MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**ELECTRICAL WORK**

DET:MS 1 of 13 APPR:BMB:NJM:08-04-22

**a. Description.** This work consists of electrical construction including traffic signal work and/or relocation of lighting facilities with Public Lighting Department (PLD) Standards of Construction in the City of Detroit.

1. General.

Inspect all conditions that may affect the work, including traffic. No extras will be allowed for such conditions or for interference with the work by other contractors or utilities.

Furnish and maintain the lighting in areas specified for the maintenance of traffic. All work on any PLD facility is subject to PLD inspection.

Notify the PLD System Operator (313-224-0500) 48 hours prior to performing any type of work on PLD overhead or underground secondary lighting, street lighting, or primary circuits.

Do not energize or de-energize transformers without prior approval of the PLD System Operator.

Make arrangements as described above to work on street lighting circuits with the work complete and ready for operation prior to 4 p.m. each day.

Ensure construction is performed by qualified and experienced personnel. Ensure all work meets standards and practices of the PLD, the *NEC*, the *Electric Code of the City of Detroit*, the *NESC*, and the Michigan Public Service Commission.

Secure all necessary permits covering the operations, including permits from the Public Authorities having jurisdiction over the streets or other public properties in which the work is located, and the improvements therein. The bidder determines the amount of any charges required by such authorities and includes the cost thereof in the bid price.

Ascertain the requirements of said authorities and include in its bid price all costs of restoring existing improvements, including sidewalks, pavements, and landscaping, to the satisfaction of the authority having jurisdiction in each case.

The Contractor assumes all risks and responsibility due to existing soil conditions and completes the work with material and ground conditions encountered or created without additional cost to the City of Detroit, Traffic Engineering Division.

Ensure all material and equipment furnished is new, unless specified otherwise, and must comply with the specifications for that material and equipment. The City of Detroit, Traffic Engineering Division has the right to reject any equipment that does not meet specifications.

Manufacturer's test certificates in accordance with the specifications will be required for all wire and cable. Submit these certificates to the City of Detroit, PLD, immediately upon receipt. Do not install any wire or cable before it has been approved by the City of Detroit, Traffic Engineering Division.

Include on their material order, especially on wire and cable, the statement that "Material must be in strict accord with the Specifications".

Do not install any salvaged material or equipment unless it has been inspected and approved for reuse by the City of Detroit, Traffic Engineering Division.

Where the contract calls for the reuse of existing material and equipment, reuse only the best of the existing material and equipment. The PLD will have the right to furnish a new part for any that is found defective prior to dismantling. Any part or parts damaged subsequent to starting the removal are a liability of the Contractor.

Within 5 days after completion of each section of the underground conduit or cable work or the overhead line work, furnish to the City of Detroit, Traffic Engineering Division, an exact record of all underground or overhead work installed. This includes length of duct lines; location of handholes and manholes; and location and size of poles. Ensure all removed street lighting, traffic signal, communication and all PLD material is salvaged and delivered in usable condition to the City of Detroit, PLD.

The locations of existing underground obstructions or facilities of other utilities are not necessarily shown on the plans. Where facilities of other utilities are shown, their locations are only approximate, and their exact location is not guaranteed for correctness. Exercise caution in avoiding damage to other utilities and notify the other utilities that they are in fact proposing to break pavement or excavate so that they may be provided with the very latest information or drawings of their existing facilities.

The Contractor is responsible for maintenance, vandalism, and accidental damage to the lighting, traffic signal, conduit, wood poles, overhead wires, cable, etc., and all other material installed, or to be installed, related to, or necessary for the electrical installation of the project until the installation is complete, tested, and accepted by City of Detroit, Traffic Engineering Division.

Pick up materials furnished by the PLD at the warehouse as designated by the PLD.

During installation of cable, conduit, and all related work, maintain traffic in the manner and requirements noted in the Special Provision for Maintaining Traffic.

**b. Materials.**

1. Conduit. Furnish conduits, fittings, and bends that are plastic (acrylonitrile butadiene or PVC) in accordance with *NEMA Standards Publication TC6-1974*, Type EB for concrete encased installation.

