

DIVISION 17
SIGNALS AND TRAFFIC MANAGEMENT SYSTEMS
SECTION 1700
GENERAL REQUIREMENTS

1700-1 DESCRIPTION.

Furnish, install, modify, and remove signals, flashing beacons, traffic management systems, electrical systems, and provisions for future systems in accordance with the plans and specifications.

1700-2 MATERIAL.

Refer to Article 1098-1.

1700-3 CONSTRUCTION METHODS.

(A) General:

Before beginning signal work, verify that all existing signal equipment is in satisfactory working order. Report all defective signal equipment to the Engineer so as not to be held responsible for the defects.

Locate the existing conduit, cable runs, inductive detection loops, lead-in, junction boxes, and detection equipment before installing or using equipment that can damage or interfere with such facilities. The locations of existing inductive detection loops shown on the plans are approximate.

Locate all underground utilities before beginning drilling, digging, or trenching operations.

Immediately cease work and notify the Engineer and the affected owners if damage to existing utilities, cables, or equipment occurs. Make all required repairs and replacements at no additional cost to the Department.

(B) Regulations and Codes:

Furnish material and workmanship conforming to the National Electric Code (NEC), the National Electric Safety Code (NESC), Underwriter's Laboratories (UL), and all local safety codes in effect on the date of advertisement. Comply with Article 4, Chapter 87 of the North Carolina General Statutes (Licensing of Electrical Contractors). Comply with all regulations and codes imposed by the owner of affected utility poles. In the event of a conflict between these documents and the specifications contained herein, the cited documents will govern.

Notify the Engineer, local traffic enforcement agency, local utility company, and any affected railroad companies seven business days before operational shutdowns to coordinate connection or disconnection to an existing utility or system.

Install standoffs, meter bases, and service disconnects as required by the NESC, the NEC, local utility companies, and ordinances.

(C) Utility Services:

Coordinate all work to ensure that electrical power of the proper voltage, phase, frequency, and ampacity is available to complete the work. Use electrical services cables that have THW insulation.

When electrical and telecommunication service is not furnished by the Department and is required, contact the utility company and make application to ensure that all work can be completed. Obtain authorization for service in the Department's name and make application for service in the Department's name.

The Department will be responsible for direct payment of utility company charges.

(D) Maintenance and Repair of Material:

Maintain and repair all signal and traffic management communications related equipment within the construction limits of the project until completion of the observation period and receipt of written notification of final acceptance of the project.

Furnish the Engineer with the name, office telephone number, cellular (mobile) telephone number, and pager number of the supervisory employee who will be responsible for maintenance and repair of equipment during all hours.

For all failures, malfunctions, or damages to this equipment, begin necessary repairs within four hours of notification. Complete repairs within eight hours of notification. Comply with Section 150 for maintenance of traffic flow. The inability to contact the supervisory employee or prearranged alternate will not extend repair time requirements.

Remove and replace all signal and traffic management communications related equipment that fails. The Department will furnish the contractor replacement equipment for Department-furnished equipment that fails.

(E) Removal of Existing Equipment and Material:

Remove all Department-owned signal and communications related equipment and material that will not be used. Assume ownership of removed poles, messenger cable, interconnect cable, communications cable, and supporting hardware. Return all other equipment and material between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project.

The Department will deduct the cost of Department-owned equipment damaged by the contractor from money due to the contractor.

(F) Railroad Preemption:

Where railroad preemption is required, coordinate all work with the railroad company. Do not place signals into operation until signal equipment has been interconnected with required railroad-highway crossing devices and railroad preemption is working properly. Ensure that preemption sequences begin immediately after activation of train detection.

Contact and coordinate with the railroad company to schedule interconnection of the signal to the railroad controller cabinet. Install type 1 lead-in cable between the signal controller cabinet and the railroad company control cabinet for the railroad crossing. Install wire from the signal controller cabinet to a railroad company furnished and installed lockable junction box. Interconnection will be made by the railroad company.

Provide fail-safe operation such that removal of voltage from the railroad side of the isolation relay will initiate the railroad preemption sequence.

(G) Vehicle Preemption Systems:

Where vehicle preemption systems are required, implement and install vehicle preemption systems. Coordinate vehicle preemption work with the proper operating authority. Contact the proper operating authority and schedule installation of preemption equipment.

(H) Timing of Signals:

Implement timing values for signal controllers.

Reinstall all existing time-based coordination. As directed, make modifications to existing coordination to account for changes in signal phasing.

The Department reserves the right to make, or have the contractor make, field timing changes necessary for pattern optimization and to eliminate identifiable, potential hazards to the motoring public. The Engineer will notify the contractor of timing changes made.

(I) Wire and Cable:

For installation in a conduit system, lubricate cable and wires prior to installing in conduit. Use lubricant that will not physically or chemically harm the cable jacket, wire insulation, and conduit.

Splice all electrical wire and cable at recessed-screw, barrier type terminal blocks or in junction boxes. Unless specifically allowed, connect no more than two conductors to the same terminal screw.

Maintain color coding of wires through splices.

Protect ends of wire and cable from water and moisture.

Install all wire and cable with necessary hardware including, but not limited to deadend strandvises, shoulder eyebolts, washers, nuts, thimbleyelets, three-bolt clamps, J-hooks, split bolt connectors, grounding clamps, and lashing material.

(J) Grounding:

Provide a grounding system at all new and revised electrical service points unless otherwise noted.

Provide a length of detectable metallic burial tape at a depth of 1 to 1.5 feet (0.3 to 0.5 m) directly over grounding electrodes and conductors.

1700-4 BASIS OF PAYMENT.

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section.

**SECTION 1705
SIGNAL HEADS**

1705-1 DESCRIPTION.

Furnish and install signal heads and signal cable with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish vehicle and pedestrian signal heads with incandescent and light emitting diode (LED) sections, visors, interconnecting brackets, reflectors, wire entrance fittings, glass lenses, signal lamps, messenger cable mounting assemblies, mast arm mounting assemblies, pedestal mounting assemblies, signal cable, side-of-pole mounting assemblies, lashing wire, pedestrian push buttons, R10-3B signs, grounding systems and all necessary hardware.

1705-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of advertisement.

Refer to Division 10:

Signal Heads..... Article 1098-2

1705-3 CONSTRUCTION METHODS.

(A) General:

Install vehicle and pedestrian signal heads with incandescent and light emitting diode (LED) sections, visors, reflectors, wire entrance fittings, glass lenses, signal lamps, interconnecting brackets, messenger cable mounting assemblies, mast arm mounting assemblies, pedestal mounting assemblies, signal cable, side of pole mounting assemblies, lashing wire, pedestrian push buttons, R10-3B signs, grounding systems, and all necessary hardware.

Bag new pedestrian and vehicle signal heads with burlap bags or bags made of non-ripping material specifically designed for covering signal heads until the signal heads are placed in operation.

When new signal heads are placed into operation, immediately bag and remove signals heads that are not to be reused.

Vertically and horizontally adjust each signal head so that light output will be of maximum effectiveness for the traffic and pedestrians. Do not tilt signal heads forward.

Reposition signal heads as required for various construction phases.

(B) Vehicle Signal Heads:

Install vehicle signal heads at the heights required in the North Carolina Supplement to the MUTCD in effect on the date of advertisement.

Where vehicle signal heads are installed on messenger cable, install mounting hardware consisting of a messenger cable hanger, balance adjuster, bottom cap, wire entrance fitting bracket, and insulating bushings.

Where vehicle signal heads are installed on mast arms, install mounting hardware consisting of rigid vehicle signal head mounting brackets.

Install signal cable in continuous lengths between signal controller cabinets and signal heads. Route signal cable to minimize the length of cable installed, and the number of cables and conductors in each run. Pull 36 inches (900 mm) of additional signal cable into controller cabinets. Do not install more than six signal heads on one neutral conductor.

Wrap signal cable to messenger cable with at least four turns of wrapping tape spaced at intervals less than 15 inches (380 mm) or lash signal cable to messenger cable with one 360 degree spiral of lashing wire per 12 inches (300 mm).

Make electrical connections inside each signal head, signal controller cabinet, and termination compartment in metal poles. Do not splice cable outside signal heads.

Coil sufficient signal cable beside each vehicle signal head to accommodate head shifts during various construction phases. For all cables entering or leaving vehicle signal heads at final head locations, provide a minimum of 36 inches (900 mm) of signal cable coiled beside each head.

(C) Pedestrian Signal Heads:

Install pedestrian signal heads at the height required in the MUTCD in effect on the date of advertisement.

Install signs with mounting hardware immediately above pedestrian push-buttons as required by the MUTCD in effect on the date of advertisement.

1705-4 METHOD OF MEASUREMENT.

Actual number of signal heads of each type, size, and number of sections with mounting hardware furnished, installed, and accepted.

Linear feet (linear meters) of signal cable shown on the plans as being necessary to complete the work. Where signal plans have been revised, the quantity as shown on the revised signal plans. No measurement for payment will be made for this pay item, and no adjustment in the contract unit price or quantity will be made for any variation from the approximate quantity shown except in accordance with Article 1098-1(F).

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No measurement will be made of incandescent and light emitting diode (LED) sections, visors, reflectors, wire entrance fittings, glass lenses, signal lamps, interconnecting brackets, messenger cable mounting assemblies, mast arm mounting assemblies, pedestal mounting assemblies, side of pole mounting assemblies, lashing wire, pedestrian push buttons, and R10-3B signs as these will be considered incidental to furnishing and installing signal heads.

No measurement will be made between 14-4 and 14-7 signal cable as this will be considered incidental to furnishing and installing signal cable.

1705-5 BASIS OF PAYMENT.

The quantity of signal heads, measured as provided in Article 1705-4, will be paid for at the contract unit price each for “_____ Signal Head (_____).”

The quantity of signal cable, measured as provided in Article 1705-4, will be paid for at the contract unit price per linear foot (linear meter) for “Signal Cable.”

Payment will be made under:

- Vehicle Signal Head (_____).....Each
- Pedestrian Signal Head (_____).....Each
- Signal Cable Linear Foot (Linear Meter)

**SECTION 1706
BACKPLATES**

1706-1 DESCRIPTION.

