

## Part VI - Traffic Engineering Electrical & Pavement Markings

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## **ARTICLE 601 - GENERAL REQUIREMENTS**

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### **601.1 Description.**

Traffic signal and street lighting construction shall consist of excavating the required trenches and tunnels; furnishing and laying therein the required conduit; placing cable-in-duct and/or signal cable; installing the required structures and appurtenances; backfilling the trenches; restoring the site of the work; and completing the work to the required lines and grades. All work shall be performed as shown on the plans and in accordance with the contract.

The existing signal and lighting poles, conduits, handholes, and manholes not scheduled for removal or abandonment shall be protected during construction. If the contractor believes that damage to such facilities is unavoidable, the contractor shall not damage or remove any facilities until the City Traffic Engineering electrical inspector has reviewed and approved such actions. Any damage or removal of City electrical conduit, wire, fiber, or structures, without the specific approval by the City Traffic Engineering electrical inspector shall be promptly repaired or replaced by and at the expense of the contractor. The City may elect to do repair work with City crews. The cost for any repair work done by the City will be billed to the contractor.

Any damage or removal of City street lighting, traffic signal, or communication facilities shall be repaired or replaced within 24 hours, but any resulting street light outage resulting from such damage or removal shall be confined to as few numbers of street lights as possible. The streetlight circuits shall remain operational each and every night. The City reserves the right to make temporary or permanent repairs at any time after the damage or removal, even within 24 hours of the damage or removal, with the full cost of such work, including engineering time, billed to the general contractor.

Unless a manhole (utility access structure), handhole, or structure is specifically designated for removal, it shall be saved. The contractor shall consult with the Traffic Engineering Electrical Inspector before removing or damaging any existing facilities.

### **601.2 Equipment.**

Equipment and tools necessary for performing all parts of the work shall be satisfactory in design, capacity, and mechanical condition for the purposes intended, and any equipment which is not maintained in full working order, or which as used by the Contractor is inadequate to obtain the results prescribed, shall be repaired, improved or supplemented to obtain the progress and quality of work contemplated by the contract.

### **601.3 Finishing Work and Maintenance.**

The Contractor shall maintain all trenches and other excavations, keeping them well filled and in a safe condition for travel, and shall deliver to the City, at the time of acceptance, a finished job with all trenches in a condition satisfactory to the Engineer.

All concrete, asphalt, and gravel pavements; stone flagging or paving; sidewalks; curbs and gutters; culverts; fences; or other structures which may have been damaged or displaced by the Contractor shall be relaid properly to the original line and grade. In areas with established and tended sod, the Contractor shall resod areas disturbed by the construction; all other areas disturbed by the construction shall be seeded. All of the above work shall be in accordance with these Specifications, or in absence of applicable specifications, to restore the original condition of the structure or area.

The Contractor shall restore and maintain all asphalt and gravel surfaces in first class condition until final acceptance of the project by the Common Council. All structures and conduit shall be cleaned of any accumulations of silt, debris or other foreign matter. Conduit shall be cleaned by use of the proper size mandrel. The area along the entire installation shall be left clean and graded in a condition satisfactory to the City of Madison Traffic Engineering Inspector. Responsibility of new installations and locating services will be transferred from the contractor once written acceptance is received from the City Traffic Engineering Inspector.

Unless otherwise provided, all costs of the work included in this Section shall be at the expense of the Contractor, and shall be included in the unit price bid for the contract items with which such work is associated. Final payment will be withheld until such work is done in a manner satisfactory to the Engineer.

#### **601.4 Repairs and Replacement.**

Contractor is responsible for repairs to damaged new and existing Traffic Engineering infrastructure, unless determined otherwise by City Inspector. When compliance with these Specifications requires repairs, such repairs shall be made by replacement of the defective section with new materials of equal quality installed in accordance with the construction specifications governing the original installation. These repairs shall include total and complete restoration of any disturbed surface to its original, or better than original, condition. Unless otherwise provided, all costs of the work included in this Section shall be at the expense of the Contractor.

#### **601.5 Codes, Permits and Inspections.**

The electrical work shall be done in strict accordance with the Wisconsin State Electrical Code and the Electrical Code of the City of Madison and shall be subject to inspection by the City Building Inspection and Rehabilitation Unit.

The Contractor shall obtain and pay for all necessary permits and certificates of inspection.

The City Traffic Engineering Inspector shall be notified at least twenty-four (24) hours in advance of beginning any underground electrical construction work, such as installing cable-in-duct, PVC conduit and concrete bases, and shall be updated frequently as to stopping and restarting underground work. All underground conduit, cable, or concrete base forms shall be inspected by the City Traffic Engineering Inspector before any trench is backfilled or concrete is poured. Any work completed without such inspection is subject to rejection as unacceptable work and shall be immediately removed and acceptably replaced or otherwise satisfactorily corrected by and at the expense of the Contractor.

#### **601.6 Testing.**

The Contractor shall furnish all equipment and appliances necessary to test all installed cable systems. The Contractor shall test and demonstrate to the satisfaction of the Traffic Engineer that the lighting circuits are properly connected and operational; continuous and free from short circuits and unspecified grounds; that they are connected in accordance with the wiring layout; and that with fuses removed the resistance to ground of nongrounded circuits between any two adjacent terminals is not less than five (5) megohms.

All cable shall be “Meggered” and the results recorded. All values shall be in accordance with standard practice for the lengths and type of cable used. All electrical circuits and equipment shall be tested and remain in operating condition.

**601.7 Disposal of Excess Excavation.**

The Contractor shall be responsible for the disposal of any excess excavation. In the event the Contractor encounters stones, boulders, debris, or other material which would not normally be expected when excavating for lighting units or trenching for cable placement, the Contractor shall remove and dispose of such material as may be necessary.

**601.8 Tree Trimming.**

All tree trimming and incidental related work shall be performed by the Contractor under the supervision of the City Parks Division. The Contractor shall schedule the work to provide reasonable notification to the Parks Division (Forestry) of the tree trimming necessary and to further provide continuity of such work.