Furnish galvanized pipe conduit for direct burial, or jacking and boring riser or cable raceway, meeting the requirements of the *Federal Specification WW-C 581d* and so identified. If required on the plans, ensure direct buried or Schedule 80 PVC conduit meets the dimensional and compounding requirements of *NEMA TC-2*.

Furnish concrete for encased conduit as specified under section c. Construction of this special provision.

2. General Overhead Line Section.

A. Description. This work will consist of furnishing, installing, removing, and relocating wood poles, overhead street lighting units, overhead lines, cable poles, transformers, and overhead line material. Included is all related work, materials and equipment required to provide a complete and operating job, as specified herein and as shown on the plans.

B. Crossarms. Furnish all crossarms made from Douglas fir and in accordance with the *Edison Electric Institute Specification TD90-1960* and the following options specified therein:

(1) Dense or close-grain grades or a mixture of the two is satisfactory.

(2) Ensure dimensions, drilling, and allowable tolerances are in accordance with PLD Drawing No. 42-0422.

(3) Incise all crossarms on all four faces to a depth of 3/16 inch.

(4) Preservative Treatment. Ensure the preservative is a pentachlorophenol-petroleum solution in accordance with the *AWPA Standards P9-64 and P9-65*. Ensure the solution contains not less than five percent of pentachlorophenol by weight.

Ensure the treatment uses an empty-cell pressure process with 6 pcf retention of pentachlorophenol in accordance with the *AWPA Standard C-26* with the minimum penetration of the preservative longitudinal from ends and holes of not less than 2½ inches.

(5) Cleanliness. Ensure crossarms are clean for handling upon receipt at destination. Ensure there is no free oil, sludge, or sediment apparent on any face upon completion of the preservative treatment or upon receipt by the user.

(6) Alternate wood species, treatment and physical manufacturing details are subject to approval by the PLD before purchase and/or use by Contractor.

(7) Contact PLD before purchasing crossarms. Crossarms with holes sized for metal pins may be required.

C. Steel Insulator Pins. Ensure steel insulator pins for use on wood crossarms are hot dip galvanized.

Pins must have a 5-inch shaft height, 5/8-inch shaft diameter, 6½-inch shank length, 1-inch diameter lead thread, 3¼-inch thread length, 2-inch diameter base with one 2-inch round washer, 1-split lock washer, and 1-square nut.

D. Miscellaneous Hardware. Furnish miscellaneous pole line hardware that is hot-dip galvanized and standard products of such manufacturers as Kearney, Line Material, Oliver, or approved equal.

E. Guys and Guy Anchors. Furnish 7 strand guy wire of the size shown on the plans.

Furnish 3/8-inch guy wire that is Extra High-Strength Grade.

Furnish guy anchors that are heavy duty, eight bladed, and expansion type.

Furnish guy anchor rods that are galvanized, 3/4-inch by 8 feet, thimble-eye type. Ensure all anchor guys are provided with metal or plastic guards.

F. Potheads. Furnish potheads as shown on the detail drawings.

G. Wire. Furnish all wire and cable as shown on the drawings.

H. Overhead Wire. Furnish number 8 duplex (#8 AWG twin) wire in accordance with the *PLD Specification #23:0113*.

(1) Triplex Aerial Cable, 600 Volt Rated, #6 AWG. Furnish triplex aerial cable consisting of two insulated copper conductors wound spirally around a supporting neutral conductor, right-hand lay, 36 inches plus or minus 2 inches length of lay.

Furnish #6 AWG, 7-strand uncoated soft-drawn or annealed copper insulated conductors in accordance with *ASTM B8*. Ensure the neutral is bare, and consists of a single strand of copper-clad steel wire and two strands of hard-drawn copper wire, right-hand lay, maximum overall resistance of 0.415 ohm per 1,000 feet at 60 °F. Ensure the tensile breaking strength of the neutral is 2,300 pounds, minimum.

Ensure insulation is black cross-linked polyethylene, 0.060 inch thick, in accordance with *Interim Standards #2, ICEA Publication S-66-524*.