Furnish and install backplates for vehicle signal heads with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish backplates and all necessary hardware.

1706-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10:

- Backplates Article 1098-3

1706-3 CONSTRUCTION METHODS.

Install backplates for vehicle signal heads so as not to interfere with the function of all door hinges, signal section latches, and mounting hardware. Do not bend or deform backplates during installation. Goose-neck fittings may be installed in reverse to accommodate backplates. Use stainless steel fasteners for attaching backplates to signal sections.

1706-4 METHOD OF MEASUREMENT.

Actual number of backplates for vehicle signal heads with mounting hardware furnished, installed, and accepted. No measurement will be made for different sizes of backplates.

1706-5 BASIS OF PAYMENT.

The quantity of backplates, measured as provided in Article 1706-4, will be paid for at the contract unit price each for “Backplate.”

Payment will be made under:

- Backplate Each

**SECTION 1710
MESSENGER CABLE**

1710-1 DESCRIPTION.

Furnish and install messenger cable (spanwire) with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish messenger cable with cable clamps, machine bolts, eyebolts, strandvises, eyenuts, split-bolt connectors, and all necessary hardware.

1710-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10:

Messenger CableArticle 1098-4

1710-3 CONSTRUCTION METHODS.

Install guy assemblies prior to installing messenger cable.

Bond messenger cable installed for the purpose of supporting communications cable at intervals not to exceed 1,300 feet (396 meters). Use existing pole grounds when available. Should existing poles not have a grounding system, install a new grounding system that complies with Article 1720-3.

Use 3/8 inch (10 mm) messenger cable for spans supporting vehicle signal heads, or signs, or signal heads and signs.

Use 1/4 inch (6 mm) messenger cable for spans supporting only cables unless otherwise shown on the plans.

For messenger cable crossing over railroad tracks, provide a minimum of 30 feet (9.1 m) of vertical clearance.

For permanent installation, install messenger cable in continuous lengths with no splices except where an insulator is required. For temporary installations and with prior approval, existing messenger may be extended instead of installing a new messenger cable.

Tension messenger cable to eliminate appreciable sag and to match the sag of surrounding utilities. Otherwise, allow a sag of three to four percent of the length of the span between poles.

Provide 3-bolt clamp assemblies consisting of 5/8 inch (16 mm) diameter machine bolts, j-hooks, washers, and square nuts to attach messenger cable to wood poles. Provide machine bolts that are 3 inches (75 mm) longer than the pole diameter.

Attach messenger cable to poles using cable clamps with J-hooks in mid-runs and deadend strandvises at termination poles.

Use 5/8 inch (16 mm) diameter eyebolts with washers and nuts (or eyenuts where required) to attach strandvises to wood poles at controller cabinets and poles where cable is terminated into a strandvise.

On joint use poles at signal and traffic management systems equipment installations (i.e. Controller Cabinets, CCTV Cabinets, DMS Cabinets, etc.). Do not use existing utility company grounds. Install a grounding system for the signal and traffic management communications system equipment.

Bond messenger cable installed for the purpose of supporting communications cable at intervals not to exceed every 1300 feet (396 m). Use existing pole grounds when available. Should existing poles not have a grounding system, install a new grounding system for bonding the messenger cable.

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Install ground wires so as to minimize damage from vandalism and environmental exposures. Use Number 6 AWG solid copper ground wire. Install ground wire up the pole to a point adjacent to the uppermost span. To secure the ground wire to poles, use hot-dipped galvanized wire staples on 12 inch (300 mm) centers from ground level to 8 feet (2.4 m). Above 8 feet (2.4 m), use wire staples on 24 inch (600 mm) centers. Install a 5/8 inch x 8 foot (16 mm x 2.4 m) ground rod at the base of the pole and exothermically weld the ground wire to the ground rod. Bond the messenger cable to the ground wire using a Burndy Clamp (UCG25RS) or equivalent.

Maintain electrical continuity at all splices.

1710-4 METHOD OF MEASUREMENT.

Measured horizontal linear feet (linear meters) of messenger cable furnished, installed and accepted. Sag and vertical segments will not be paid for as these distances will be considered incidental to the installation of the messenger cable.

No measurement will be made of cable clamps, machine bolts, eyebolts, strandvises, 3 bolt assemblies, eyenuts, and split bolt connectors, pole grounding system as these will be considered incidental to furnishing and installing messenger cable.

1710-5 BASIS OF PAYMENT.

The quantity of messenger cable, measured as provided in Article 1710-4, will be paid for at the contract unit price per linear foot (linear meter) for “Messenger Cable (_____).”

Payment will be made under:

Messenger Cable (_____) Linear Foot (Linear Meter)

**SECTION 1715
UNDERGROUND CONDUIT**

1715-1 DESCRIPTION.

Furnish and install conduit for underground installation in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish conduit for underground installation with backfill, graded stone, paved materials, detectable metallic marker tape, tracer wire, miscellaneous fittings, seeding and mulching, and all necessary hardware.

Furnish “green” insulated Number 14 AWG, THWN, stranded, copper, wire to serve as a tracer wire in conduits containing fiber optic communications cable.

1715-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10 except as noted herein:

- Non-metallic Conduit..... Article 1097-5
- Metallic Conduit..... Article 1097-5
- Backfill.. Article 1018-2
- Graded Stone..... Articles 545-2 and 545-3

Provide schedule 40 non-metallic conduit.

1715-3 CONSTRUCTION METHODS.

(A) General:

Install conduit for all underground runs. Clean existing underground conduit that will be incorporated into a new system. Bond all metallic conduit.

Comply with the following except as noted herein:

Conduit..Article 1409-3

If more than one conduit is required between the same points, install conduit in one trench using manufacturer’s spacers.

Install conduit at a minimum depth of 30 inches (760 mm) below finished grade or 6 inches (150 mm) below roadway subgrade, whichever is deeper.

Install longitudinal runs of conduit at a minimum of 1 foot (0.3 m) from the back of curb or 6 feet (1.8 m) from the edge of pavement in the absence of curb.

Extend threaded ends of conduit 2 inches (50 mm) above concrete surfaces and 4 inches (100 mm) above crushed stone bases and install bushings. For metallic conduit, install metallic bushings. For non-metallic conduit, install non-metallic bushings.

Seal spare conduits and conduits containing fiber-optic communications cable with mechanical sealing devices.

Ensure that conduit is free of moisture and debris prior to pulling cables.

Upon completion, restore the surface to like-original condition within seven calendar days of the occurrence of damage. Tamp backfill in 6 inch (150 mm) lifts with a mechanical tamp until compacted density is at least equal to surrounding density.

Where repairs cannot be performed immediately, comply with Article 545.4.

(B) Unpaved Trenching:

Install non-metallic conduit in all unpaved areas. Place detectable metallic marker tape at a depth of 12 to 18 inches (300 to 400 mm) below the finished grade. Rake smooth the top 1 1/2 inch (40 mm), seed with the same type of grass as the surrounding area, and mulch unpaved areas.

(C) Paved Trenching:

Install metallic conduit in all paved trenching areas. Paved areas include streets, sidewalks, paved driveways, and parking lots.

Except on concrete surfaces, neatly cut and replace the width of the trench with like material. On concrete surfaces, replace the entire joint of concrete unless otherwise directed.

(D) Jack and Bore:

For all jack and bore areas, comply with the following except as noted herein:

Pipe Installation.....Article 342-3

For all jack and bore areas, install metallic conduit at a minimum depth of 30 inches (750 mm) below finished grade or 6 inches (150 mm) below roadway sub-grade. Provide 3 feet (1 m) of conduit from back of curb or from edge of pavement. Terminate ends of conduit into junction boxes.

Perform work that complies with the NCDOT Policies and Procedures for accommodating Utilities on Highway Rights-of-Way in effect on the date of advertisement.

(E) Tracer Wire:

Pull tracer wire simultaneously in a continuous length with the fiber-optic communications cable. Where multiple pulls of fiber optic communications cable are required, only one tracer wire is required. Where tracer wire is spliced provide waterproof butt splices. Splicing is allowed only in cabinets and junction boxes. Label and connect the tracer wires to the equipment ground buss bar in all cabinets.

1715-4 METHOD OF MEASUREMENT.

Measured horizontal linear feet (linear meters) of trenching for underground conduit installation of each type furnished, and accepted. Measurement will be along the approximate centerline of the trench.

Measured horizontal linear feet (linear meters) of tracer wire furnished, installed and accepted. Measurement will be along the approximate centerline of the trench. Vertical segments will not be paid for as these distances will be considered incidental to the installation of the tracer wire. No payment will be made for excess tracer wire in junction boxes and/or cabinets.

Measured horizontal linear feet (linear meters) of jack and bore for underground conduit installation furnished and accepted. Measurement will be along the approximate centerline of the bore from junction box to junction box. Vertical segments will not be paid for as these distances will be considered incidental to installation of underground conduit.

No measurement will be made of non-metallic conduit, metallic conduit, backfill, graded stone, paved materials, miscellaneous fittings, and seeding and mulching as these will be considered incidental to trenching installation for the conduit.

1715-5 BASIS OF PAYMENT.

The quantity of trenching, measured as provided in Article 1715-4, will be paid for at the contract unit price per linear foot (linear meter) as “Trenching (_____).”

The quantity of tracer wire, measured as provided in Article 1715-4, will be paid for at the contract unit price per linear foot (linear meter) as “Tracer Wire.”

The quantity of jack and bore, measured as provided in Article 1715-4, will be paid for at the contract unit price per linear foot (linear meter) as “Jack and Bore.”

Payment will be made under:

Trenching (_____).....	Linear Foot (Meter)
Jack and Bore	Linear Foot (Meter)
Tracer Wire	Linear Foot (Meter)

**SECTION 1716
JUNCTION BOXES**

1716-1 DESCRIPTION.

Furnish and install junction boxes (pull boxes) with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish junction boxes with covers, graded stone, grounding systems, and all necessary hardware.

