(e) Optical detectors shall have received sensitivity of -28dBm, worst case

(f) Fiber optic ports may be integrated into the fiber Ethernet switch, or may be of the SFP type

2.12.5 All single mode fiber optic ports of Ethernet switches supplied on the project shall be fully compatible with each other, as well as with existing Ethernet switches on adjacent projects with which they must connect and interoperate. This compatibility shall include, but not be limited to, such characteristics as optical operating wavelengths, transmit power, receive sensitivity, and operating protocols.

2.12.6 Fiber optic ports shall support the following network standards:

(a) IEEE.802.3u 100 Base-FX

(b) IEEE.802.1d Spanning Tree

(c) IEEE.802.1w Rapid Spanning Tree

(d) IEEE.802.1q VLAN

(e) IEEE.802.1p Class of service (CoS)

(f) Support for IGMP Multicast

2.12.7 The 1 Gbps Fiber Ethernet Switches shall meet all of the requirements of the 1 Gbps Ethernet switch described above, and shall also meet the following:

2.12.7.1 The 1 Gbps Fiber Ethernet Switches shall include at a minimum the following troubleshooting and management support methods:

(a) ICMP from device

(b) Viewing and clearing the ARP cache

(c) Viewing and clearing the SAT table

(d) Spanning tree monitoring and troubleshooting

2.12.7.2 The two single mode fiber optic ports shall meet the following requirements:

(a) Optical emitters shall be laser diode type

(b) Fiber optic ports shall have an operating wavelength of 1310 nm, single mode, and/or 1550 nm, single mode

(c) Fiber optic ports shall each have an optical power budget of 16dB, minimum

(d) Optical emitters shall have a transmit power of -12dBm, minimum

(e) Optical detectors shall have received sensitivity of -28dBm, worst case

(f) Fiber optic ports may be integrated into the fiber Ethernet switch, or may be of the SFP type

2.12.7.3 All single mode fiber optic ports of Ethernet switches supplied on the project shall be fully compatible with each other, as well as with existing Ethernet switches on adjacent projects with which they must connect and interoperate. This compatibility shall include, but not be limited to, such characteristics as optical operating wavelengths, transmit power, receive sensitivity, and operating protocols.

2.12.7.4 Fiber optic ports shall support the following network standards:

(a) IEEE.802.3u 100 Base-FX

(b) IEEE.802.3z 1000 Base-FX

(c) IEEE.802.1d Spanning Tree

(d) IEEE.802.1w Rapid Spanning Tree

(e) IEEE.802.1q VLAN

(f) IEEE.802.1p Class of service (CoS)

(g) Support for IGMP Multicast

2.13 Meter and Disconnect Pedestal

2.13.1 Meter and Disconnect Pedestals, also known as metered service pedestals, shall be UL listed "Suitable for Service Equipment" and shall be acceptable to the local utility companies for use as a service connection.

2.13.2 Meter Pedestals shall consist of a galvanized steel post containing a main circuit breaker for service disconnect, branch circuit breakers, and an integral meter socket.

2.13.3 Meter Pedestals shall contain a 100 amp main circuit breaker and two 50 amp branch circuit breakers, or as otherwise shown on the Plans.

2.13.4 Disconnect Pedestals shall consist of a galvanized steel post containing a single branch circuit breaker.

2.13.5 Disconnect Pedestals shall not be metered. If a meter socket is provided, the Disconnect Pedestal shall contain a meter bypass.

2.13.6 Disconnect Pedestals shall contain a single 40 amp circuit breaker, or as otherwise shown on the Plans.

2.13.7 The metered service installed shall provide power with a reserve capacity of 50 percent over the requirements of the connected ITS equipment cabinet(s) and all installed equipment, including the connected ITS loads.

2.13.8 The Design-Build Team shall adhere to all applicable NEC, IEEE 1100-1992, UL 1459, and UL 1950 standards and practices.

2.14 Transformers. Transformers shall be 5.0 KVA Step-Up or Step-Down, and shall meet the following requirements:

2.14.1 Incoming Power.

2.14.1.1 The Step-Up Transformer shall receive incoming power at 120/240 Volts AC, single phase. The primary (input) side of the Step-Up Transformer shall be capable of accepting 120 Volts AC single phase power (two wire), 240 Volts AC single phase power (two wire), and 120/240 Volts AC single phase power (three wire).