Ensure one insulated conductor is identified throughout by a permanent stripe or rib. Certified test reports are required in accordance with the above standard, including insulation thickness, insulation physical and aging tests, all insulation electrical tests, water absorption test, heat distortion test, and resistance of each conductor on all reels.

(2) Triplex Aerial Cable, 600 Volt Rated, #2 AWG. Furnish triplex aerial cable consisting of a copper messenger and two separately insulated copper conductors wound spirally around the messenger. Ensure the two insulated conductors are entirely supported by the messenger.

Furnish #2 AWG, 7-strand uncoated soft-drawn or annealed copper insulated conductors in accordance with *ASTM B8*. Use the #2 AWG, 7-strand, uncoated messenger as a bare, grounded circuit neutral conductor, of hard drawn copper wire, right hand lay.

Ensure the insulated conductors are spiraled around the neutral conductor (messenger) for mechanical support. Use the same direction of lay of the insulated conductors as the neutral conductor strands, and the length of the lay will be 36 to 42 inches. Ensure the insulation on the two power conductors is abrasion resistant, black cross-linked polyethylene, suitable for outdoor use at 90 °C conductor temperatures. Ensure the insulation on each of the power conductors is 0.045 inch thick, with a minimum thickness at any point not less than 90 percent of the nominal thickness. Ensure the electrical and physical properties of the insulation conforms to the *ICEA Publication No. S-66-524*. Ensure one of the two insulated conductors is identified throughout its length by a permanent stripe, rib or equivalent of which does not reduce the insulation.

Furnish certified test reports, in accordance with *ICEA publication No. S-66-524*, from the manufacturers. These test reports will include:

(a) The results of insulation physical and aging tests, all insulation electrical tests, the accelerated water absorption test, and heat distortion test.

(b) The resistance per 1,000 feet of each of the three conductors on all reels and the tensile strength of the hard drawn copper messenger.

I. Line Wire. Furnish overhead wire in accordance with *PLD #23-0115 Revision R* and either *ANSI No. C8.34-1954 (R-1962)* or *ANSI/ICEA No. S-70-547-1984*.

Conductors and hardness will be as follows:

|  |  |  |
| --- | --- | --- |
| #6 | Solid | Hard-drawn |
| #2 | Solid | Hard-drawn |
| #2/0 | Stranded | Hard-drawn |
| #4/0 | Stranded | Medium Hard-drawn |

Ensure the coverings adhere to the conductor but not be bonded to it; will strip clean but not be free-sliding.

Furnish certified copies of test reports for all tests stipulated in subsection b.2.I are required.

J. Tie Wire. Furnish solid, soft-drawn, neoprene-covered tie wire in accordance with *ANSI Specification C8.34-1954*.

Furnish #2 AWG copper, 7-strand, soft-drawn ground wire for all applications except traffic signals, unless otherwise noted on the drawings.

Furnish 5/8-inch by 8 feet copper clad steel ground rods for all applications, except traffic signals, unless otherwise noted on the drawings.

Ensure traffic signal foundations are grounded such that resistance to ground is 10.0 ohms or less. Contact PLD for further information.

K. Insulators. Furnish insulators for series street lighting circuits that are medium blue, pin type, plain glaze (not radio-free type), Class 55-2, in accordance with *ANSI Standard C29-5-1969 (R 1974)*.

Furnish insulators for 2.4 kilovolt (KV) to 7.2 KV distribution circuits that are white, pin type, plain glaze (not radio free type) Class 55-4 in accordance with *ANSI Standard C29-5-1969 (R 1974)*.

Furnish primary dead end/suspension insulators for street lighting and distribution circuits in accordance with the requirements of *ANSI C29.2 Class 52-2* and *52-4* insulators with unibody weather shed construction molded on fiberglass rod. Ensure insulators are rated at 15,000 pounds ultimate with hot dip galvanized ductile iron end fittings.

Furnish spool type insulators that are white, Class 53-1, or 53-2 in accordance with *ANSI Standard C29.3-1961 (R1974)*.