**601.9 Electrical Equipment.**

All electrical equipment shall provide suitable interchangeability and durability of performance and shall require the approval of the Traffic Engineer.

**601.10 Materials Furnished by the City.**

All materials which are to be furnished by the City shall be picked up by the Contractor at the Traffic Engineering Shop, 1120 Sayle Street, unless otherwise specified. All costs of the work included in this Section shall be at the expense of the Contractor unless otherwise provided. The Contractor shall provide equipment and labor to load materials onto Contractor’s vehicle or trailer. Complete quantities of an item shall be picked up on one appointment unless the City agrees to a partial quantity disbursement.

## ARTICLE 602 - UNDERGROUND DISTRIBUTION SYSTEMS

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### 602.1 General.

This item consists of installing underground signal cable and/or furnishing and installing an underground street lighting distribution system in accordance with these Specifications, the Special Provisions, and the details shown on the plans. Underground cable shall be pulled into existing and Contractor-installed conduit or installed as a cable-in-duct system as shown on the plans.

### 602.2 Materials.

#### 602.2(a) Cable-in-Duct.

1. Underground Cable Conductors. Unless otherwise specified, the underground cable system shall consist of three #4 AWG, cross-linked polyethylene insulated copper conductors, Type USE, RHH, RHW, 600 volt, paralleled with a single #8 AWG ground wire, assembled in a coilable polyethylene duct (cable-in-duct) and shall comply with the requirements of IPCEA-NEMA Standard S-66-524, and insulation thickness shall be nominal 0.060 of an inch.

Identification of the insulated conductors shall be accomplished by covering the insulation surface with a tough, strongly adherent colored coating in accordance with Method I or by surface printing in accordance with Method III of IPCEA-NEMA Standards S-19-81. White color coatings shall not be furnished or used on phase conductors.

Conductors shall be annealed copper unless otherwise specified. Conductor sizes 14-10 AWG may be solid or Class B stranding. Sizes 8 AWG and larger shall be Class B stranding. Conductors shall comply with the requirements of IPCEA-NEMA Standard S-19-81, Part 2.

The average insulation wall thickness shall be applied to the conductor with good concentricity. The minimum thickness of insulation at any point shall be not less than 90 percent of the specified average thickness.

2. Polyethylene Duct. The conductors shall be enclosed in a coilable polyethylene duct, suitable for direct earth burial, which shall meet the applicable requirements as defined in the Specifications for Polyethylene Molding and Extrusion Materials, ASTM D 1248, Type III, Class C.

The duct shall have a nominal size of 1-1/4 inches, approximate I.D. of 1.42 inches and a minimum wall thickness of 0.106 of an inch.

In addition, the duct shall meet the following requirements:

Property	Requirement	Test Method
Tensile Strength	2,800 PSI (min.)	ASTM D 638
Elongation	400% (min.)	ASTM D 638
Melt Index	0.50 (max.)	ASTM D 1238
Brittle Temperature - 80% Nonfailure	-60°C	ASTM D 746
Impact Resistance	.9 ft. #/in. of notch	ASTM D 256 Method

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3. In lieu of the routine electrical tests described below, the Contractor shall furnish a manufacturer's certificate of compliance in triplicate for the insulated conductors and polyethylene duct, indicating their conformance with these Specifications.
4. The Contractor shall furnish manufacturer's certified test reports, in triplicate, to the Traffic Engineer indicating the conformance with these Specifications.

All tests included in these Specifications shall be performed in accordance with the test procedure and frequency described in IPCEA-NEMA Standard S-19-81, Part 6.

- a. High Voltage Test: Before installation in the polyethylene duct, each reel of the completed cable shall be immersed in water for a period of not less than six hours, and while immersed shall successfully withstand the application, for a period of five minutes, of a 60 cycle test voltage of the value specified in the standard.
- b. Insulation Resistance Test: Upon completion of the above specified high voltage test, the insulation resistance of each reel of completed cable shall be measured. The insulation resistance at, or corrected to, a temperature of 60°F shall be not less than that calculated from the expression:

$$R = 50,000 \log D/d$$

Where R = Insulation resistance, megohms - 1000 feet

D = Diameter over insulation - inches  
d = Diameter under insulation - inches

602.2(b) Electrical Conduit.

1. Rigid Steel Conduit (commonly called GS conduit)

Rigid steel conduit (zinc coated) shall conform to the requirements of the American Standards Association Specifications for Rigid Steel Conduit, Zinc Coated, ANSI Designation: C 80.1, except with regard to identification and inspection. In addition to the manufacturer's name or trademark, as required by ANSI Designation: C 80.1, each length of conduit and nipple elbow shall have the Underwriters Laboratories, Inc. label, or an acceptable equivalent, firmly affixed.

2. Polyethylene Conduit

The conduit shall be either a medium density or high density grade polyethylene conduit suitable for direct earth burial. Medium density polyethylene shall meet the applicable requirements for Polyethylene Molding and Extrusion Materials, ASTM D-1248, Type II, Class C. High density polyethylene shall meet the applicable requirements for Polyethylene Molding and Extrusion Materials, ASTM D 1248, Type III, Class C.

The above materials shall also pass:

ASTM D 638: Tests for Tensile Strength and Elongation.  
ASTM D 746: Brittle Temperature, 80% Non-failure.

ASTM D 1238: Test for Flow Rate.

The conduit shall correspond to the following dimensions:

Nominal Size	O.D.	I.D.	Min. Wall Thickness
1 in.	1.30 in.	1.05 in.	--
1-1/4	1.65	1.38	0.10 in.
1-1/2	1.90	1.61	--
2	2.37	2.06	0.15

The conduit shall be packaged on reels in accordance with industry standards.

3. Polyvinyl Chloride (PVC) Conduit (Schedule 40 and Schedule 80).

PVC conduit shall be used in accordance with the National Electrical Code and shall comply with all requirements in NEMA Specifications TC-2 (Conduit) and TC-3 (Fittings-UL-514), Federal Specification W-C-1094A, UL-651 (Standard for rigid nonmetallic conduit), and ANSI C33.91.