2.14.1.2 The Step-Down Transformer shall receive incoming power at 240/480 Volts AC, single phase. The primary (input) side of the Step-Down Transformer shall be capable of accepting 240 Volts AC single phase power (two wire), 480 Volts AC single phase power (two wire), and 240/480 Volts AC single phase power (three wire).

2.14.2 Output Power

2.14.2.1 The Step-Up Transformer shall provide output power at 480 Volts AC, single phase. The secondary (output) side of the Step-Up Transformer shall be capable of providing 480 Volts AC single phase power (two wire), 240/480 Volts AC single phase power (three wire), and 240 Volts AC single phase power (two wire).

2.14.2.2 The Step-Down Transformer shall provide output power at 120/240 Volts AC, single phase. The secondary (output) side of the Step-Down Transformer shall be capable of providing 120 Volts AC single phase power (two wire), 120/240 Volts AC single phase power (three wire), and 240 Volts AC single phase power (two wire).

2.14.3 Unless specifically allowed by the transformer manufacturer, a step-up transformer shall not be a step-down transformer wired in reverse. Likewise, a step-down transformer shall not be a step-up transformer wired in reverse.

2.14.4 The Step-Up and Step-Down Transformers shall be rated by the manufacturer for supplying loads of 5.0 KVA, 60 Hz AC, when installed in an unprotected outdoor environment.

2.14.5 All equipment used on Step-Up and Step-Down Transformers shall be individually UL listed, CSA certified and suitable for outdoor use.

2.14.6 Step-Up and Step-Down Transformers shall be an enclosed dry type unit.

2.14.7 Step-Up and Step-Down Transformers shall include a means to disconnect the primary feed of the transformer from the utility power source.

2.14.8 Step-Up and Step-Down Transformers shall include a NEMA 3R enclosure sufficiently large enough to contain the transformer and disconnect means. The enclosure shall have the facilities for padlocking, and a padlock with two sets of keys shall be provided by the Design-Build Team. The enclosure shall meet all requirements specified by the transformer manufacturer including, but not limited to, size and ventilation requirements.

2.15 Uninterruptible Power Supply (UPS) with Remote Power Manager.

2.15.1 The UPS shall include a remote power manager (RPM) unit that includes a minimum of eight 120 VAC outlets. Each of the 120 VAC outlets shall be individually controllable from the Transportation Management Center (TMC) via TCP/IP. In addition, the RPM shall include the ability to program time-of-day/day-of-week schedules whereby each of the 120 VAC outlets can be individually controlled by these schedules. The RPM shall include an RJ45 Ethernet port.

2.15.2 The UPS shall be sized to provide power to all 120 VAC loads described herein, plus 50% spare power capacity. The Design-Build Team shall supply load calculations to the Engineer for approval prior to installation of the UPS.

2.15.3 The UPS batteries shall be sized to provide a hold-up time to all connected loads, plus the required spare capacity, of 15 minutes minimum, or as indicated in the Contract Documents, whichever is greater.

2.15.3.1 If the UPS provides power to a variable speed limit sign, either directly through the ITS equipment cabinet or indirectly through a downstream cabinet, the UPS shall provide a hold-up time of 4 hours minimum, or as indicated in the Contract Documents, whichever is greater.

2.15.4 The UPS batteries shall be of the sealed, maintenance free type.

2.15.4.1 A battery mat shall be supplied under all batteries within the cabinet, sized appropriately to provide complete coverage between the battery and the surface it is on.

2.15.5 During the transfer from utility power to UPS power, there shall be no transfer or switchover time, i.e., the maximum transfer or switchover time shall be zero seconds.

2.15.6 The UPS shall provide true sine wave power to all connected loads. The UPS output total harmonic distortion shall not exceed 2 percent.

2.15.7 Each cabinet-mounted UPS unit shall be SNMP compatible to allow being configured and integrated for remote monitoring via TCP/IP from the TMC. Any software required to monitor all UPSs shall be furnished, configured and integrated into the TMC monitoring system. The UPS monitoring software shall provide the following capabilities, as a minimum:

(a) Data logging

(b) Event logging

(c) Fault notification

(d) Unattended system shutdown

(e) Hibernation

(f) Manage all network UPS units

(g) Operating system shutdown

(h) Power event summary

(i) Run command file

2.15.8 The UPS shall have at least one RJ45 Ethernet connector and at least one EIA 232 connector for remote monitoring, as well as local connection to a laptop computer for configuration.