Furnish strain insulators that are white, Class 54-3/Class 54-2, in accordance with *ANSI Standard C29.4-1961 (R1974)*.

L. Distribution Transformers. Furnish distribution transformers in accordance with the *PLD Specification #20:0231*. Furnish outdoor, pole type, oil immersed self-cooled transformers in the sizes and voltage ratings specified on the plans.

Equip transformer primary windings with taps as follows:

|  |  |
| --- | --- |
| Primary Voltage Rating | Taps |
| 4800V | (2) - 2½ percent above and below normal |
| 7200V | (2) - 2½ percent above and below normal |
| 2400 by 4800V | (1) - 5 percent and (2) - 2½ percent above and below normal in the 2400V winding and (2) - 2½ percent taps above and below normal in the 4800V winding |

Furnish the PLD, Stores Division, with the manufacturers name, transformer size, primary and secondary voltages, and serial number when requesting the transformer identification disks. Install the PLD supplied brass identification disk, in a permanent manner.

M. Lightning Arrester. Furnish outdoor, valve type lightning arrester for the series street lighting circuits with top series gap, rated at 3,000V for use on 7,500V ungrounded secondary of a series street lighting current regulator. Ensure these arresters include an accessible top series gap and a solderless type ground terminal to accommodate #2 AWG to #4 AWG solid wire housed in the best grade of wet processed porcelain. Also, a bracket is to be included for crossarm mounting. Ensure all ferrous parts are hot-dipped galvanized, in accordance with *ASTM A153/A153M*.

Furnish the Engineer certification of compliance with the following requirements when tested in accordance with *ANSI-C62.1-1962*. The critical sparkover must not exceed 39 KV on impulse breakdown and the 60 cycle breakdown must not exceed 26 KV. Ensure it can withstand a lightning surge of 100,000 amperes and short circuit current of 20,000 amperes.

N. Lightning Arresters for Distribution Circuits. Ensure the lightning arresters for 2.4 KV, 4.8 KV and 7.2 KV distribution circuits are of 3 KV, 6 KV or 9 KV respectively and are valve type, distribution class, for crossarm mounting totally porcelain enclosed and for direct connection to the line. Ensure the arresters and circuits have the line connection suitably enclosed.

Furnish the Engineer certification of compliance when tested in accordance with *ANSI-C62.11- 1987*. Furnish outdoor type secondary arresters, 2 pole, rated 650V maximum lightning arresters for multiple street lighting circuits.

O. Distribution Circuit Cutouts and Disconnects. Ensure on distribution circuits thru 4,800V cutouts are outdoor type, porcelain, enclosed, 5.2 KV rated, extra heavy duty, rated 200 amperes continuous. Ensure interrupting capacity is 15,000 amperes asymmetrical at rated voltage. If specified on the plans, furnish a solid blade door rated at 400 amperes continuous.

Ensure on 7200V distribution circuits, cutouts are outdoor type, porcelain, enclosed, 7.8 KV rated, extra heavy duty, rated 100 amperes continuous. Ensure maximum interrupting capacity is one shot, 12,000 amperes asymmetrical at rated voltage. If specified on the plans, furnish a solid blade door rated 200 amperes continuous.

Furnish cutouts in accordance with *ANSI C37.42*. Ensure dead blade disconnects are outdoor, 7.8 KV rated, 400 ampere continuous rating, with a momentary rating of 20,000 amperes.

Furnish cutouts and dead blade disconnects with swivel type crossarm hangers, adjustable for 3¼ inches by 4¼ inches and 3¾ inch by 4¾ inch crossarm sections. Ensure all hardware is hot-dip galvanized in accordance with *ASTM A153/A153M*.

**c. Construction.**

1. Cable Section. Pull cable into ducts using the proper cable grip for the purpose. Handle the cable so that it is not subject to excessive strain or is not kinked when pulled thru the conduit. Do not use damaged or kinked cable. Where more than one cable is to be installed in the same duct, pull cables through simultaneously.

Splices in ducts are not permitted.

When cable is installed but not immediately spliced, seal all cable ends and rack out of the way of possible damage.