The conduit and fittings shall be clearly marked with a UL label. The type and manufacturer shall be identified by legible and permanent markings.

The conduit and fittings shall be produced by the same manufacturer and be homogeneous, virgin PVC C-300 compound free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks, or other imperfections which could mar conductors or cables.

All conduit and fittings shall be solvent welded in accordance with instructions from the manufacturer, and as directed by the Traffic Engineer. Solvent for welding PVC shall be clear, medium viscosity, with a fast set time, ASTM D 2564 or approved equal.

4. Conduit proposed for use shall be approved in writing by the Traffic Engineer prior to beginning work on the project.

The Contractor shall furnish manufacturer's certified test reports, in triplicate, to the Traffic Engineer indicating that the conduit proposed for use conforms to the above specifications.

602.2(c) Electrical Conductors.

Electrical conductors to be furnished shall be (size) AWG insulated conductors, Type USE, RHH, RHW as more fully described in Subsection 602.2(a)(1), or other typical electrical wire as specified.

**602.3 Construction Methods.**

602.3(a) Cable-in-Duct.

Cable-in-duct shall be installed in a trench and within the protection of Schedule 80 PVC conduit under all pavements and specified driveways, and in structures and in accordance with Subsection 602.3(c).



Cable-in-duct shall be installed within one (1) foot of the back of curb or as near as is practical to the back of curb as allowed by the engineer. It will, however, be the responsibility of the Contractor to locate all underground cable-in-duct in a manner to preclude damage to the cable or duct resulting from the subsequent construction. The wire part of the cable-in-duct assembly shall project at least two (2) feet above the top of each light base and the duct part shall extend 2" above the top of the raceway and be capped until the electrical connections are made within the light pole.

Under no circumstances shall cable ends be left uncovered or allowed to become submerged in water. Observations of either condition shall constitute sufficient grounds for rejection of the entire length of that cable.

The polyethylene duct which encases the wires shall be continuous to within six (6) inches of a terminal connection. Cable shall be installed in continuous lengths without splices from terminal to terminal. Splicing of cables will be permitted only in electrical handholes and electrical utility access structures, handholes in poles, and breakaway bases; or as otherwise provided in the plans.

The Contractor shall exercise care when installing the cable-in-duct to insure that the completed duct raceway is smooth and free of sharp bends and that the wires/cables inside the installed duct are "free" and capable of being easily removed and replaced.

Unless otherwise specified, all backfill shall be in accordance with the requirements of Section 502.1 of these Specifications. Native material will not be allowed for backfill if it is thirty (30) percent or more stones by volume. No rocks larger than four (4) inch diameter, stone aggregate, or any foreign debris shall be backfilled, unless otherwise approved by the engineer. When sand backfill is required, a six (6) inch minimum sand padding shall be used below the conduit and a six (6) inch minimum sand lift shall be used above the conduit.

#### 602.3(b) Electrical Conduit.

Electrical conduit, of size and type noted on the plans and/or in the Special Provisions, shall be installed in accordance with Subsection 602.3(c) at the locations specified, unless otherwise directed by the Traffic Engineer. In general, Schedule 80 PVC conduit shall be installed under commercial driveways and street pavements to provide protection for underground cable.

Each conduit run between access points to the wiring (e.g., handholes, electrical utility access structures, poles) shall be one size for its entire length. Electrical conduit shall be installed within one (1) foot of the back of curb or as near as practical to the back of curb, as allowed by the Engineer, when it is being placed parallel to the curb. It will, however, be the responsibility of the Contractor to locate all underground conduit in a manner to preclude damage to the duct resulting from subsequent construction. Where curb and gutter is being replaced, the new conduit to be installed parallel to the curb and gutter shall be placed according to the Typical Conduit Installation detail. When existing utilities preclude placing conduit as shown in the detail, the conduit shall be placed under the curb or as close to the curb as possible. When curb and gutter is not being replaced, the new conduit to be installed parallel to the curb and gutter shall be placed in the roadway, three feet from the edge of gutter, and as approved by the City Traffic Engineering Electrical Inspector.

For each conduit run in which cable will not be installed as part of the contract, the ends of the conduit shall be capped with standard conduit caps to preclude water and soil infiltration. If threaded caps are used, the threads shall be lubricated. Conduits terminating in a nonpaved location and not in

a structure shall be turned up and end at terrace finish grade with a PVC cap securely attached, as shown on Standard Detail 6.13).

For each run of conduit, no more than 315° in bends unless approved by City Traffic Inspector. Label direction of conduits at each handhole, pole base and controller base. All splices between reels of polyethylene conduit and connections to steel or PVC conduit shall be made with approved watertight coupling assemblies. Standard conduit fittings shall be used and all costs for couplings and joints shall be included in the unit price bid for the conduit.

When connections are to be made to an existing conduit, the Contractor shall first verify that the existing conduit is fully clear and useable for its entire cross-section and length. When the existing conduit is found to be defective, the Contractor shall notify the Inspector and not proceed until the Inspector so directs. If the Contractor connects to an existing defective conduit without the express direction from the Inspector, the Contractor shall make any and all necessary repairs and replacements to all conduits, including conduit that was “existing” prior to the Contractor starting work, in accordance with Section 601.4. All costs of this work shall be at the expense of the Contractor.

Unless otherwise specified, all backfill shall be in accordance with the requirements of Section 502.1 of these Specifications. Native material will not be allowed for backfill if it is thirty (30) percent or more stones by volume. No rocks larger than four (4) inch diameter, stone aggregate, or any foreign debris shall be backfilled, unless otherwise approved by the engineer. When sand backfill is required, a six (6) inch minimum sand padding shall be used below the conduit and a six (6) inch minimum sand lift shall be used above the conduit.

With prior approval from the Traffic Engineer, the Contractor may substitute a larger size of conduit than that specified for a run; however, any resulting additional costs shall be borne by the Contractor and no adjustment in compensation will be made.

Conduit to be placed under existing pavements, sidewalks and driveways shall be installed by pushing, gophering, or boring.

Entering existing manholes shall be made by watertight methods.