1716-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10:

Junction Boxes	Article 1098-5
Graded Stone.....	Articles 545-2 and 545-3

1716-3 CONSTRUCTION METHODS.

Comply with the following except as noted herein:

Junction boxes.....	Article 1411-3
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Install the junction boxes flush with finished grade. Do not install sealant compound between junction boxes and covers.

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Install junction boxes at maximum intervals of 250 feet (90 m), or where shown on the plans and at locations where underground splicing of lead-in cable is necessary, whichever is less.

1716-4 METHOD OF MEASUREMENT.

The actual number of junction boxes of each size and type furnished, installed, and accepted.

No measurement will be made of covers, graded stone, and required grounding systems as these will be considered incidental to furnishing and installing junction boxes.

1716-5 BASIS OF PAYMENT.

The quantity of junction boxes, measured as provided in Article 1716-4, will be paid for at the contract unit price each for "Junction Box (_____)."

Payment will be made under:

Junction Box (_____).....Each

**SECTION 1720
WOOD POLES**

1720-1 DESCRIPTION.

Furnish and install wood poles with grounding systems and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish wood poles with grounding systems and all necessary hardware.

1720-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of advertisement.

Refer to Division 10:

Wood PolesArticle 1098-6

1720-3 CONSTRUCTION METHODS.

Mark final pole locations and receive approval prior to installing poles. Unless otherwise shown, locate poles a minimum of 6 feet (1.8 m) behind face of curb or 10 feet (3.0 m) from edge of travelway.

Drill or auger a hole for placement of the pole and to allow for compacting. Set the pole at the depth recommended by the manufacturer, but at a minimum depth of 5 feet (1.5 m) and so that when the pole is fully loaded as required by the plans, the pole is within two degrees of vertical.

Backfill the hole with the pole installed and tamp backfill in 6 inch (150 mm) lifts with a mechanical tamp until compacted density is at least equal to surrounding density.

On joint use poles, at signal and traffic management systems equipment installations (i.e. Controller Cabinets, CCTV Cabinets, DMS Cabinets, etc.), install a grounding system for the signal and traffic management communications system equipment.

Install ground wire so as to minimize damage from vandalism and environmental exposures. Use Number 6 AWG solid copper ground wire. Install ground wire up the pole to a point adjacent to the uppermost span. To secure ground wire to poles, use hot-dipped galvanized wire staples on 12 inch (300 mm) centers from ground level to 8 feet (2.4 m). Above 8 feet (2.4 meters), use wire staples on 24 inch (600 mm) centers. Install a 5/8 inch x 8 foot (16 mm x 2.4 m) ground rod at the base of the pole and exothermically weld the ground wire to the ground rod.

1720-4 METHOD OF MEASUREMENT.

Actual number of wood poles for signals and traffic management communications equipment with grounding systems furnished, installed, and accepted.

No measurement will be made for installing grounding systems as these will be considered incidental to furnishing and installing wood poles.

1720-5 BASIS OF PAYMENT.

The quantity of wood poles for signals and communications equipment, measured as provided in Article 1720-4, will be paid for at the contract unit price each for "Wood Pole."

Payment will be made under:

Wood PoleEach

**SECTION 1721
GUY ASSEMBLIES**

1721-1 DESCRIPTION.

Furnish and install guy assemblies with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish and install guy assemblies and all necessary hardware.

1721-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of advertisement.

Refer to Division 10:

Guy AssembliesArticle 1098-7

1721-3 CONSTRUCTION METHODS.

Install guy assemblies with guy cable, guy guards, anchors, strandvises, three bolt clamps and associated fittings. Except as required below, where there is room on the pole to install a two bolt attachment in compliance with the NESC, attach the guy assembly and the guy cable to two separate bolts with one bolt for the span and one bolt for the guy cable. Provide 8 to 12 inch (200 to 300 mm) separation between bolts or as required by the pole owner. If there is not sufficient room for two-bolt attachment, use a Department approved one-bolt attachment method for attachment of messenger cable and guy assemblies.

Use the Department approved one bolt attachment method for attachment of messenger cable and guy assemblies for all communications cable installations.

Ground guy assemblies to pole grounds using Burndy Clamps (UCG25RS) or equivalent. Do not bond to utility company grounding systems at signal and traffic management systems equipment installations (i.e. Controller Cabinets, CCTV Cabinets, DMS Cabinets, etc.).

When installing messenger cable at locations other than signalized intersections, use the Department approved one-bolt attachment method for attachment of messenger cable and guy assemblies for the purpose of supporting communications cable. Use existing pole grounds when available. Should existing poles not have a grounding system, install a new grounding system for bonding the messenger cable. Provide grounding systems that comply with Article 1320-3.

Do not attach to existing guy assemblies unless specifically approved by the owner.

1721-4 METHOD OF MEASUREMENT.

Actual number of guy assemblies with anchors, guy cable, and guy guards furnished, installed, and accepted.

No measurement will be made of guy cable as this will be considered incidental to furnishing and installing guy assemblies.

1721-5 BASIS OF PAYMENT.

The quantity of guy assemblies, measured as provided in Article 1721-4, will be paid for at the contract unit price each for "Guy Assembly."

Payment will be made under:

Guy Assembly.....Each

**SECTION 1722
RISER ASSEMBLIES**

1722-1 DESCRIPTION.

Furnish and install risers assemblies with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish riser assemblies with clamp-on, aluminum weatherheads or heat shrink tubing, galvanized pole attachment fittings, and all necessary hardware.

1722-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of advertisement.

Provide metallic conduit for risers.

Refer to Division 10:

Metallic Conduit..... Article 1097-5

Provide Tyco™(Raychem™) part number 066193-000 or equal heat shrink tubing for the installation of fiber-optic cable. Obtain pre-approval for any heat shrink tubing retrofit or expansion kits.

1722-3 CONSTRUCTION METHODS.

Install risers with required weatherheads or heat shrink tubing on poles using pole attachment fittings.

Use separate 1/2 inch (12.5 mm) riser with weatherhead for pedestrian pushbutton cable.

Use separate 1 inch (25 mm) riser with weatherhead for electrical service.

Use separate 2 inch (50 mm) risers with weatherheads for signal cables (bundled). Use separate 2 inch (50 mm) riser with weatherhead for the combination of all lead-in and twisted-pair communications cable.

Use separate 2 inch (50 mm) riser with heat shrink tubing for fiber-optic communications cable. Install risers with heat shrink tubing so that fiber-optic cable can be installed without violating the cable's minimum bending radius. Install fiber-optic cable so that it does not share a riser with any other cable. Install the heat shrink tubing in accordance with the manufacturer's recommendations. Provide tubing that is a minimum of 5 inches (125 mm) in length with a minimum of 2.5 inches (62.5 mm) extended over the fiber-optic cables and 2.5 inches (62.5 mm) extended over the riser after the heat has been applied. Use nylon filler rods with UV protection or an equal and sealing spacer clips to separate the fiber-optic cables where multiple fiber-optic cables enter a riser. Ensure that sealing spacer clips have a sealing compound that is heat activated with the sealing

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compound fully encapsulating the space between the cables. Ensure that the heat shrink tubing provides a watertight fit around individual fiber-optic cables and the outer walls of the risers. Do not use cut sections of the fiber-optic cable or any other devices in lieu of filler rods. Use aluminum tape around fiber-optic cables to prevent damage to the cables from sealing chemicals. Use a heat source that will provide even heat distribution around the tubing. Ensure that no damage occurs to any cables.

1722-4 METHOD OF MEASUREMENT.

Actual number of risers of each type and size for signals and traffic management systems furnished, installed, and accepted.

1722-5 BASIS OF PAYMENT.

The quantity of risers, measured as provided in Article 1722-4, will be paid for at the contract unit price each for “____-Inch (____-mm) Riser with _____.”

Payment will be made under:

__" (mm) Riser with _____.....Each

**SECTION 1725
INDUCTIVE DETECTION LOOPS**

1725-1 DESCRIPTION.

Furnish and install inductive detection loops with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish inductive detection loops with loop slot sealant, loop wire, 1 inch (25 mm) conduit with fittings, and all necessary hardware.

1725-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10:

Inductive Detection LoopsArticle 1098-8

1725-3 CONSTRUCTION METHODS.

Notify the Engineer one week prior to installing inductive detection loops.

Coordinate sawcutting and loop placement with pavement markings. For new construction or for resurfacing, install inductive detection loops prior to placement of the final layer of surface course. On unmarked pavement, premark locations of stop lines and lane lines prior to locating inductive detection loops.

Prior to sawcutting, premark inductive detection loop locations and receive approval. Sawcut pavement at approved premarked locations. Do not allow vehicles to travel over unsealed loop slots.

Install 1 inch (25 mm) non-metallic conduit with bushings from edge of pavement to junction box. Do not sawcut through curb.

Remove all loose material and wash saw slots with a high-pressure method using an air and water mixture. Dry saw slots with compressed air. Clear saw slots of jagged edges and protrusions. Seat loop conductor at the bottom of the saw slot without damage.

Prior to sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megohms.

Embed loop conductors in the saw slot with loop sealant. Seal saw slot and dispose of excess sealant in an environmentally safe manner. Provide the Engineer with the Material Safety Data Sheet and the manufacturer’s test data. Upon request, demonstrate the integrity of sealant by trial applications.

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Between corners of loops and junction boxes, twist loop conductor pairs a minimum of 5 turns per foot (15 turns per meter). Permanently label each twisted pair in the junction box with nylon cable tie using indelible ink. Indicate loop number and loop polarity on the tie.

1725-4 METHOD OF MEASUREMENT.

The actual linear feet (linear meters) of inductive loop sawcut furnished, installed, and accepted.

No measurement will be made of loop slot sealant, loop wire, 1 inch (25 mm) conduit, and conduit fittings as this will be considered incidental to furnishing and installing inductive detection loops.

1725-5 BASIS OF PAYMENT.

The quantity of inductive loop sawcut, measured as provided in Article 1725-4, will be paid for at the contract unit price per linear foot (linear meter) for “Inductive Loop Sawcut.”