Ensure the ends of the cables which are to be abandoned and left in place are sealed with a watertight cap.

Rack cables neatly on cable racks in all manholes after being formed to their final position. Rack cables slightly higher than the duct entrances so that they will not rest on the edges of the duct. Tag each new cable and any existing cable which has its circuit number changed in all manholes and handholes in which it is exposed.

Ensure the sheaths of all lead sheathed cables are bonded to one another in each manhole and handhole with flexible copper braid approximately equal to #9 AWG.

Install all new cable between lighting standards by a continuous pull. Splices between standards are not permitted. The use of wire nuts in splices and taps are not permitted.

2. Steel Standards. Orient the steel standard on the foundation so that the handhole is on the side of the steel standard opposite oncoming traffic.

3. Conduit. Ensure conduit runs are built in as straight a line as possible. When conduit sweeps are necessary, only one sweep, in one direction is permitted between manholes or between manhole and pole. Ensure the radius of the sweep is not less than 24 feet.

Use factory conduit bends only when entering foundations or at the base of poles.

Place all main conduit runs at a depth to leave at least 36 inches from the top of the conduit encasement or top of direct buried rigid conduit to top of finished grade. For lateral conduit runs, the corresponding depth will be 30 inches. Typical depth and widths of excavations are shown on the plans. Grade the trench to handhole and manhole locations, so that the finished conduit runs have no low spots where water might accumulate but drains into a handhole or manhole.

Place sheeting and bracing in the trenches as required and adequately support all pipes or other structures exposed in the trenches. This support will be considered to be included in the cost of the conduit construction and will not be paid for separately.

Encase conduit runs in concrete or direct bury as shown on the plans. Space adjacent conduits a minimum of 1-inch from each other and the top, bottom, and side of the concrete conduit encasement. Where steel reinforcement is required, separate the reinforcing bars from the conduits by 2 inches of concrete and ensure a minimum of 3 inches of concrete from the reinforcing bars to the outside of the encasement. Stagger conduit joints vertically. Use concrete or plastic separators, spacers, blocks, or supports if left in the finished concrete structure. Space supports no more than 7 feet apart when 20-foot lengths of conduit are installed and no more than 5 feet apart when 10-foot lengths of conduit are installed.

Design the concrete mix used to encase the conduit, with enough workability (slump greater than 8 inches) to ensure encasement underneath the conduit. Line the bottom of the trench shelf with a polyethylene sheet to ensure integrity of the concrete.

Consolidate concrete during and immediately after placement by means of mechanical vibrators. Work the concrete around enforcements, embedded fixtures, and into corners. Ensure to provide a dense, waterproof encasement, free of voids and honeycomb. Prevent the conduit bank from floating up when the concrete is poured, by anchoring to stakes at intervals not to exceed 10 feet in firm soil and not to exceed 5 feet in loose soil. A bank of encased conduits may be constructed in either of two ways as described herein.

A. Tier-By-Tier Method. Place a base of concrete at least 3 inches thick on the bottom of the trench after it has been graded. When steel reinforcement is required place a thickness of at least 5 inches with the reinforcing bars in place. On this concrete base lay the bottom tier of conduits, separated from each other by suitable spacers. Fill the space between conduits of this first tier with concrete and cover the conduits to the height of the next succeeding conduit tier. Construct succeeding tiers in a similar manner. Ensure work proceeds as continuous operation with no interruptions more than 45 minutes between the placing of successive layers of concrete.

B. Built-Up or Monolithic Method. Place masonry supports at intervals of 3 to 5 feet, or a foundation of concrete at least 3 inches thick, in the bottom of the trench after it has been graded. Where steel reinforcement is required place a thickness of at least 5 inches with reinforcing bars in place. Place all conduits using plastic or concrete separators, to erect a rigid, self-supporting structure of conduits. Completely fill the spaces between the conduits with concrete without damaging or displacing the conduits. Ensure no conduits are encased until it has been inspected and approved by the City of Detroit, PLD.

Typical sections and various typical arrangements of conduit are shown on the plans. Backfill trenches as shown on the plans.