The location of each conduit under pavement shall be marked on the pavement or curb as shown on Standard Detail 6.11 or as directed by the Traffic Engineer.

Upon completion of the work under the contract, including roadway finishing operations, the Contractor shall, in the presence of the Traffic Engineer or Inspector, make an inspection of each installed conduit. A mandrel at least six (6) inches in length and of the proper size shall be used during the inspection to insure that the conduit is fully open for its entire length. The Contractor shall furnish all required tools, equipment and labor necessary to make the inspections. Any conduit found crushed or damaged, or determined by the Traffic Engineer to be unsatisfactory, shall be replaced by the Contractor at the Contractor’s expense before the work will be accepted.

### 602.3(c) Minimum Cover Requirement.

Conduit, duct, or other raceways shall be installed in accordance with the minimum cover requirements specified in the following table. Exceptions shall require the approval of the Traffic Engineer.

With prior approval, the required minimum cover may be reduced by six (6) inches for installations where a two (2) inch thick concrete pad, or equivalent in physical protection, is placed in the trench over the underground installation.

For the purposes of this subsection, “cover” is defined as the distance between the FINISHED grade and the TOP of the conduit, duct, or other raceway.

<b>MINIMUM COVER REQUIREMENTS (0 TO 600 VOLTS)</b>		
<b>WIRING METHOD</b>	<b>MINIMUM COVER (INCHES)</b>	
	<b>IN TERRACE OR UNDER SIDEWALK</b>	<b>ROADWAY</b>
Rigid Non-Metallic Conduit Approved for Direct-Burial without Concrete Encasement	30	24
Other Approved Raceways*	30	Not applicable
Within five feet of any handhole	40	Not applicable

\*Note: Encased Raceways shall require a concrete envelope not less than two (2) inches thick.

**602.3(d) Electrical Conductors.**

The proper type, size and number of electrical conductors as shown on the plans shall be installed. Installation methods shall conform to that described in Subsection 602.3(a) and other appropriate Subsections of these Specifications.

**602.3(e) Pull Wire.**

Unless specified or directed by the Traffic Engineer, a pull wire shall be installed in each conduit run as part of the contract, including conduit connecting to existing conduit. The pull wire shall be a No. 10 AWG, or larger size, copper (insulated) TW wire approximately four (4) feet longer than the conduit run, and shall be **stripped and spliced wire to wire in each access point.**

The cost of pull wire shall be incidental to the cost of conduit unless specified otherwise on the plans and in the contract.

**602.3(f) Signal Cable.**

Signal cable will be furnished by the City. Following receipt of the cable by the Contractor at the Traffic Engineering Shop, 1120 Sayle Street, the Contractor shall be responsible for storage and handling and placing such cables as are specified on the plans. Signal cable not used in the project shall be returned by the Contractor to the Traffic Engineering Shop with no additional compensation for this work.

The Contractor shall install signal cable using acceptable trade methods and practices. When pulling cable into or out of electrical utility access structures and handholes, the Contractor shall use pulleys. The Contractor shall at all times exercise caution to protect the cable and its insulation from being damaged by sharp edges. Cable shall project at least two (2) feet above bases, except at the signal controller, where it shall project at least three (3) feet above the base. Under no circumstances shall cable ends be left uncovered or allowed to become submerged in water.

Cable shall be installed in continuous lengths without splices from terminal to terminal. Splicing of cables will be permitted only in electrical handholes and electrical utility access structures, handholes in poles, pole bases, or as otherwise provided in the plans.

#### **602.4 Measurement and Payment.**

##### **602.4(a) Cable-in-Duct.**

This item, complete in place and accepted, shall be measured in linear feet in a horizontal plane, from terminal connection to terminal connection along the center line of the trench or conduit with the terminal connection being the center line of the lighting unit base, electrical utility access structure, handhole, junction box or other terminal location as required by the plans and or specifications.

Additional lengths of cable necessary for making splices and connections at lighting units, junction boxes, distribution centers and other terminal locations shall be installed by the Contractor and considered as part of the work included in this item, but will not be measured or paid for directly.

The quantity, measured as provided above, will be paid for at the contract unit price per linear foot for cable-in-duct, which price shall be payment in full for furnishing all materials, unless otherwise indicated by the plans and Special Provisions; for trench work such as excavation, bedding and backfilling, including any sand, asphalt, concrete or other required materials, unless trench and backfill are specifically noted as separate bid items; for placing cable-in-duct; for making connections and testing installed cable systems; for disposal of surplus materials; for restoration of disturbed or damaged areas including seeding and sodding, unless general terrace restoration is required and is a separate bid item; for making inspections; and for all labor, tools, equipment and incidentals necessary to complete this item of work in accordance with the contract.

##### **602.4(b) Electrical Conduit.**

This item, complete in place and accepted, shall be measured in linear feet in a horizontal plane from terminal connection to terminal connection along the centerline of the trench or conduit, with the terminal connection being the centerline of the street light or traffic signal base, electrical utility access structure, handhole, junction box or other terminal location as required by the plans and specifications. The quantity measured for payment shall be the summation of linear feet of each size and type.

Additional lengths of conduit necessary for terminating conduit at or above grade shall be installed by the Contractor and considered as part of the work included in this item, but will not be measured or paid for directly.

The quantity, measured as provided above, will be paid for at the contract unit price per linear foot of each of the specified sizes and types, which price shall be payment in full for furnishing, hauling and placing the conduit, hangers, clips, fittings, and attachments; for trench work, such as excavation, bedding and backfilling, including any sand, asphalt, concrete or other required materials, unless trench and backfill are specifically noted as separate bid items; for furnishing and installing pull wire as required by Subsection 602.3(e); for drilling holes in manholes and resealing such openings after the conduit is installed; for disposal of surplus materials; for restoration of disturbed or damaged areas including seeding and sodding, unless general terrace restoration is required and is a separate bid item; for making inspections; and for all labor, tools, equipment and incidentals necessary to complete this item of work in accordance with the contract.