Payment will be made under:

Inductive Loop Sawcut Linear Foot (Linear Meter)

**SECTION 1726
LOOP LEAD-IN CABLE**

1726-1 DESCRIPTION.

Furnish and install loop lead-in cable with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish loop lead-in cable and all necessary hardware.

1726-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10:

Loop Lead-In CableArticle 1098-9

1726-3 CONSTRUCTION METHODS.

Install type 1 or type 2 lead-in cable. Except as otherwise specified herein, selection of type 1 or type 2 lead-in cable will be at the contractor’s option.

For underground runs, install lead-in cable in 2 inch (50 mm) non-metallic conduit. For aerial installation, wrap lead-in cable to messenger cable with at least four turns of wrapping tape spaced at intervals less than 15 inches (380 mm) or lash lead-in cable to messenger cable with one 360 degree spiral of lashing wire per 12 inches (300 mm).

Where direct bury is required, install type 1 lead-in cable. Direct bury lead-in cable and waterproof all splices. For direct bury lead-in cable, use a trench with a minimum depth of 12 inches (300 mm). Do not direct bury lead-in cable for final loop installation.

Where railroad preemption is required, install type 1 lead-in cable from the signal controller cabinet to a railroad company furnished and installed lockable junction box.

Splicing of lead-in cable will be allowed only for runs in excess of 750 feet (246 m). Splice lead-in cable in junction boxes or condulets on poles.

Test each complete loop system from the controller cabinet by using a megger to verify that impedance from the loop system to the ground is at least 50 megohms. After successful completion of megger test, test the loop system resistance using an electronic ohmmeter to verify that loop system resistance is less than 0.0036 ohms per foot (0.012 ohms per meter).

1726-4 METHOD OF MEASUREMENT.

Linear feet (linear meters) of lead-in cable shown on the plans as being necessary to complete the work. Where the signal plans have been revised, the quantity as shown on the revised signal plans. No measurement for payment will be made for this pay item, and no adjustment in the contract unit price or quantity will be made for any variation from the approximate quantity shown except in accordance with Article 1700-2(F). If type 2 lead-in cable is furnished and installed, adjustments in quantities will be based upon two times the length of type 2 lead-in cable furnished and installed.

1726-5 BASIS OF PAYMENT.

The quantity of loop lead-in cable, measured as provided in Article 1726-4, will be paid for at the contract unit price per linear foot (linear meter) as “Lead-In Cable.”

Payment will be made under:

Lead-In Cable..... Linear Foot (Linear Meter)

SECTION 1727

VIDEO IMAGING LOOP EMULATOR DETECTION SYSTEMS

1727-1 DESCRIPTION.

Design, furnish, and install video imaging loop emulator detection systems with all necessary hardware and provide training in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Design and furnish loop emulator detection systems and all necessary hardware. Provide training on the operation and maintenance of loop emulator systems.

1727-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10:

Video Imaging Loop Emulator Detection Systems Article 1098-10

Ensure that software is licensed for use by the Department and by any other agency responsible for maintaining or operating the loop emulation system. Provide the Department with a license to duplicate and distribute the software as necessary for design and maintenance support.

1727-3 CONSTRUCTION METHODS.

Prior to beginning work at locations requiring video imaging loop emulator detection systems, furnish system software. Upon activation of detection zones, provide detector configuration files. Ensure that up-to-date detection configuration files are furnished for various detection zone configurations that may be required for construction phasing.

Place into operation loop emulator detection systems. Configure loop emulator detection systems to achieve required detection zones. Have a certified manufacturer’s representative on site to supervise and assist with installation, set up, and testing of the system.

Install the loop emulator processor unit (LEPU) in the signal controller cabinet. Make all necessary modifications to install LEPU, cabling harnesses, and camera sensor interface panels with surge suppression.

Perform necessary modifications to camera sensor unit gain, sensitivity, and iris limits prior to installation of the sensor.

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Install coaxial cable and sensor power cable from each sensor to the signal controller cabinet along signal cabling routes. Install surge protection and terminate coaxial cable and sensor power cable.

Provide at least 8 hours of training on the set up, operation, troubleshooting, and maintenance of the loop emulator detection system to a maximum of ten Department personnel. Arrange for training to be conducted by the manufacturer’s representative at an approved site within the Division responsible for administration of the project. Thirty days prior to conducting training submit a detailed course curriculum, draft manuals and materials, and resumes. Obtain approval of the submittal prior to conducting the training. At least one week prior to beginning training, provide three sets of complete documentation necessary to maintain and operate the system. Do not perform training until installation of loop emulator detection systems is complete.

1727-4 METHOD OF MEASUREMENT.

Actual number of loop emulator detection systems designed, furnished, installed, and accepted.

No measurement will be made of video imaging loop emulator system support, loop emulator processing units, sensor units, poles, mast arm supports, trenching, conduit, and messenger cable used exclusively for the operation of the video imaging loop emulator detection systems as these items will be considered incidental to furnishing and installing video imaging loop emulator detection systems.

1727-5 BASIS OF PAYMENT.

The quantity of video imaging loop emulator detection systems, measured as provided in Article 1727-4, will be paid for at the contract unit price per each as “Loop Emulator Detection System.” Partial payments of 50 percent will be made for each video imaging loop emulator system when furnished, installed, and accepted. Upon successful completion of the training, partial payments of the remaining 50 percent will be made for each video imaging loop emulator system furnished, installed, and accepted.

Payment will be made under:

Loop Emulator Detection SystemEach

**SECTION 1730
FIBER-OPTIC CABLE**

1730-1 DESCRIPTION.

Furnish and install single mode fiber-optic (SMFO) communications cable, drop cable assemblies, and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish SMFO communications cable with grounding systems, fiber-optic cable storage racks (snow shoes), communications cable identification markers, lashing wire, and all necessary hardware.

1730-2 MATERIALS.

Refer to Division 10:

Fiber-Optic CableArticle 1098-11

1730-3 CONSTRUCTION METHODS.

(A) General:

Provide cable manufacturer’s attenuation and Optical Time Domain Reflectometer (OTDR) testing data for each reel of cable.

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Install single mode fiber-optic (SMFO) communications cable with grounding systems, snow shoes, communications cable identification markers, lashing wire, and all necessary hardware.

Comply with NESC and manufacturer's recommendations. Install communications cable on signal poles, utility poles, on messenger cable, and in conduits as required to bring the fiber-optic cable into and, if necessary, out of each splice enclosure.

Take all precautions necessary to ensure that cable is not damaged during storage, handling, and installation. Do not violate the minimum bending radius of 20 times the radius of the cable diameter or the manufacturer's recommendation, whichever is greater. Do not step on cable nor run over cable with vehicles or equipment. Do not pull cable over or around obstructions, or along the ground.

Determine lengths of cable necessary to reach from termination-point to termination-point. Install cable in continuous lengths between approved splicing facilities. Additionally, provide a sufficient amount of slack cable to allow for an additional 20 feet (6.1 m) of cable to be present after removal of the outer sheath for termination. Measure slack cable by extending cable straight out of the cabinet door.

Keep cable ends sealed at all times during installation to effectively prevent the ingress of moisture. Use approved heat shrink cable end cap. Do not use tape to seal cable ends.

Before installing cable, provide three copies of the cable manufacturer's recommended and maximum pulling tension. Do not exceed the manufacturer's recommended pulling tension. Use pulling grips containing a rotating swivel. Coil cable in a "figure-8" configuration whenever cable is unreeled for subsequent pulling.

Install fiber-optic cable in separate 2 inch (50 mm) risers with heat shrink tubing. Do not share risers with other type cable.

(B) Aerial Installation:

Double lash fiber-optic cable to messenger cable with one 360 degree spiral per foot (three 360 degree spirals per meter).

Use pole attachment hardware and roller guides with safety clips to install aerial run cable.

Maintain tension during the pulling process for aerial run cable by using an approved mechanical clutch (dynamometer) device. Do not allow cable to contact the ground or other obstructions between poles during installation. Do not use a motorized vehicle to generate cable pulling forces.

Use a cable suspension clamp when attaching cable tangent to a pole. Select and place cable blocks and corner blocks so as not to exceed the cable's minimum bending radius. Do not pull cable across J-hooks.

Store 100 feet (30 m) of slack fiber-optic cable over-head on all cable runs that are continuous without splices and are greater than 2,500 feet (762 m) and as shown on the plans. Obtain approval for spare cable storage locations. Store spare fiber-optic cable on fiber-optic cable storage racks (snow shoes). Locate spare cable storage in the middle of spans between termination points. Do not store spare fiber-optic cable over the roadway or driveways.

Install one communications cable identification marker within 36 inches (914.4 mm) of pole attachment points and at locations where more than one cable originates or terminates.

Maintain electrical continuity of messenger cable at all poles.

(C) Underground Installation:

Install fiber-optic cable underground in conduit using cable pulling lubricants approved by the fiber-optic cable manufacturer and the Engineer.

Obtain approval of cable pulling lubricant and method of pulling before installing underground fiber-optic cable.

Use a dynamometer (clutch device) so as not to exceed the maximum allowable pulling tension if the cable is pulled by mechanical means. Do not use a motorized vehicle to generate cable pulling forces.

Keep tension on the cable reel and pulling line at the start of each pull. Do not release tension if the pulling operation is halted. Restart the pulling operation by gradually increasing tension until the cable is in motion.

For pulling cable through manholes, junction boxes, and vaults. Feed the cable by manually rotating the reel. Do not pull cable through intermediate junction boxes, handholds, or openings in conduit unless otherwise approved.

Install communications cable identification markers on each communications cable entering a junction box.

(D) Installation of Drop Cable Assembly:

Determine the length of drop cable needed, including slack, to reach from termination point to termination point.

At aerial splice enclosures, store 100 feet (30 m) of slack cable on cable storage racks. At below ground splice enclosures, coil 100 feet (30 m) of slack cable in the manhole or junction box where the enclosure is located.

At the equipment cabinet end of the drop cable assembly, terminate all fibers with ST-PC connectors to the connector panel. Label all connectors and the connector panel. At the aerial splice enclosure location, cap off all unused or designated fibers and label to correspond with the connector panel.