After the conduit runs are built, pull a mandrel 12 inches long (shorter in conduit runs with bends) and 1/2-inch smaller in diameter than the conduit and a suitable swab or cleaning device designated to clear the conduit of debris. Notify the inspector prior to performing this phase of the work so that they may be present during this work. Certify that this work has been done before payment is made.

Place a coupling on the ends of all conduits terminations and plug with a suitable removable plug.

Backfill for trenches outside the roadbed may be the material excavated therefrom unless it is unsuitable for backfill material. Ensure backfill for trenches within the limits of the roadbed is a Grade A fill material.

Where iron pipe conduit is installed, ensure plastic conduit is installed within the iron pipe. Then install the cable within the plastic conduit. Never install cable in an iron pipe without the plastic conduit installed within.

Within 5 days after completion of the conduit work or of any portion where a working cable is installed, furnish to the City of Detroit, PLD a record of the length of the duct lines as constructed, clearly showing any departures from the original plans. Measure the lengths from the inside walls of manholes and the center of post foundations, cable poles, and handholes. Final payment will be withheld until these records are received.

Ensure the concrete encasement is not in contact with any obstruction. Provide a vertical clearance of 9 inches, except those conduits parallel to water and gas mains must be separated by not less than 12 inches.

Notify the City of Detroit, PLD, 48 hours prior to the pouring of any concrete encasement.

Stake conduit grades at 8-foot intervals or less. Fill the excavation below the bottom line of the trench with compacted Grade A backfill. Grade down to the lowest manhole or handhole, or from the middle of the run down toward both holes, at not less than 4 inches per 100 feet.

Restore all surfaces that have been dug up or disturbed for any reason in kind to its original condition including but not limited to topsoil and grass, sidewalk ramp, curb and gutter, and roadway bed including subbase and pavement materials.

4. Foundations. No construction rubble, broken sidewalk or other foreign material is permitted in place of concrete. Cracked or otherwise defective foundations will not be accepted.

Do not install standards on foundations until the concrete has cured for a minimum of 7 days.

Properly protect and guard foundations to prevent injury to people until the standards are installed.

Do not pour foundation until the curb is in place. Locate foundations as shown on the plans unless otherwise authorized by the Engineer.

Install ground rods and ground wires as shown on the detail drawings. Embed the ground wire in the foundation and connect to the ground rod with a copper clad steel solderless type clamp. Ensure the connection is electrically solid and mechanically secure.

Pour the lower portion of the foundation without forms unless the soil is subject to cave-in and the use of forms is authorized by the Engineer. Use forms to shape the upper part of the foundation, as shown on the plans. Ensure the top surface of the foundation is horizontal and at the elevation shown on the plans or established by the Engineer.

Use concrete to fill the entire hole excavated for the foundation. Do not use forms except to form the foundation top, without the prior approval of the Engineer.

Install foundations in undisturbed earth. Ensure foundation excavation is augured, or hand dug only.

Wire foundation anchor bolts in place near the bottom of the excavation to prevent movement of the bolts during the pour.

Wire conduit bends in place to the anchor bolts to prevent movement of conduit bends during the pour.

Seal openings of conduit bends prior to pour to prevent entry of concrete into conduit.

Coat anchor bolt projections above grade with oil prior to pouring to prevent concrete from adhering to anchor bolts.

Ensure conduit extends vertically outside foundation envelope a minimum of 4 inches. A coupling and a straight extension may be used to obtain the necessary vertical projection.

Place the entire foundation, exclusive of the cap, with a single pour of concrete.

5. Cable Tags for Installation in Manholes and Handholes.

A. Material. Tags are to consist of UV inhibited polypropylene, with 0.040-inch-thick black polypropylene character embedded in a colored polypropylene substrate. Material to be non-conductive, non-corrosive, abrasion resistant, chemically inert, and tolerate a temperature range of -50 °F to +300 °F.

B. Size and Color. Legend to consist of 1-inch-high block style letters, except tags with special legends as given below. Text to be black on yellow substrate except for the following characters, which are to consist of black characters on orange substrate:

2.4 KV / 4.8 KV 7.2 KV / 13.2 KV

In addition, the 24 KV tag is to consist of black characters on a red substrate. Mount characters making up tag in a polyethylene holder, and fastened to the cable with nylon tie straps.