The quantity of conduit installed by pushing, gophering, or boring, measured as provided above, will be paid for at the contract unit price per linear foot of each of the specified sizes, which price shall be payment in full for furnishing, hauling and placing the conduit and fittings; for securing all necessary permits; for all necessary excavation, bedding and backfilling, including any sand, concrete or other required materials; for restoration of disturbed or damaged area including seeding and sodding, unless general terrace restoration is required and is a separate bid item; for disposal of surplus materials; for making inspections; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work. Item 60241, Gopher Raceway, shall include any and all work associated with determining locations of existing utilities, such as underground locates. Item 60241 shall include raceways created by pushing, gophering or boring. The measured quantity will only include distances installed directly underneath curb and gutter, roadway, and sidewalk sections that are not removed or constructed with this project. Minor alterations in conduit location may be made by the City Traffic Engineering Electrical Inspector to avoid gopher installation.

**602.4(c) Electrical Conductors and Signal Cable.**

This item, complete in place and accepted, shall be measured in linear feet in a horizontal plane, from terminal connection to terminal connection along the center line of the trench or conduit with the terminal connection being the center line of the signal or light base, electrical utility access structure, handhole, junction box or other terminal location as required by the plans and/or specifications.

Additional lengths of cable or conductors necessary for making splices and connections at signal bases and other terminal locations shall be installed by the Contractor and considered as part of the work included in this item, but will not be measured or paid for directly.

The quantity of cable installed, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be payment in full for storing, handling, transporting, and installing; for furnishing all labor, tools, equipment and incidentals necessary to complete this item of work.

**602.5 Electrical Trench.**

**602.5(a) Construction Methods.**

This item consists of excavating, bedding, and backfilling a trench in roadways and terraces for electrical conduit installation. The width of the trench shall be sufficient to accommodate the conduit installations shown on the plan without stacking the conduits. The trench shall be excavated true to line and to provide a 30 inch depth for conduit, except as otherwise authorized by the Engineer in the field. Backfill shall be carefully and adequately compacted in place. In most cases, the surface restoration will be provided as a part of the general roadway contract work.

Unless otherwise specified, all backfill shall be in accordance with the requirements of Section 502.1 of these Specifications. Native material will not be allowed for backfill if it is thirty (30) percent or more stones by volume. No rocks larger than four (4) inch diameter, stone aggregate, or any foreign debris shall be backfilled, unless otherwise approved by the engineer. When sand backfill is required, a six (6) inch minimum sand padding shall be used below the conduit and a six (6) inch minimum sand lift shall be used above the conduit.

602.5(b) Method of Measurement.

Electrical trench, complete and accepted, shall be measured by length in linear feet, in a horizontal plane along the center line of the trench.

602.5(c) Basis of Payment.

The quantity of trench, measured as provided above, will be paid for at the contract unit price per linear foot, or as part of conduit or cable-in-duct installation if a separate bid item for electrical trench is not provided, which price shall be payment in full for excavating, bedding, and backfilling, including any select fill as required in Article 202 of these Specifications, including sand or other required materials; for surface restoration with topsoil and seed; for disposal of surplus materials; for making inspections; and for furnishing all materials; labor, tools, equipment, and incidentals necessary to complete the work.

## **ARTICLE 603 - REMOVAL OF AERIAL DISTRIBUTION SYSTEMS**

---

### **603.1 General.**

This item consists of removing an existing aerial electrical distribution system for street lighting in accordance with these Specifications, the Special Provisions, and the details shown on the plans.

### **603.2 Construction Methods.**

The Contractor shall remove existing aerial cable in such a manner as to maintain service to existing street lights. The Contractor shall remove existing aerial cable and its appurtenances from existing street light standards as noted on the plans and/or in the Special Provisions. Rewiring of the street light standard, if required, shall be performed in accordance with Article 605 of these Specifications.

### **603.3 Measurement and Payment.**

This item shall be measured as a lump sum, with aerial cable and its appurtenances completely removed from existing lighting standards and with all lighting systems outside of the project area remaining in operation.

This item, measured as provided above, will be paid for as a lump sum, which price shall be payment in full for disposal of surplus materials and for all labor, tools, equipment, and incidentals necessary to complete this item of work in accordance with the contract.

## **ARTICLE 604 - BASES FOR STREET LIGHTING UNITS AND TRAFFIC SIGNAL STANDARDS AND CONTROLLERS**

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### **604.1 General.**

This item consists of constructing concrete bases with the necessary hardware for traffic signal standards, controllers, and street lighting units in accordance with these Specifications, the applicable Standard Plate for the base involved, the Special Provisions, and the details shown on the plans.

### **604.2 Materials.**

All requirements specified in Article 301 - Concrete and Concrete Materials, regarding mix design, high-early strength concrete, testing, materials, mixing, placing, curing, and protecting the concrete, shall apply to the concrete used in the construction of said bases.

### **604.3 Construction Methods.**

Where bases are to be installed within existing sidewalks or improved terraces, the Contractor shall remove and replace the entire stone of sidewalk or improved terrace affected by the installation unless otherwise specified or directed by the Traffic Engineer.

The general locations of the bases are shown on the plans. The exact locations and elevations shall be established in the field by the Traffic Engineer. Unless otherwise specified, bases shall be placed with one side parallel to the center line of the street and the center of the base shall be four (4) feet from the face of the curb. The elevations of the bases shall be as shown on the applicable Standard Plate unless otherwise specified.

Forms shall be placed with sufficient depth to provide a minimum of twelve (12) inches of formed base below the finished grade on the low side of the base. The top surface of the base shall be level, with a three-fourths (3/4) inch bevel on the edges, and given a float finish.

A five-eighths (5/8) inch by eight (8) foot copper-weld ground rod shall be cast into each base. The ground rod shall extend a minimum of seven (7) feet below the bottom of the base and shall be connected with a No. 4 stranded copper wire and approved connector to one anchor bolt. The No. 4 stranded copper wire shall be of sufficient length to protrude three (3) feet above the top of the base for the Contractor to connect the wire to the ground lug in the pole or metal base.