1730-4 METHOD OF MEASUREMENT.

Actual linear feet (linear meters) of fiber-optic cable of each fiber count furnished, installed, and accepted. Measurement will be made by calculating the difference in length markings located on the outer jacket of the fiber-optic cable from the start of the fiber run to the end of the fiber run for each fiber run. Terminate all fibers before determining the length of the cable run.

Measured linear feet (linear meters) of fiber optic drop cable assemblies furnished, installed, and accepted. Sag and vertical segments will not be paid for as these distances are considered incidental to the installation of drop cable assemblies.

No measurement will be made for terminating, splicing, and testing of the fiber-optic cable, for communications cable identification markers, or for fiber-optic cable storage racks, grounding of messenger cable, as this will be considered incidental to the installation of the fiber optic cable.

1730-5 BASIS OF PAYMENT.

The quantity of fiber-optic cable, measured as provided in Article 1730-4, will be paid for at the contract unit price per linear foot (linear meter) for “Communications Cable (___-Fiber).”

The quantity of drop cable assemblies, measured as provided in Article 1730-4, will be paid for at the contract unit price per linear foot (linear meter) as “Drop Cable.”

Payment will be made under:

Communications Cable (___-Fiber)	Linear Foot (Linear Meter)
Drop Cable	Linear Foot (Linear Meter)

**SECTION 1731
FIBER-OPTIC SPLICE CENTERS**

1731-1 DESCRIPTION.

Furnish and install fiber-optic interconnect centers, fiber-optic aerial splice enclosures, and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish interconnect centers and aerial splice enclosures and all necessary hardware. Provide aerial splice enclosures that are suitable for aerial, pedestal, buried, junction box, and/or manhole installations.

1731-2 MATERIALS.

Refer to Division 10:

Fiber-Optic Splice CenterArticle 1098-12

1731-3 CONSTRUCTION METHODS.

(A) General:

Install interconnect centers with connector panels, splice trays, storage for slack cable or fibers, mounting and strain relief hardware, and all necessary hardware.

Install aerial splice enclosures with splice trays, basket containment assemblies, racking for slack cable or fibers, mounting and strain relief hardware, and all other necessary hardware.

Fusion splice and secure SMFO cable in splice trays inside the splice enclosure.

Do not exceed 0.05 dB of attenuation per splice.

Furnish strain relief so that no tensile force is on the SMFO cable when it is held within the interconnect center or aerial splice enclosure.

(B) Termination and Splicing within Interconnect Center:

Terminate and splice all fibers including unused fibers.

Label all fiber-optic connectors, whether on jumpers, connector panels, or other equipment, to prevent improper connection. Obtain approval of the fiber-optic connectors labeling method.

Ensure that all buffer tubes are contained within the splice tray so that no bare fibers are outside the tray.

For all fibers designated for termination to a connector panel within the interconnect center, fusion splice the fibers to the pigtails.

For all cut fibers designated to be expressed through the interconnect center, fusion splice the fibers.

For all buffer tubes designated to be expressed through the interconnect center, neatly coil the excess tubing inside the interconnect center. Do not damage the cable or violate the minimum bending radius of the cable.

(C) Termination and Splicing within Aerial Splice Enclosure:

Fusion splice all fibers including fibers designated to be coupled with fibers from a drop cable assembly and cut fibers designated to be expressed through the splice enclosure.

For all buffer tubes designated to be expressed through the splice enclosure, neatly coil the excess tubing inside the basket provided with the enclosure.

Ensure that all buffer tubes are contained within the splice tray so that no bare fibers are outside the tray.

Do not damage the fiber or exceed the minimum bending radius of the fiber.

Label all fiber-optic splices. Obtain approval of the method of labeling all fiber-optic connections.

Install heat shrink cable shields using methods recommend by the manufacturer of the enclosure. Perform a pressurization flash test on the enclosure in accordance with the manufacturer's recommend procedures at the conclusion of the splicing procedure and prior to the final placement of the enclosure.

For aerial installations, secure enclosures to messenger cable using the manufacturer supplied hardware. Secure SMFO cable and drop cable assemblies to snowshoes.

Install enclosures with a sufficient amount of slack cable to allow the enclosure to be lowered to ground level and extended into a splicing vehicle that is located within 10 feet (3 m) of the equipment cabinet.

For underground, manhole, and junction box facility installations, place the enclosure along with required spare cables in the facility in a neat and workmanship like manner. Do not damage cable or violate the minimum bending radius of the cable.

(D) Testing:

Provide written notification a minimum of ten days before beginning fiber-optic cable testing.

After completion of splicing, perform the two patch cable test procedure and the OTDR test on each fiber, including unused fibers, to ensure that the following:

- fusion splice loss does not exceed 0.05 dB,
- terminations and connections have a loss of 0.5 dB or less,
- and reflection loss is 40 dB or greater for each connector.

If exceeded, remake splices until the loss falls below 0.05 dB. The Department will record each attempt for purposes of acceptance.

Furnish durable labeled plots and electronic copies on 3.5 inch (89 mm) diskette of test results for each fiber including engineering calculations demonstrating that OTDR test results meet or exceed the attenuation requirements and that optical properties of the cable have not been impaired. Label all test results (plots and diskettes) with the manufacturer and model number of the OTDR testing equipment. Provide engineering calculations and tests for fiber-optic cable that demonstrates the loss budget where the fiber originates and the point where the fiber meets an electronic device.

If any fiber exceeds the maximum allowable attenuation or if the fiber-optic properties of the cable have been impaired, take approved corrective action including replacement of complete segments of fiber-optic cable if required. Corrective action will be at no additional cost to the Department.

1731-4 METHOD OF MEASUREMENT.

Actual number of fiber-optic interconnect centers furnished, installed and accepted.

Actual number of fiber-optic splice enclosures furnished, installed and accepted. No measurement will be made between aerial, underground, manhole, or junction box installation of the fiber-optic splice enclosure.

No measurement will be made of splice trays, pigtails, jumpers, connector panels, and testing, as this will be considered incidental to furnishing and installing fiber optic interconnect centers and aerial splice enclosures.

1731-5 BASIS OF PAYMENT.

The quantity of fiber-optic interconnect centers, measured as provided in Article 1731-4, will be paid for at the contract unit price each for "Interconnect Center."

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The quantity of splice enclosures, measured as provided in Article 1731-4, will be paid for at the contract unit price each for "Aerial Splice Enclosure."

Payment will be made under:

Interconnect Center	Each
Aerial Splice Enclosure.....	Each

**SECTION 1732
FIBER-OPTIC TRANSCEIVERS**

1732-1 DESCRIPTION.

Furnish and install fiber-optic transceivers with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish shelf-mounted, modular designed, single mode fiber-optic transceivers and all necessary hardware that are compatible with the system equipment and designed for RS-232 drop-and-repeat communications. Do not provide transceivers that are internal to the system equipment. Provide identical transceivers at all locations and that are capable of being interchanged throughout the system.

1732-2 MATERIALS.

Refer to Division 10:

Fiber-Optic Transceivers.....	Article 1098-13
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1732-3 CONSTRUCTION METHODS.

Install fiber-optic transceivers in each equipment cabinet and comply with the manufacturer's installation instructions.

1732-4 METHOD OF MEASUREMENT.

Actual number of fiber-optic transceivers furnished, installed and accepted.

1732-5 BASIS OF PAYMENT.

The quantity of fiber-optic transceivers, measured as provided in Article 1732-4, will be paid for at the contract unit price each for "Fiber-Optic Transceiver."

Payment will be made under:

Fiber-Optic Transceiver	Each
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**SECTION 1733
DELINEATOR MARKERS**

1733-1 DESCRIPTION.

Furnish and install delineator markers with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish delineator markers and all necessary hardware.

1733-2 MATERIALS.

Refer to Division 10:

Delineator Markers.....	Article 1098-14
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1733-3 CONSTRUCTION METHODS.

Submit a sample of the proposed delineator markers for approval prior to installation.

Install delineator markers using a method that firmly and securely anchors the delineator marker in the ground to prohibit twisting and easy removal.

1733-4 METHOD OF MEASUREMENT.

Actual number of delineator markers furnished, installed and accepted.

1733-5 BASIS OF PAYMENT.

The quantity of delineator markers, measured as provided in Article 1732-4, will be paid for at the contract unit price each for "Delineator Marker."

Payment will be made under:

Delineator MarkerEach

**SECTION 1740
METAL STRAIN POLES**

1740-1 DESCRIPTION.

Furnish and install metal strain signal poles with grounding systems and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish metal strain signal poles with signal head support mounting systems, grounding systems, and all necessary hardware.

1740-2 MATERIALS.

Refer to Division 10:

Metal Poles.....Article 1098-15

1740-3 CONSTRUCTION METHODS.

Furnish shop drawings for approval. Provide triplicate copies of detailed shop drawings for each type of structure. Ensure that shop drawings show materials specifications for each component and identifies welds by type and size. Do not furnish structures until approval is received.

Install metal poles, hardware, and fittings as shown on the manufacturer's installation drawings. Install metal poles so that when the pole is fully loaded it is within 2 degrees of vertical. Install poles with the manufacturer's recommended "rake." Use threaded leveling nuts to establish rake. Do not use shims or other types of leveling devices.

For holes in the poles used to accommodate cables, install grommets prior to wiring of pole or arm. Do not cut or split grommets.

Connect poles to grounding electrodes and the intersection grounding systems.

1740-4 METHOD OF MEASUREMENT.

Actual number of metal strain signal poles without regard to height furnished, installed and accepted.

1740-5 BASIS OF PAYMENT.

The quantity of metal strain signal poles, measured as provided in Article 1740-4, will be paid for at the contract unit price each for "Metal Strain Signal Pole."

Payment will be made under:

Metal Strain Signal Pole.....Each

**SECTION 1741
SIGNAL SUPPORT MAST ARMS WITH METAL POLES**

1741-1 DESCRIPTION.

Furnish and install signal support mast arms with metal poles and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish signal support mast arms with metal poles, grounding systems, and all necessary hardware. Provide either steel or aluminum arms as indicated on the plans.