2.15.9 The UPS shall have status indicators that display, as a minimum:

(a) Power

(b) Remaining battery capacity, as a ratio of total battery capacity

(c) Load level, as a ratio of maximum UPS capacity

(d) Overload

(e) Battery failure

2.15.10 The UPS shall be field hardened and rated by its manufacturer in accordance with the operating temperature, storage temperature, and relative humidity requirements of the NEMA TS2 Standard. The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome effects due to temperature in the specified environmental range.

2.15.11 The UPS shall have a manual power on/off switch.

2.15.12 The UPS shall have transient voltage surge protection that protects itself as well as connected loads against normal mode and common mode power line transients and surges. The UPS shall be capable of providing surge protection of 800 joules, minimum, and 6500 amperes, maximum. The UPS response time to transients and surges shall be no more than 5 nanoseconds.

2.15.13 The UPS shall provide output voltage regulation. The output voltage variation shall not exceed 5 percent.

2.15.14 The UPS shall include one Category 6 Ethernet patch cord, a minimum of three feet in length, and terminated on both ends with Type RJ45 connectors.

2.16 Transient Voltage Surge Suppression.

2.16.1 All ITS cabinets shall have a transient voltage surge suppressor (TVSS) sized for the incoming current and loads to be protected.

2.16.2 The TVSS shall be UL 1449 Compliant.

2.16.3 The TVSS shall be field hardened and rated by its manufacturer in accordance with the operating temperature, storage temperature, and relative humidity requirements of the NEMA TS2 Standard. The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome effects due to temperature in the specified environmental range.

2.16.4 The TVSS shall have protected lines L, N, and G.

2.16.5 The TVSS shall operate with a maximum leakage current of less than 0.3 mA.

2.16.6 The TVSS shall satisfy a maximum attenuation of -55 dB@ 100 MHz, typical.

2.16.7 The TVSS shall satisfy a maximum surge current of 18 kAmp per mode, 8/20 impulse.

2.16.8 The TVSS shall provide lightning induced voltage surge protection.

2.16.9 The TVSS shall filter and absorb power line noise and switching transients.

2.16.10 The TVSS shall utilize three stages for power line voltage spike and Radio Frequency Interference (RFI) suppression.

2.17 Service Wires for Power.

2.17.1 Single conductor cable shall be copper, Type THWN as designated by the Underwriter's Laboratory (UL) Specifications. The single conductor cable shall have heat and moisture resistant insulation for a maximum operating temperature of 75 degrees C, in wet and dry conditions.

2.17.2 Bare stranded copper ground wire shall consist of 7 copper strands of soft-drawn bare copper wire, size #4 AWG or larger if required by the NEC, complying with ASTM B-3 and ASTM B-8. The ground wire shall be UL approved.

Add to Construction Requirements (Special Provision to Section 677 - Intelligent Transportation Systems (ITS) Equipment – Base Specification):

3.12 ITS Cabinets and Equipment.

3.12.1 All equipment housed in the cabinet shall be rack mounted, unless otherwise noted.

3.12.2 Ground mounted cabinets shall be mounted and secured on concrete foundations as shown on the control cabinet details.

3.12.3 A 3'0" x 3'0" x 4" concrete work pad shall be installed in front of each cabinet door. The pad shall be placed on a minimum of 4-inches of compacted granular material, and the pad shall be set with at least 1 percent grade sloping away from the cabinet. Where the work pad is installed on a slope, the depth of the pad shall be increased such that there is at least two inches of the concrete pad below grade.

3.12.4 All conduits terminating in the cabinet shall be sealed with duct sealant. Use of tape to permanently seal conduits shall be prohibited.

3.12.4.1 Conduits less than 1 in. diameter shall be sealed with a silicone sealant

3.12.4.2 Conduits greater than 1 in. diameter shall be filled with steel wool in addition to being sealed with duct sealant.

3.12.5 Prior to placing the ITS cabinet on the concrete foundation, silicone sealant shall be applied to the area of contact. A two-inch gap shall be left without sealant on the front side of the cabinet.

3.12.6 Where indicated, spare sweeps shall be provided in the cabinet foundations for future use. If no spare sweeps are identified in the plans, the Design-Build Team shall supply one 3-inch PVC conduit sweep as a spare.

3.12.7 All ground-mounted cabinets shall include grounding at described in section 3.20.

3.12.8 Ground mounted cabinets shall be installed with doors opening parallel to adjacent traffic.

3.12.9 All cabinet electrical wiring and communication cables shall be of diameters and colors as required by the device manufacturers.

3.12.9.1 Wire connections shall be made without excessively long exposed conductors, or unraveled strands extending beyond connections, to prevent shock hazards.