City-furnished anchor bolts shall be cast into the base. These bolts shall be placed in accordance with the base detail and other directions furnished by the City as to location and projection above the top of the base, and shall be true vertical. All anchor bolts 1" diameter and larger shall be placed in the form before concrete is poured. The bolts shall be secured by tack welding or wiring horizontal rebar to the bolts to form an anchor bolt cage. The horizontal rebar shall be placed 18" from the top and 12" from the bottom of the bolts.

The Contractor shall furnish and install a minimum of two manufactured elbows in all bases and more where specified. The contractor shall install the elbows to permit cable entrance from the street side of, or along the line of, the poles, as shown on the plans. Manufactured galvanized steel elbows with grounding bushings shall be furnished and installed in those bases where galvanized steel conduit is used, as shown on the plans. Existing conduit shall be extended into the bases. The conduit extending above the concrete base shall be centered.



Unless otherwise specified, all backfill shall be in accordance with the requirements of Section 503.2 of these Specifications.

#### **604.4 Measurement and Payment.**

These items shall be measured as units, complete in place and accepted in accordance with the contract.

These items, measured as provided above, will be paid for at the contract unit price for each of the various types of bases, which price shall be payment in full for furnishing and installing reinforcing rods, conduit elbows, clamps, ground rods, and copper wire; for picking up and installing anchor bolts; for furnishing and placing concrete masonry; for excavation, backfill, and disposal of surplus materials; and for all labor, tools, equipment and incidentals necessary to complete these items of work.

#### **604.5 Removal of Existing Street Light Pole, Traffic Signal Poles and Cabinets, and Miscellaneous Electrical Bases and Abandoning Handholes and Electrical Utility Access Structures.**

##### 604.5(a) Description.

This work shall consist of removing, wholly or in part, street light bases, poles, arms and fixtures and concrete bases for fire alarm pedestals, traffic signal poles and traffic signal cabinets; and abandoning handholes and electrical utility access structures.

##### 604.5(b) Construction Methods.

The Contractor shall remove those street light pole (poles, arms, metal base, and fixtures), traffic signal pole (including metal base and other attachments), traffic signal cabinet, and other miscellaneous electrical bases, and shall abandon handholes and electrical utility access structures as identified on the plan or by the Engineer. All street light poles, metal base, arms, fixtures, traffic signal poles, traffic signal cabinets, and all handhole and electrical utility access structure frames and covers removed by the Contractor, shall be delivered to the Traffic Operations Shop, 1120 Sayle Street, unless designated by the Engineer to be reinstalled in the project area or not returned to the City. The Contractor shall dispose of old concrete bases at a site provided by the Contractor.

Abandon Electrical Utility Access Structures (also known as manholes), shall consist of the following:

1. Removing the concrete roof and the top three feet of walls.
2. Breaking the floor to promote drainage; the maximum unbroken floor size shall be two-foot by two-foot.
3. Backfill and compact with sand fill.
4. Remove and return the steel frame and cover to TE Shop, 1120 Sayle Street.

**604.5(c) Method of Measurement.**

Removing street light pole, traffic signal pole, traffic signal cabinet, and miscellaneous electrical bases and abandoning handholes and electrical utility access structures will be measured as units. A traffic signal control cabinet base shall be considered a traffic signal base for measurement.

**604.5(d) Basis of Payment.**

The contract unit price for removal of street light pole shall be payment in full for removing the fixture, arm, metal base, and pole; and transporting/storing/disposing of materials as previously provided in these Specifications; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. The Contractor shall be responsible for any damage to the street light fixtures, metal bases, and poles during removal, reinstallation and return.

The contract unit price for removal of traffic signal pole and traffic signal cabinet shall be payment in full for removing the equipment and transporting/storing/disposing of the materials as previously provided in these Specifications; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. The Contractor shall be responsible for any damage to the existing equipment during removal, reinstallation, and return.

The contract unit price for miscellaneous electrical base removal shall be payment in full for removing and disposing of the bases as provided in the Specifications; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The contract unit price for abandoning handholes and electrical utility access structures shall be payment in full for removal and return of the frame and cover, as provided in these Specifications; for backfilling the handhole or electrical utility access structure to be abandoned; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

**604.6 Auger Street Light Base.**

**604.6(a) Description.**

The work under this item shall consist of augering one or two holes in a concrete street light base to provide a raceway for designated duct in and out of the base.

**604.6(b) Method of Measurement.**

Auger Street Light Base will be measured by the number of bases so augered.

**604.6(c) Basis of Payment.**

The contract unit price for Auger Street Light Base shall be payment in full for providing necessary entrance and exit for designated ducts at existing street light bases and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

## **604.7 Base for Multi Space Parking Meters.**

### **604.7(a) Description.**

This item consists of picking up and installing city provided steel bases for multi space parking meters in accordance with these Specifications, the Special Provisions, and the Standard Detail shown on the plans.

### **604.7(b) Materials.**

All requirements specified in Article 301 - Concrete and Concrete Materials, regarding mix design, high-early strength concrete, testing, materials, mixing, placing, curing, and protecting the concrete, shall apply to the concrete used in the construction of said concrete slab around said bases.

### **604.7(c) Construction Methods.**

Where bases are to be installed within existing sidewalks or improved terraces, the Contractor shall remove and replace the entire stone of sidewalk or improved terrace affected by the installation unless otherwise specified or directed by the Engineer.

The general locations of the bases are shown on the plans. The exact locations and elevations shall be established in the field by the Parking Utility Maintenance Supervisor (Dan Valenza, 266-4744). Unless otherwise specified, bases shall be placed with one side parallel to the center line of the adjacent sidewalk and the center of the base shall be four (4) feet from the face of the curb. The elevations of the bases shall be as shown on the detail unless otherwise specified.

The city-furnished steel base shall be cast into the concrete sidewalk slab. The top of the steel base shall be level, with a minimum depth of two inches below the finished slab grade. Aggregate shall be compacted around the base to ensure that the base does not rock. The parking Utility will provide a reusable 13" X 20" wooden form attached to the top of the base. A representative from the Parking Utility or a designee from Traffic Engineering must approve the installation before the concrete pour. Contact the Parking Utility Maintenance Supervisor (Dan Valenza, 266-4744) 48 hours in advance prior to the concrete pour to set up a time for approval.