1741-2 MATERIALS.

Refer to Division 10:

Metal Poles.....	Article 1098-15
Mast Arms.....	Article 1098-16

1741-3 CONSTRUCTION METHODS.

Comply with Article 1740-3.

Install signal support mast arms with metal poles, hardware, and fittings as shown on the manufacturer’s installation drawings. If horizontal-type arms are furnished, install arms within 2 degrees of horizontal when loaded with signal heads and signs.

For holes in the arms used to accommodate cables, install grommets prior to wiring of pole or arm. Do not cut or split grommets.

Connect arms to grounding electrodes and intersection grounding systems.

1741-4 METHOD OF MEASUREMENT.

Actual number of signal support mast arms with metal poles furnished, installed, and accepted.

1741-5 BASIS OF PAYMENT.

The quantity of signal support mast arms with metal poles, measured as provided in Article 1741-4, will be paid for at the contract unit price each for “Signal Support Mast Arm with Metal Pole.”

Payment will be made under:

Signal Support Mast Arm with Metal Pole.....	Each
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**SECTION 1742
METAL POLE FOUNDATIONS**

1742-1 DESCRIPTION.

Furnish and install metal signal pole foundations and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish metal signal pole foundations, grounding systems, and all necessary hardware.

1742-2 MATERIALS.

Refer to Division 10:

Portland Cement Concrete	Section 1000
Reinforcing Steel.....	Section 1070
Metal Poles.....	Subarticle 1098-15(A)

Furnish foundations constructed of Class A concrete.

1742-3 CONSTRUCTION METHODS.

Perform work as required by AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

Locate foundations. Determine the elevation of foundations and submit the findings before construction of the foundations. Obtain the Engineer’s approval of the concrete foundation locations and elevations. Do not construct the concrete footings prior to receiving approval.

Construct foundations in accordance with Section 825. Cast concrete for pole foundations against undisturbed soil unless otherwise permitted. Provide forms with chamfer strips that measure one inch along the diagonal face at all corners above ground level. Do not install foundations over uncompacted fill or muck.

Provide a copper clad steel grounding electrode with at least a 5/8 inch (16 mm) diameter in each foundation. Install the electrode so that it extends into undisturbed earth from the side or bottom of the foundation for a minimum of 8 feet (2.5 m), and extends 3 inches (75 mm) above the foundation. Ensure that the location of the electrode does not interfere with the entry, dressing, or connection of cables.

Install rigid galvanized conduit in foundations.

Securely place, position, and align anchor bolts symmetrically about the center of the concrete foundation.

Give exposed vertical concrete surfaces an ordinary surface finish. Give exposed horizontal surfaces a float finish.

Level tops of concrete foundations. Do not allow tops to exceed 6 inches (150 mm) above the adjacent ground surface.

Fill spaces between the top of the foundation and the base plate with a waterproof caulking compound and finish neatly. Provide for drainage of water from inside the support.

Do not erect metal poles until concrete in the foundations has attained a minimum compressive strength of 3,000 psi (20.7 Mpa) as determined by cylinder breaks.

1742-4 METHOD OF MEASUREMENT.

Actual number of metal signal pole foundations furnished, installed and accepted.

1742-5 BASIS OF PAYMENT.

The quantity of metal signal pole foundations, measured as provided in Article 1742-4, will be paid for at the contract unit price per each for “Metal Signal Pole Foundation.”

Payment will be made under:

Metal Signal Pole Foundation.....Each

**SECTION 1743
SIGNAL PEDESTALS**

1743-1 DESCRIPTION.

Furnish and install signal pedestals with foundations and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish signal pedestals with foundations, grounding systems, and all necessary hardware.

1743-2 MATERIALS.

Refer to Division 10:

PedestalsArticle 1098-17

Furnish foundations constructed of Class A concrete.

1743-3 CONSTRUCTION METHODS.

Furnish shop drawings for approval. Provide triplicate copies of detailed shop drawings for each type of pedestal. Ensure that shop drawings show materials specifications for each component and identifies welds by type and size. Do not furnish pedestals until approval is received.

Perform work as required by AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

Locate foundations. Determine the elevation of foundations and submit the findings before construction of the foundations. Obtain the Engineer’s approval of the concrete foundation locations and elevations. Do not construct the concrete footings prior to receiving approval.

Construct foundations in accordance with Section 825. Cast concrete for pole foundations against undisturbed soil unless otherwise permitted. Provide forms with chamfer strips that measure one inch along the diagonal face at all corners above ground level. Do not install foundations over uncompacted fill or muck.

Provide a copper clad steel grounding electrode with at least a 5/8 inch (16 mm) diameter in each foundation. Install the electrode so that it extends into undisturbed earth from the side or bottom of the foundation for a minimum of 8 feet (2.5 m), and extends 3 inches (75 mm) above the foundation. Ensure that the location of the electrode does not interfere with the entry, dressing, or connection of cables.

Install rigid galvanized conduit in foundations.

Securely place, position, and align anchor bolts symmetrically about the center of the concrete foundation.

Give exposed vertical concrete surfaces an ordinary surface finish. Give exposed horizontal surfaces a float finish.

Level tops of concrete foundations. Do not allow tops to exceed 6 inches (150 mm) above the adjacent ground surface.

Fill spaces between the top of the foundation and the base plate with a waterproof caulking compound and finish neatly. Provide for drainage of water from inside the support.

Do not erect pedestals until concrete in the foundations has attained a minimum compressive strength of 3,000 psi (20.7 Mpa) as determined by cylinder breaks.

1743-4 METHOD OF MEASUREMENT.

Actual number of signal pedestals with foundations furnished, installed and accepted.

1743-5 BASIS OF PAYMENT.

The quantity of signal pedestals with foundations, measured as provided in Article 1743-4, will be paid for at the contract unit price per each for “Signal Pedestal with Foundation.”

Payment will be made under:

Signal Pedestal with Foundation.....Each

**SECTION 1744
STRUCTURE DESIGN OF SIGNAL SUPPORTS.**

1744-1 DESCRIPTION:

Design traffic signal supports with foundations and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

1744-2 MATERIALS:**(A) General:**

As required by the plans, design traffic signal supports with foundations consisting of metal strain poles or mast arms with metal poles and foundations.

Design metal signal poles and support systems that contain no guy assemblies, struts, rods, stay braces, clamps or U-bolts, except where noted otherwise. Provide designs of completed assemblies with hardware that equal to or exceeding AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Specifications) in effect on the date of advertisement, and that assume ice and average winds for a 25-Year Mean Recurrence Interval with a 1.3 gust factor when loaded. Provide assemblies with a round or near-round cross-sectional design consisting of no less than six sides. The sides may be straight, convex, or concave.

The lengths of the metal signal poles shown on the plans are estimated from available data for bid purposes. Determine the actual length of each pole from field measurements and adjusted cross-sections. Furnish the revised pole heights to the Engineer. Use all other dimensional requirements shown on the plans.

Submit design drawings including foundation designs, showing design details and copies of the design strength and deflection calculations for each completed assembly for review and acceptance prior to fabrication. Include as part of the design calculations, the ASTM specification numbers for the materials to be used. Provide the types and sizes of welds on the design drawings. Have design drawings and calculations signed, dated, and sealed by the responsible Professional Engineer. Have such Professional Engineer be licensed in the State of North Carolina and immediately bring to the attention of the Engineer any structural deficiency which becomes apparent in any assembly or member of any assembly as a result of the design requirements imposed by these Specifications, the plans, or the typical drawings. Said Professional Engineer is wholly responsible for the design of all poles and arms and review and acceptance of these designs by the Department does not relieve said Professional Engineer of this responsibility.

Ensure that the design permits cables to be installed inside poles and mast arms. For holes in the poles and arms used to accommodate cables, provide full-circumference grommets.

Use the following in the design of the pole/arm structures:

Assume the combined minimum weight of a messenger cable bundle (including messenger cable, signal cable and detector lead-in cables) is 1.3 lbs/ft (1.94 kg/m). Assume the combined minimum diameter of this cable bundle is 1.3 inches (33 mm).

Signal head on mast arm including backplate and Astro-Brac (or equivalent):

- 1-way, 3-section, 8 inch (200 mm)
Mass: 43 lbs (19.5 kg)
Projected area: 6.8 ft² (0.63 m²)
- 1-way, 4-section (vertical-type), 8 inch (200 mm)
Mass: 53.5 lbs (24.3 kg)
Projected area: 8.0 ft² (0.74 m²)
- 1-way, 5-section, 8 inch (200 mm)
Mass: 75 lbs (34.0 kg)
Projected area: 11.0 ft² (1.02 m²)
- 1-way, 3-section, 12 inch (300 mm)
Mass: 60.5 lbs (27.4 kg)
Projected area: 9.5 ft² (0.88 m²)
-

- 1-way, 4-section (T-type), 12 inch (300 mm)
Mass: 90 lbs (40.8 kg)
Projected area: 16.5 ft² (1.53 m²)
- 1-way, 4-section (vertical-type), 12 inch (300 mm)
Mass: 74 lbs (33.6 kg)
Projected area: 11.8 ft² (1.09 m²)
- 1-way, 5-section, 12 inch (300 mm)
Mass: 103 lbs (46.7 kg)
Projected area: 16.5 ft² (1.53 m²)

Signal heads attached to messenger cable including backplate, hanger and balance adjuster:

- 1-way, 3-section, 8 inch (200 mm)
Mass: 41 lbs (18.6 kg)
Projected area: 6.8 ft² (0.63 m²)
- 1-way, 4-section (vertical-type), 8 inch (200 mm)
Mass: 49 lbs (22.2 kg)
Projected area: 8.0 ft² (0.74 m²)
- 1-way, 5-section, 8 inch (200 mm)
Mass: 62 lbs (28.1 kg)
Projected area: 11.0 ft² (1.02 m²)
- 1-way, 3-section, 12 inch (300 mm)
Mass: 56 lbs (25.4 kg)
Projected area: 9.5 ft² (0.88 m²)
- 1-way, 4-section (T-type), 12 inch (300 mm)
Mass: 76 lbs (33.1 kg)
Projected area: 16.5 lbs (1.53 m²)
- 1-way, 4-section (vertical-type), 12 inch (300 mm)
Mass: 69 lbs (31.3 kg)
Projected area: 11.8 ft² (1.09 m²)
- 1-way, 5-section, 12 inch (300 mm)
Mass: 89 lbs (40.4 kg)
Projected area: 16.5 ft² (1.53 m²)

All signal heads attached to pole or pedestal shaft, worst case, common mounting:

Mass: 135 lbs (61.2 kg)

Projected area: 9.5 ft² (0.88 m²)

Signs with span wire hanger or Astro-Brac (or equivalent):

- 24 x 30 inch (600 x 750 mm) sign
Mass: 11 lbs (5.0 kg)
Projected area: 5 ft² (0.47 m²)
- 30 x 30 inch (750 x 750 mm) sign
Mass: 12.5 lbs (5.7 kg)
Projected area: 6.3 ft² (0.58 m²)
- 30 x 36 inch (750 x 900 mm) sign
Mass: 14 lbs (6.4 kg)
Projected area: 7.5 ft² (0.70 m²)

Compute ice loadings based on 0.6 inches (15 mm) of ice at 60 lbs/ft³ (961 kg/m³) on the surfaces of cables, signals, poles and mast arms and on one face of the sign panels.