3.12.10 Each cabinet shall contain a power panel containing a primary circuit breaker, which will accept the incoming 120 VAC, single-phase power. This primary circuit breaker shall serve as the electrical disconnect for the cabinet and shall shut off all cabinet power when in the "off" position.

3.12.11 The primary circuit breaker shall be a single pole, 30-amp breaker. Two additional single pole, 20 amp circuit breakers shall be supplied, installed and be fed from the primary circuit breaker.

3.12.11.1 One of the 20 amp circuit breakers shall feed the four 15 amp, electrical outlets to be installed in the cabinet. The other 20 amp circuit breaker shall feed a power distribution buss, providing hard wired electrical feed for the lamps, the cabinet heater, the electric fan, and all other integrated electrical equipment.

3.12.12 The power panel shall also contain a single phase filtering surge protector, as described in sections 2.6.12 and 3.20.3.

3.12.13 The cabinet shall contain all necessary AC power equipment required for connections to utility power and generator power. This shall include: disconnect switches, circuit breakers, surge suppressors, power distribution equipment and other equipment required to fully power the cabinet and its equipment.

3.12.14 The cabinet shall include power inputs for connections to external power sources, including both the local utility company AC lines service, and from an external generator.

3.12.14.1 The cabinet shall include an external generator plug and transfer switch, with which a generator can be connected to the cabinet without opening the cabinet doors. The transfer switch shall toggle the cabinet between AC line service and generator supplied power.

3.12.14.2 Access to the external manual transfer switch shall be protected by a keyed lock. The generator transfer switch access key shall be different from the cabinet's main door keys.

3.12.15 The field cabinet shall be provided with a minimum of 4 utility duplex electric power outlets to support electrical equipment. The power outlets shall be installed with minimum 2 inch spacing between each other. The utility power outlets shall be installed within the field cabinet and not on the cabinet door.

3.12.16 The field cabinet shall contain a power switch mounted within the cabinet to control power to all duplex outlets.

3.12.17 The field cabinet shall include a thermostatically controlled electric cooling fan, capable of maintaining temperatures inside the cabinet to that recommended by the equipment Manufacturer's for outside installations, or as specified in these Special Provisions.

3.12.18 Cabinet heaters shall have a hardwired connection to the cabinet's electrical power distribution buss. The heater shall be installed in the lower portion of the cabinet, mounted such that it is not blocking or touching installed equipment. It shall not be installed directly under a shelf. There shall be sufficient space around the unit to facilitate proper airflow and prevent damage or overheating of other installed equipment. The control knob for the heater thermostat shall be located such that it can easily be read and adjusted by field personnel.

3.12.19 All exposed, high voltage electrical terminals shall be insulated with non-conducting material such as rubber boots or silicon/rubber caulking.

3.12.20 The cabinet shall be electrically bonded to all of its associated metallic ITS Device support structure grounding systems, as described in section 3.20 or shown on the plans or directed by the Engineer.

3.12.21 All air venting arrangements shall contain air filters. All fans shall be located above the air filters at the top of the cabinet. All exhaust vents shall be furnished with a screen to prevent insects from entering the field cabinet.

3.12.22 The cabinet shall be supplied and installed with two internal white LED tube lights located in the top of the cabinet, 1 inside each door. This light shall automatically turn on when the cabinet door is open and shut off when the door is closed. The lights shall be hardwire-connected to the cabinet's electrical power distribution buss.

3.12.23 The cabinet shall include a generator anchoring system and pad integrated with the cabinet's foundation. The location of the anchoring system shall be on the same side as the cabinet's power supply. The anchoring eyebolt shall be installed in a 5/8 inch diameter hole drilled into the concrete foundation such that the eyebolt does not interfere with the cabinet's anchor bolt system or the opening of the cabinet doors. The eyebolt shall be bonded into the concrete by a two-component epoxy compound (resin and hardener). The epoxy compound shall fill the drilled hole and cover the threads of the eyebolt.

3.12.24 A solid 1/4 inch diameter weatherproof padlock approved by the Engineer shall be installed with each cabinet. All padlocks supplied as part of this Contract shall be keyed alike.

3.12.25 Two sets of keys shall be supplied for the generator transfer switch access. Four sets of keys shall be supplied for each of the two cabinet locks, and the padlock.