The concrete must be vibrated on the two open ends of the base and through the six 2.25" openings on the sides. Any bases that have insufficient compaction of aggregate or insufficient penetration of concrete into the base leading to the base rocking once a multi space meter is installed shall be removed and replaced at contractor's expense, including replacement of the entire concrete slab.

No concrete shall be allowed to extend over the top surface of the steel base.

The contractor shall install conduit as shown in the plan. Conduit shall extend three inches above the top of the steel base plate.

Unless otherwise specified, all backfill shall be in accordance with the requirements of Section 503.2 of these Specifications.

### **604.7(d) Measurement and Payment.**

This item shall be measured as units, complete in place and accepted in accordance with the contract.

## Part VI - Traffic Engineering Electrical

This item, measured as provided above, will be paid for at the contract unit price for each base, which price shall be payment in full for picking up and installing the city provided steel plate in the concrete slab and placing the concrete slab; for excavation, backfill, and disposal of surplus materials; and for all labor, tools, equipment and incidentals necessary to complete these items of work.

## **ARTICLE 605 - INSTALLATION OF STREET LIGHTING UNITS**

### **605.1 General.**

This item consists of installing luminaires, lamps, and metal or precast concrete poles as complete street lighting units in accordance with the Plans, these Specifications and the Special Provisions.

Lighting units shall be grouped to operate from branch circuits which are energized by lighting contactors remotely controlled by photocell. Where a system is employed, no individual lighting units shall be controlled by photocells or time switches. Time switches control only the removal from service of the midnight and 3:00 a.m. circuits.

Each system shall be wired in a manner that presents as near as is possible a balanced load at the source of supply during midnight, or 3:00 a.m. operation and all-night operation.

### **605.2 Construction Methods.**

#### **605.2(a) General.**

Conductors to each luminaire from the bottom of the pole shall be two No. 14 solid annealed copper, UF, 600 volt, as manufactured by General Cable, Anaconda, Rome, Kaiser, or approved equal. On all systems, the phase wire at the pole handhole shall have a secondary in-line fuse assembly, Series 64, as manufactured by Elastic Stop Nut Corporation of America, Buss Tron HEB-AA fuseholder, or approved equal, with a Bussmanteype FNM or FNQ fuse of the required size (refer to the following table).

<b>REQUIRED SIZE - IN-LINE SECONDARY FUSES</b>					
<b>VOLTAGE</b>	<b>LUMINAIRE WATTAGE</b>				
	<b>400W</b>	<b>250W</b>	<b>200W</b>	<b>150W</b>	<b>100W or less</b>
480V	2 amp	2 amp	2 amp	2 amp	2 amp
240V	5 amp	3.2 amp	2 amp	2 amp	2 amp
120V	6.25 amp	5 amp	5 amp	3.2 amp	2 amp

The phase wire shall not be spliced between the fuse assembly and luminaire. A sufficient length of No. 12 conductor shall be installed in the pole to permit removal of this fuse-holder through the handhole before disconnecting.

A 24" length of #12 THHN Stranded Conductor tail shall be installed to supply wires permitting easy removal of fixture wires and fuse holder through the handhole. A tail of #4 wire from the neutral conductor splice shall be grounded to each ground rod and metal street light pole. The following color coding shall be used at all street light bases: Midnight Circuit (red), all night circuit (black), and neutral (white). Electrical splices and connections shall be electrically secure and made with pressure or compression fittings as manufactured by Thomas & Betts, Burndy, 3-M (scotch lock brand) or approved equal and used as recommended by the engineer. Taps and splices shall be protected in the following manner: all wire connections shall be coated with No-Lox Compound; taps and splices made with irregularly shaped connectors shall first be built up with insulating material, "Air Seal" #18415 manufactured by Kearney or approved equal; all sharp corners and voids shall be filled; over this, install 3 half lapped layers of rubber electrical tape, dielectric strength, 300 volts per mil - self vulcanizing tape, installed as per manufacturer's instructions; over this, apply 3 half lapped layers Scotch Brand 33 Plus or approved equal, vinyl plastic electrical tape; then dip the entire splice 1"

beyond the insulating material in Scotch-Kote or approved equal. The constructed splice shall be allowed to air dry completely before insertion into the street light pole. All wires leaving the splice shall be in one direction. Split bolts, when used, shall be hammered and retightened three times and a spacer shall be provided between any copper and aluminum conductors. The fuse holder shall be connected to the All-Night circuit or Midnight circuit as indicated on the plans with an approved wire nut (3M or Ideal). The wire nut shall be dipped in Scotch-Kote or approved equal.

The lighting units shall be connected with the underground or overhead cable, as is applicable, and shall provide a complete, operational system when finished.

#### 605.2(b) Metal Pole.

Metal poles shall be set and plumbed with the use of leveling nuts furnished with the anchor bolts. Luminaires shall be leveled after erecting and leveling the metal standards with bracket arms. The proper leveling method may be obtained from the manufacturer's instruction manual. Nuts on anchor and transformer bolts shall be torqued to 175-200 foot pounds or as directed by the Engineer. Rust, corrosion, and anti-seize protection shall be provided at all threaded assemblies by coating and mating surfaces with Markal (Hightemp-E-Z Break), Never-Seez (Marine Grade), LPS 100, Lubriplate, or approved equal.

The stranded copper ground wire that is installed as a part of base construction shall be attached with an approved connector (Fargo GC 202 or approved equal) to a ground nut located inside the pole and opposite the handhole.

Grout shall be troweled between the pole and concrete base and finished at an angle from the edge of the pole base to the outer edge of the foundation. A 1/2 inch slot for drainage shall be left through the grouting on the street side at the top of the concrete base. The grout shall be Patch-crete (manufactured by Ready-Crete of Milwaukee, Wisconsin) or approved equal.

#### 605.2(c) Precast Concrete Butt-Base Pole.

The Contractor shall install the pole in an augered or hand-dug hole and shall tamp the pole securely in a plumb position using six (6) inch lifts of select salvage material. When debris is present in the salvage material to such an extent that in the Traffic Engineer's opinion good compaction cannot be obtained, material specified by the Traffic Engineer shall be used as fill.