(B) Metal Poles:

Design for either steel or aluminum poles as indicated on the plans.

Comply with the following for Aluminum Poles:

- Have poles fabricated from Aluminum Association Alloy 6061-T6, 6063-T6, or approved equivalent.
- Have shafts tapered by spinning and cold-working a seamless extruded tube of the aluminum alloy.
- Have shafts with no longitudinal or circumferential welds except at the lower end joining the shaft to the base.
- Have shafts with a satin brush finished and individually "tire wrapped."
- Have bases of the shaft fabricated in accordance with the Aluminum Association Alloy 356.0-T6, and of adequate strength, shape and size, and capable of withstanding the design load of the shaft.
- Have aluminum surfaces in contact with concrete or dissimilar metal coated with bituminous paint.

Comply with the following for Steel Poles:

- Have shafts of the tapered tubular type and fabricated of steel conforming to ASTM A-595 Grade A or an approved equivalent
- Have galvanization in accordance with ASTM A-123.
- Have shafts that are continuously welded for the entire length by the submerged arc process, and with exposed welds ground or rolled smooth and flush with the base metal. Have shafts with no circumferential welds except at the lower end joining the shaft to the base. Provide welding that conforms to Article 1072-20 except that no field welding on any part of the pole will be permitted.
- Have anchor bases for steel poles fabricated from plate steel meeting the requirements of ASTM A 36M or cast steel meeting the requirements of ASTM A 27M Grade 485-250 or an approved equivalent.

Classify each pole by type as follows:

Type 0 applies only to strain poles and indicates that the pole does not support a mast arm.

Types 1, 2 and 3 apply to both mast arm poles and strain poles with mast arm attachments. The types indicate the lengths of mast arms which the pole is to be designed to support as follows:

- **Type 1** - Up to 30 feet (9.1 m) arm;
- **Type 2** - 30⁺ to 45 feet (9.1⁺ to 13.7 m) arm; and
- **Type 3** - 45 feet⁺ (13.7 m⁺) arm.

For types 1,2, and 3 poles provide designs with provisions for pole plates and associated gussets and fittings for the attachment of required mast arms. As part of each mast arm attachment, provide a grommeted cable passage hole in the pole to allow passage of the signal cables from the pole to the arm.

For each strain pole, provide designs with provisions for a span wire clamp and associated hardware for the attachment of the support cable of the span wire suspension. Ensure that the diameter of the clamp is appropriately designed to its location on the pole.

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For each strain pole, provide designs with provisions for a 2 inch (50 mm) hole equipped with a grommet on the span wire load side of the pole to accommodate passage of the signal cables from inside the pole to the suspension.

If tapered poles are scheduled to be provide, design tapers for all shafts that begin at base and that have diameters which decrease uniformly at the rate of not more than 0.14 inch per foot (11.7 millimeters per meter) of length.

Ensure that allowable pole deflection does not exceed that allowed by AASHTO Specifications. For messenger cable poles (with primarily transverse loads), ensure that the maximum deflection at the top of the pole does not exceed 3 percent of the pole height. For mast arm poles (with primarily moment loads), ensure that the maximum angular rotation of the top of the pole does not exceed 1° 40'. For combination poles with both span wire and mast arm attachments, the worst of the two criteria shall govern in sizing the pole.

Design for a base plate on each pole. Ensure that designs have anchor bolt holes with a diameter 1/4 inch (7 mm) larger than the anchor bolt diameters in the base plate. Design for elongated anchor bolt holes in the base plates for adjustment of the pole's orientation.

Provide designs using anchor bolts with two anchor nuts and two washers for each pole. Have the anchor bolts fabricated from steel with a minimum yield strength of 55,000 psi (370 MPa) and a minimum ultimate tensile strength of 70,000 psi (483 MPa). Ensure that the anchor bolts have the required diameters, lengths, and positions, and will develop strengths comparable to their respective poles. Ensure that each anchor bolt has a 90-degree bend or a plate at the unthreaded end. If a plate is used, ensure that it is adequate to prevent pull-out of the bolts.

Provide designs with provisions for a 4 x 8 inch (100 x 200 mm) hand hole with a reinforcing frame for each pole.

Provide designs with provisions for a terminal compartment with cover and screws in each pole that encompasses the hand hole and contains a 24-terminal barrier type terminal block. Provide two terminal screws with a removable shorting bar between them for each termination. Have the terminal compartment covers attached to the pole by a sturdy chain or cable approved by the Engineer. Ensure that the chain or cable is long enough to permit the cover to hang clear of the compartment opening when the cover is removed, and is strong enough to prevent vandals from being able to disconnect the cover from the pole. Ensure that the chain or cable will not interfere with service to the cables in the pole base.

For each pole, provide designs with provisions for a 1/2 inch (12 mm) minimum thread diameter, coarse thread stud and nut for grounding which will accommodate an Number 6 AWG ground wire. Ensure that the lug is electrically bonded to the pole and is conveniently located inside the pole at the hand hole.

Ensure that designs provide a removable pole cap with stainless steel attachment screws for the top of each pole. Ensure that the cap is cast aluminum conforming to Aluminum Association Alloy 356.0F. Have the cap attached to the pole with a sturdy chain or cable. Ensure that the chain or cable is long enough to permit the cap to hang clear of the pole-top opening when the cap is removed.

When required by the plans, design for using couplings on the pole for the mounting of pedestrian pushbuttons at a height of 42 inches (1066.8 mm) above the bottom of the base. Provide mounting points consisting of 1-1/2 inch (40 mm) internally threaded half-couplings that comply with the NEC and that are mounted within the poles. Ensure that the couplings are essentially flush with the outside surfaces of the poles and are installed before any required galvanizing. Provide a threaded plug in each mounting point. Ensure that the surface of the plug is essentially flush with the outer end of the mounting point when installed and has a recessed hole to accommodate a standard wrench.

(C) Mast Arms:

For mast arm designs, provide designs with deflection limited to 8 inches (200 mm) and a fatigue category 1. Provide designs that take into consideration truck gusts and galloping.

The use of vibration mitigating devices will not be considered as a substitute for strength required by the galloping load performance check.

Design all arm plates and necessary attachment hardware, including bolts and brackets.

Design for 50 percent spare bolts for each arm.

Design for grommeted holes on the arms to accommodate the cables for the signals.

Design for arms with weatherproof connections for attaching to the shaft of the pole.

Design for hardware that is galvanized steel or stainless steel.

Design for a removable pole cap with stainless steel attachment screws for the end of each mast arm. Ensure that the cap is cast aluminum conforming to Aluminum Association Alloy 356.0F. Have the cap attached to the pole with a sturdy chain or cable. Ensure that the chain or cable is long enough to permit the cap to hang clear of the pole-top opening when the cap is removed.

Comply with the following for Aluminum Arms:

- Conform to Aluminum Association Alloy 6061-T6, 6063-T6 or approved equivalent.
- For the arms, conform to the welding requirements of the aluminum poles.
- Have a satin brush finished and be furnished individually wrapped.

Comply with the following for Steel Arms:

- Have standard weight black steel pipe conforming to ASTM A 53-90a, Type E or Type S, Grade B or an approved equivalent.
- For the arms, conform to the welding requirements of the steel poles.

After all fabricating, cutting, punching, and welding is completed, be hot-dipped galvanized inside and outside.

1744-3 CONSTRUCTION METHODS:

Furnish design drawings for approval. Provide triplicate copies of design drawings for each traffic signal support structure. Provide all engineering calculations and computations used in preparing the design drawings.

Do not fabricate the assemblies until receipt of the Engineer's approval of the design drawings.

1744-4 METHOD OF MEASUREMENT:

Actual number of designs for metal strain poles furnished and accepted.

Actual number of designs for mast arms with metal poles furnished and accepted.

No measurement will be made of foundation designs prepared as these will be considered incidental to designing signal support structures.

1744-5 BASIS OF PAYMENT:

The quantity of metal strain pole designs, measured as provided in Article 1744-4, will be paid for at the contract unit price each for "Metal Strain Pole Design."

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The quantity of mast arm with metal pole designs, measured as provided in Article 1744-4, will be paid for at the contract unit price each for “Mast Arm with Metal Pole Design.”

Payment will be made under

Metal Strain Pole Design	Each
Mast Arm with Metal Pole Design	Each

**SECTION 1745
SIGNS INSTALLED FOR SIGNALS**

1745-1 DESCRIPTION.

Furnish and install signs for signals and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish signs with cable hangers, rigid sign mounting brackets, U-channel post, and all necessary hardware.

1745-2 MATERIALS.

Comply with the following:

Sign Fabrication	Article 901-2
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Use Type III reflective sheeting, except for black sheeting. Use non-reflective for black sheeting.

Conform to the message layout, size, and color as required in the MUTCD.