3.12.26 In addition to meeting ground mounted cabinet requirements, pole mounted ITS cabinets shall meet the following:

3.12.26.1 The pole mounted ITS equipment cabinet shall be installed using stainless steel bands, Z-brackets, or rails. The cabinet shall be secured to the pole at a minimum of two locations (i.e. top and bottom), and attached in a way that prevents movement of the cabinet.

3.12.26.2 Incoming power feeds and communications feeds shall enter the pole mounted ITS cabinet through separate external conduit risers and shall not enter through the mounting pole.

3.12.26.3 The opening of the doors shall not be impeded by the mounting location of the cabinet on the support pole, nor shall the support pole's equipment or hand holes be impeded by the installed cabinet when the doors are closed.

3.12.27 The Design-Build Team shall furnish, in a watertight container, a control cabinet-wiring diagram. Three sets of identical wiring diagrams shall be furnished for each cabinet.

3.12.28 If tracer wire equipment connection points are installed inside ITS equipment cabinets, the tracer wire shall enter the cabinet through a conduit or conduit riser specifically installed for that purpose.

3.13 ITS Cables

3.13.1 All equipment shall be installed using the Manufacturer's recommended cables.

3.13.2 The Design-Build Team shall furnish, install, connectorize, and test all Category 6 (Cat. 6) cables, of the types required for the application, at locations shown in the plans or as required to construct a complete, functional system.

3.13.3 The Cat. 6 cables shall not exceed 325 feet in length unless the Design-Build Team is granted written permission from the Engineer.

3.13.4 All cables shall be installed in a continuous run. Splicing will not be allowed.

3.14 Fiber Optic Distribution Enclosures shall be rack mounted, as shown on the Plans or as directed by the Engineer, and shall be securely fastened in place as recommended by the manufacturer.

3.14.1 The Design-Build Team shall provide factory assembled fiber optic pigtails. Modified fiber optic patch cords will not be accepted.

3.15 Fiber Optic Patch Panels shall be rack mounted in the ITS Cabinet as required by the specific location. The patch panel shall be securely fastened in place as recommended by the manufacturer.

3.15.1 Connectorized fiber optic pigtails shall connect the fiber optic cable to the front panel of the Fiber Optic Patch Panel.

3.16 Ethernet and Fiber Ethernet Switches shall be installed by the Design-Build Team in the ITS cabinets as shown on the Plans or as directed by the Engineer.

3.16.1 Ethernet and Fiber Ethernet Switches shall include all accessories required for a full and complete installation, including but not limited to connecting cables, power supplies, and mounting hardware.

3.16.2 Ethernet and Fiber Ethernet Switches shall be shelf mounted or rack mounted, as shown on the Plans or as directed by the Engineer. Shelf mounted switches shall be secured to the shelf, and oriented to allow viewing of connections and status LED indicators.

3.16.3 The Design-Build Team shall configure all ports as required with IP addresses provided by the Department. The Design-Build Team shall label all ports in the switch management software.

3.16.4 Fiber optic ports shall remain covered at all times, unless connected to fiber optic cable.

3.16.5 Switches shall be provided with a minimum of twelve (12) Category 6 Ethernet patch cords, each a minimum of three feet in length and terminated on both ends with Type RJ45 connectors.

3.17 Meter and Disconnect Pedestal

3.17.1 Where multiple electrical services are to be connected near the same location, separate meter pedestals for each service shall be furnished and installed unless otherwise directed by the Contract Documents or by the Engineer.

3.17.2 The Design-Build Team shall arrange a meeting with the Engineer and the local utility company representatives to establish a schedule for utility connections before any control equipment or material is ordered.

3.17.3 The Design-Build Team shall make the necessary arrangements with the utility companies to ensure utility service is available and connected at the time of equipment testing and power-up. Any utility energization, connection, or disconnection delays will not be a valid reason for a time extension. Difficulties in securing utility company services are to be reported to the Engineer at the earliest possible time.

3.18 Transformers.

3.18.1 The Step-Up and Step-Down transformer primary and secondary wiring shall be connected in strict accordance with the manufacturer's recommendations, depending on the mode of operation.

3.18.2 The Step-Up transformer shall not be a Step-Down transformer wired in reverse. Likewise, a Step-Down transformer shall not be a Step-Up transformer wired in reverse. If such operation is allowed by the transformer manufacturer, then the Design-Build Team shall present a letter from the Manufacturer to the Engineer stating such, and also stating that the Manufacturer's warranty shall not be adversely affected by using this transformer in the reverse wiring configuration.