If a bracket-arm type of installation is required, the luminaire shall be leveled after the pole has been securely tamped in a plumb position.

The Contractor is responsible for maintaining the pole in a plumb position until the project is accepted by the Common Council.

A typical detail of City-furnished precast concrete butt-base poles is shown on Standard Plate 6.05.

### **605.3 Measurement and Payment.**

This item shall be measured as units in place, completely installed and accepted in accordance with the contract.

## Part VI - Traffic Engineering Electrical

This item, measured as provided above, will be paid for at the contract unit price, which price shall be payment in full for picking up and installing City-furnished material including transformer or breakaway bases and devices; for furnishing and installing fuses, wire and all miscellaneous hardware necessary to integrate the components into a single unit connected to the feeder system; and for all labor, tools, equipment and incidentals necessary to complete this item of work.

## **ARTICLE 606 - INSTALLATION OF METERED OR UNMETERED ELECTRIC SERVICE**

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### **606.1 General.**

This work consists of installing metered or unmetered electric service in accordance with the Special Provisions, these Specifications, the applicable Standard Plates, and the details shown on the plans.

### **606.2 Construction Methods.**

The Contractor shall install a City-furnished pre-wired control cabinet on the pole or base specified and, unless specified otherwise, install a City-furnished photoelectric cell on the luminaire closest to the control cabinet.

The Contractor shall install a two (2) inch conduit or base elbow when applicable for the electric utility to install an underground service as shown on the Standard Plate.

The Contractor shall install two 5/8" x 8' copper ground rods, with six (6) foot minimum horizontal spacing, connecting them with a No. 4 copper wire using ground clamps. Ground rods and connection wire shall have thirty (30) inch minimum ground cover. No. 4 wire shall be continuous and extend up the outside of two (2) inch G.S. conduit to control panel and connect to the ground buss on the main disconnect.

Wiring of the photoelectric cell shall be internal for a steel or precast concrete pole and within a Contractor-furnished and installed metal conduit for a wood pole installation. The wiring shall be done with 3 conductor No. 14 UF cable.

The Contractor shall obtain the electrical permits necessary for this work from the Building Inspection and Rehabilitation Unit of the City Department of Planning and Development.

### **606.3 Measurement and Payment.**

This item shall be measured by the unit complete and operational in place and accepted in accordance with the contract.

This item, measured as provided above, will be paid for at the contract unit price, which price shall be payment in full for furnishing wire, ground rods, ground clamps, and galvanized steel conduit; for picking up and installing the City-furnished control cabinet and photoelectric cell; and for all labor, tools, equipment and incidentals necessary to complete this item of work.



## **ARTICLE 607 - ELECTRICAL UTILITY ACCESS STRUCTURES, ELECTRICAL HANDHOLES AND BOX-OUTS**

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### **607.1 General.**

This work consists of constructing electrical utility access structures, electrical handholes and box-outs in accordance with details shown on the plans and in accordance with these Specifications and the applicable Standard Plate for the structure involved.

All materials used in construction of electrical utility access structures, electrical handholes and box-outs shall conform to the requirements for the various types of materials contained in these Specifications.

Electrical Handhole, Type I shall be gray colored polymer concrete construction. Box dimensions for Type I shall be 19" wide X 32" long X 24" deep and come with a cover rated to withstand 15,000 lbs over a 10" square with a minimum test load of 22,568 lbs. Electrical Handhole, Type III, shall be 12" x 12" x 12". The box and cover shall be rated to withstand 20,000 lbs. Electrical Handhole, Type V, shall be gray colored polymer concrete construction. Box dimensions shall be 26" wide by 38" long by 24" deep. The box and cover shall be rated at 15,000 lbs over a 10" square with a minimum test load of 22,568 lbs. Type VII, shall be gray colored polymer concrete construction and shall have a split lid. Box dimensions shall be 30" wide by 48" long by 36" deep. The box and cover shall be rated at 15,000 lbs over a 10" square with a minimum test load of 22,568 lbs.

### **607.2 Construction Methods.**

Unless otherwise specified, all backfill shall be in accordance with the requirements of Section 502.1 of these Specifications.

### **607.3 Measurement and Payment.**

These items shall be measured as units complete in place and accepted in accordance with the contract.

These items, measured as provided above, will be paid for at the contract unit price for each, which price shall be payment in full for furnishing and installing all materials necessary to complete the installation, including excavation, backfill and disposal of surplus materials; and for all labor, tools, equipment and incidentals necessary to complete these items of work.

## **ARTICLE 608 - PAVEMENT MARKINGS**

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### **608.1 Description**

This section describes the furnishing and applying, or removing, of pavement markings.

### **608.2 General Requirements**

All aspects of the current edition of the Wisconsin Department of Transportation Standard Specifications, Part 6 Section 646 & Section 647 as they pertain to the bid items within this section, except for the measurement of items described in the following section, shall apply.

Acceptable performance of pavement markings will be evaluated during the proving period in sections. Each solid line, double line, or dotted line, measured through 600 foot length will be considered a section. Intersection markings including solid lines, groupings of diagonal lines, stop lines, crosswalks, median nose, symbols, and words or miscellaneous markings including parking stalls will be evaluated separately as a section.

### **608.3 Method of Measurement**

608.3(a) Median Nose.

Shall be measured by the square foot of material applied.

608.3(b) Double Line, 4-Inch.

Shall be measured per linear foot of two(2) 4" lines of material applied/removed.

608.3(b) Bike Lane & Straight Arrow.

Shall be combined and measured as a unit of each.

608.3(b)

Removal of lines shall be measured per linear foot and width of material removed.

## **ARTICLE 609 - TEMPORARY PAVEMENT MARKINGS.**

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### **609.1 Description**

This section describes the furnishing and applying, or removing, of temporary pavement markings.

### **609.2 General Requirements**

All aspects of the current edition of the Wisconsin Department of Transportation Standard Specifications, Part 6 Section 649 as they pertain to the bid items within this section shall apply.