For messenger cable mounting, furnish either messenger cable hangers with free-swinging, 360 degree adjustable sign brackets or three bolt clamps as directed. Furnish aluminum, galvanized steel, or stainless steel messenger cable mounted sign supporting hardware.

For ground mounting, furnish steel, 3 lb. (4.5 kg), U-channel posts with hardware for ground mounting. Comply with the following:

Sign Supports	Article 903-2
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For mast-arm mounting, furnish rigid aluminum, galvanized steel or stainless steel sign mounting brackets.

1745-3 CONSTRUCTION METHODS.

Install signs with applicable mounting hardware. Comply with sign offsets and mounting heights as shown in the MUTCD and Standard Drawing numbered 904.50.

For messenger cable mounting, install signs a minimum of 6 inches (150 mm) from signal heads.

For ground mounting, comply with the following:

Ground Mounted Sign Supports.....	Article 903-3
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For signs mounted on mast arms, install attachment brackets to signs to allow the positions to be adjusted so that signs:

- are aimed in the required direction,
- are plumb as viewed from their respective approaches,
- may be tilted forward or backward as required,
- and may be raised or lowered on the mast arm throughout the full length of the sign.

1745-4 METHOD OF MEASUREMENT.

Actual number of signs for signals, without regard to the different mounting methods, furnished, installed, and accepted.

1745-5 BASIS OF PAYMENT.

The quantity of reflective sheeting signs, measured as provided in Article 1745-4, will be paid for at the contract unit price each for "Sign for Signal."

Payment will be made under:

Sign for SignalsEach

**SECTION 1750
SIGNAL CABINET FOUNDATIONS**

1750-1 DESCRIPTION.

Furnish and install signal cabinet foundations and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish either poured concrete foundations or preformed cabinet pad foundations and all necessary hardware. Selection of the type of foundation will be the contractor's option.

1750-2 MATERIALS.

Preformed cabinet pad foundation material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of advertisement.

Provide pads with a minimum pad area that extends 24 inches (600 mm) from the front and back of the cabinet, and 3 inches (75 mm) from the sides of the cabinet .

Furnish poured cabinet foundations with chamfered top edges. Provide Class B concrete or better.

Refer to Division 10:

Portland Cement Concrete Article 1000-4

Where field conditions permit, preformed cabinet pad foundations may be furnished. Ensure that preformed cabinet pad foundations provide chamfered top edges and a 7 (l) x 18 (w) inch (165 (l) x 420 (w) mm) minimum opening for the entrance of conduits. Ensure that no more than four 3/4 inch (19 mm) holes are cast or drilled in each pad for the purposes of handling or placing. Provide preformed cabinet pad foundations constructed of Class A concrete or better.

1750-3 CONSTRUCTION METHODS.

Comply with the following:

Incidental Concrete Construction..... Section 825

Obtain approval for final cabinet foundation locations before pouring the concrete base. Do not install foundations over uncompacted fill or muck.

Use procedures, equipment, and hardware as follows:

- Hand tamp the soil on which the concrete is to be placed before placing the concrete.
- Maintain a minimum distance of 12 inches (305 mm) from the service pole to the closest point on the cabinet foundation unless approved.
- Use a minimum of four 1/2 inch (12.5 mm) diameter expanding type anchor bolts to secure the cabinet.
- Install foundations a minimum of 4 inches (100 mm) above the finished grade and 4 inches (100 mm) below the finished grade.

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- Install conduits no more than 4 inches (100 mm) above the foundation. Locate external stubbed out conduit at the cabinet foundation so that the conduit is in the middle of the cabinet. Provide a service conduit as the rightmost conduit coming into the cabinet. Provide two spare conduits stubbed out; one pointed toward the service pole and the other toward the direction of the lead-in cable. Inscribe an identification arrow in the cabinet foundation indicating the direction of spare conduits.
- Give the cabinet foundation a broom finish.
- Seal the space between the base of the cabinet and the foundation with a permanent, flexible, waterproof sealing material.

1750-4 METHOD OF MEASUREMENT.

Actual number of signal cabinet foundations furnished, installed, and accepted.

1750-5 BASIS OF PAYMENT.

The quantity of signal cabinet foundations, measured as provided in Article 1750-4, will be paid for at the contract unit price each for "Signal Cabinet Foundation."

Payment will be made under:

Signal Cabinet Foundation Each

**SECTION 1751
CONTROLLERS WITH CABINETS**

1751-1 DESCRIPTION.

Furnish and install controllers with cabinets and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

As specified on the plans, furnish either Type 170E, Type 2070L, or NEMA TS-2, Type 2 controllers with cabinets. Furnish all pole or foundation mounting hardware, detector sensor cards, external electrical service disconnects, one Corbin Number 2 cabinet key, one police panel key, conflict monitors or malfunction management units, surge protection, grounding systems, AC/DC isolator cards, and all necessary hardware. Permanently inscribe cabinet identification information on the interior of the door.

1751-2 MATERIALS.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of advertisement.

Refer to Division 10:

Type 170E Controllers	Article 1098-18
Type 170E Cabinets	Article 1098-19
Type 2070L Controllers	Article 1098-20
NEMA TS-2, Type 2 Controllers.....	Article 1098-21
NEMA TS-2, Type 1 Cabinets.....	Article 1098-22

1751-3 CONSTRUCTION METHODS.

(A) General.

Remove existing controllers and cabinets where required. Remove the maintenance diary from the cabinet and place it in the new cabinet or present it to the Engineer. Take existing equipment out of service only at the time directed.

Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.

Install controllers, cabinets, detector sensor units, and hardware that provide the required phasing, color sequence, flash sequence, interconnection, railroad clearance and preemption, and emergency vehicle clearance and preemption.

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Stencil the signal inventory number on the side of the cabinet that faces the roadway. Use 3 inch (75 mm) black characters.

Provide an external electrical service disconnect at all new and existing cabinet locations unless otherwise shown on the plans.

Do not program controllers for late night flashing operation at railroad preemption installations. For all other installations, program the controller for late night flashing operation from 11:00 p.m. until 6:00 a.m. unless otherwise directed. Have all signal heads for the same approach flash concurrently during flashing operation.

Provide the serial number and cabinet model number for each new controller and controller cabinet installed.

Modify cabinet foundations where required.

Where pole mounted cabinets are required, install cabinets so that the height to the middle of the cabinet is 4 feet (1.2 meters).

Activate controllers with the proposed phasing and timing, and modify proposed phasing and timing of existing controllers.

Ensure that maximum resistance between the grounding electrode and all points in the grounding system does not exceed 5 ohms.

In addition to the requirements of the NEC, test grounding electrode resistance at the connection point to the electrical service ground bus for a maximum of 20 ohms. Furnish and install additional ground rods to the grounding electrode system as necessary to meet test requirements.

(B) System Interconnection:

When interconnection of signals is required, install interface equipment and hardware for signals. Demonstrate proper operation of the interconnection using manual commands after interconnection is complete.

(C) Workshop:

Provide an enclosed workshop with a test board for testing new controllers and cabinets before installation. Locate the workshop within the Division responsible for administration of the project. Ensure that the workshop provides protection from weather and sufficient space to house two test observers, test material, and controllers and cabinets being tested.

Test controllers and cabinets for proper operation, color sequence, flashing operations (including late night flash) and phase timings. Demonstrate that conflict monitor programming cards or malfunction management programming cards are properly programmed before installation at intersections. Demonstrate that simultaneous inputs to conflicting phases will cause the conflict monitor or malfunction management unit to revert the cabinet to flashing operation. Ensure that controllers and cabinets operate without malfunction for at least eight hours in the workshop before installation at an intersection.

1751-4 METHOD OF MEASUREMENT.

Actual number of each type of controllers with cabinets furnished, installed, and accepted.

Actual number of each type of detector card channels furnished, installed, and accepted.

No measurement will be made of conflict monitors, malfunction management units, external electrical service disconnect, required system interconnection, surge protection, grounding systems, and workshop for testing controllers and cabinets as this will be considered incidental to furnishing and installing controllers with cabinets.

1751-5 BASIS OF PAYMENT.

The quantity of controllers with cabinets, measured as provided in Article 1751-4, will be paid for at the contract unit price each for “Controller with Cabinet (_____).”

The quantity of detector card channels, measured as provided in Article 1751-4, will be paid for at the contract unit price each for “Detector Channel (_____).”

Payment will be made under:

Controller with Cabinet (_____)	Each
Detector Channel (_____)	Each

**SECTION 1752
CLOSED LOOP SYSTEM MASTER CONTROLLERS**

1752-1 DESCRIPTION.

Furnish and install closed loop master controllers and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Furnish closed loop master controllers with system software, auxiliary equipment, communications equipment, software, and cabinet accessory equipment for use in closed loop systems comprised of interconnected actuated signal controllers. Furnish on-street master controllers with all necessary modems, serial ports, and telemetry necessary to enable all required communications.

1752-2 MATERIAL.

Material, equipment, and hardware furnished under this section must be pre-approved on the Department’s QPL by the date of advertisement.

Refer to Division 10:

Closed Loop System	Article 1098-23
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Ensure that software is licensed for use by the Department and by any other agency responsible for maintaining or operating the signal system equipment. Provide the Department with a license to duplicate and distribute the software as necessary for design and maintenance support.

1752-3 CONSTRUCTION METHODS.

Install on-street master controllers with software and modems in local intersection controller cabinets. Comply with Article 1751-3.

Program telemetry command sequences and enable devices necessary for testing of communication between local controllers and field master controllers, and between field master controllers and the central computer.

1752-4 METHOD OF MEASUREMENT.

Actual number of master controllers of each type furnished, installed, and accepted.

No measurement will be made of dial-up telephone modems, telemetry panels and equipment, auxiliary equipment, software, and cables as these will be considered incidental to furnishing and installing closed loop master controllers.

1752-5 BASIS OF PAYMENT.

The quantity of master controllers with software, measured as provided in Article 1752-4, will be paid for at the contract unit price per each as “Master Controller (_____).”

Payment will be made under:

Master Controller (_____)	Each
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