3.18.3 The Step-Up and Step-Down transformers shall be installed in accordance with the Manufacturer's recommendations and consistent with the local utility company requirements. In the event the Manufacturer's recommended mounting requirements exceed the mounting layouts

described below, the Design-Build Team shall install the transformers in accordance with the Manufacturer's recommendations.

3.18.4 Ground mounted transformers shall be mounted to a 6-inch thick concrete pad meeting Section 608 for concrete sidewalks. Width and length of the pad shall be at least 3 inches greater than the transformer's dimensions. The concrete pad shall be installed on 6 inches of crushed gravel conforming to item 304.4.

3.18.5 Pole mounted transformers shall be mounted to metal struts (galvanized or stainless steel) spanning between two 6-inch x 6-inch wood posts embedded in the ground a minimum of four feet, or aluminum struts spanning between two 4-inch round aluminum poles on concrete foundations in accordance with NHDOT Standards PS-4 and PS-9.

3.19 Uninterruptible Power Supply (UPS) unit shall be housed in each ITS equipment cabinet, and shall supply power to all ITS equipment cabinet devices, except as otherwise indicated. The UPS shall be connected to a 120 VAC, non-GFCI, line power outlet.

3.19.1 The UPS shall supply power to all ITS equipment cabinet devices, except as otherwise indicated.

3.19.1.1 In the event that environmental control equipment, such as heaters and/or air conditioners, or spare 120 VAC auxiliary convenience outlets are installed in the ITS equipment cabinet, they shall not be connected to UPS power.

3.19.2 All equipment connected to the UPS shall be properly connected and insulated to prevent shock hazard.

3.19.3 The UPS control software shall be configured to display the correct battery backup amp-hour ratings.

3.19.4 The UPS shall include a remote power manager (RPM) unit.

3.19.4.1 The RJ45 Ethernet port on the RPM shall be connected to an RJ45 Ethernet port on the Ethernet Switch. Any and all software needed at the TMC to control the RPM shall be supplied, installed, and configured by the Design-Build Team. Additional power strips shall be supplied and installed as needed to facilitate plugging devices into the RPM.

3.19.4.2 The Design-Build Team shall label all ports of the RPM in the RPM control software.

3.20 Grounding, Bonding and Surge Suppression

3.20.1 Provide grounding and Transient Voltage Surge Suppression (TVSS) at all ITS cabinets and all metallic ITS device structural supports. The Design-Build Team shall provide grounding connection between each TVSS device and the main grounding terminus in the cabinet. Each TVSS device shall have a dedicated grounding connection, directly with the grounding terminus. Daisy-chaining of grounding connection is not permitted.

3.20.2 The Design-Build Team shall furnish and install TVSS devices for all power and communications conductors leaving the ITS equipment cabinets, including but not limited to utility service, and power and communications for all ITS devices that are external to the cabinet.

3.20.3 The power panel of all ITS cabinets shall contain a single phase filtering surge protector, connected to the load side of the primary circuit breaker. The electrical neutral buss, the ground buss, the cabinet shell, and the ground rod shall all be wired in conformance to the applicable electrical codes.

3.20.4 All grounding shall meet the requirements of the installed equipment Manufacturers. In the event that the Manufacturers' requirements are more stringent than those of the national, state, and local codes, then the Manufacturers' grounding requirements shall apply.

3.20.5 Each ITS cabinet and each metallic ITS device support structure, including but not limited to camera poles, detector sensor poles, and dynamic message sign structures, shall include at least one 3/4-inch by 10-foot ground rod made of solid copper or copper-clad steel rod. A #4 AWG copper ground wire shall be connected to the ground lug on the cabinet or support structure, and exothermically welded to the ground rod. Additional ground rods shall be furnished and installed to provide required grounding.

3.20.5.1 For grounding connections internal to the cabinet or support structure, a conduit shall be installed through the foundation specifically to provide the means to connect the ground wire to the ground rods. Ground wires shall not be mounted externally to any structure, and shall not be installed in conduit with any other power or communication wiring.

3.20.6 All ITS cabinets shall be electrically bonded to their associated ITS device support structure ground system using #4 AWG copper wires. The #4 AWG copper wires shall be installed between the support structures and the cabinet providing a common ground system for each terminus.

3.21 Service Wires for Power. The Design-Build Team shall furnish, install, and test the Service Wires for Power for proper operation at locations shown in the plans. All materials including splice connectors shall conform to the latest version of the National Electric Code published at the time of installation.

3.21.1 The Design-Build Team shall be responsible for coordinating and scheduling any utility inspections required for connecting to utility power service.