C. Legends. Contact PLD Engineering Division for cable and circuit designations.

D. Method of Construction. Each tag is to be mounted with two nylon tie straps. Tags are to be installed near the duct pocket and when conditions allow, in a location on the cable where they may be read without having to enter manholes and handholes.

6. Cable Tags for Use in Lighting Load Centers and Controllers.

A. Material. Individual tags are to be made of polypropylene, with raised high relief letters. Material to be non-corrosive, non-conductive, weatherproof, stabilized for UV, resistant to salt water, organic solvents, mild acid or alkali solutions, and high humidity.

B. Size and Color. Legend to consist of 3/8-inch-high block style black letters on a yellow background. Mount characters making up tag in a polyethylene holder which is fastened to the cable with nylon tie straps.

7. General Overhead Line. Relocate all PLD and foreign contacts required for right-of-way preparation unless it is noted on the drawings that the owning utility has been requested to relocate its facilities.

Ensure all thru splices in line wire are made with automatic line splices. Keep the number of such splices to a minimum but do not exceed one splice in three consecutive spans of wire.

Ensure all wire which is trained under crossarms or vertically on the pole is covered with wood or plastic molding.

Dead end #6 AWG line wire on double pins and double arms. Dead end line wire larger than #6 AWG as shown on the plans.

Use two street lighting strain insulators or "breakers" to separate the line conductors on 3-way and 4-way overhead series circuit connections.

Use three "breakers" to separate the conductors of two different series circuits which are “dead ended” – “back-to-back” at the same crossarms.

Use a single "breaker" in the line conductor when installing series ballast.

When installing a series ballast in a two-wire series circuit lead, ensure the ballast is connected into that wire of the pair that is physically closest to the luminaire which the ballast serves. Ensure single wire runs of different series street lighting circuits do not occupy adjacent pin positions on the same side of the pole.

Use #6 AWG tie wire with all line wire #2 AWG and larger. Use #8 AWG tie wire with #6 AWG line wire. Use #12 AWG tie wire with #8 AWG duplex.

Ensure no splice is made in a #8 AWG duplex run between ballast and luminaire unless the length of wire required from ballast to luminaire exceeds 500 feet.

8. Traffic Signals. Ensure no traffic signal installation is placed in service without the prior approval of the Engineer.

The representative of the manufacturer of the controller and cabinet is responsible for programming the controller, wiring of the cabinet, and installation of the transformer. The traffic signal timing permits will be provided by the City of Detroit, Traffic Engineering Division.

Install all traffic signal cable as shown on the plans. Ensure the cable type and size is as shown on the plans. Ensure all traffic signal head cables are of stranded copper construction and meet *IMSA 20-1*. Install cables in one length without joints from the controllers to each traffic signal, except when shown otherwise on the plans. Train cables near the top of the wall of manholes and handholes and bends must not be so small as to cause damage to cable. Bundle cables together under 1½-inch-wide lead straps, which are secured to the wall with galvanized anchors. Maintain a maximum spacing of 2 feet between supports.

Make all cable connections at each signal head and at the controller. Input controller timing, in the field, after all cable connections have been completed.

Bring the traffic signal cable into the traffic signal head and extend for a minimum of 48 inches into the controller cabinet. Ensure all traffic signal cables are securely strapped inside the controller cabinet. Tag or stamp each cable in the traffic signal controller with the number of the traffic signal to which it is connected. Ensure overhead signals are prewired with standard wire prior to mounting.

Tag each signal cable with the number of the signal head to which it is connected inside the controller cabinet and in each handhole and manhole.

Test all cables, including interconnect and secondary service cables, for continuity and resistance to ground before final connections are made. Test the complete final installation in operation prior to placing in service. Testing includes verification of proper operation and sequencing of each signal indication and measurement of secondary voltage under load. Furnish the tabulated results of these tests to the Engineer before the installation is placed in service.

To minimize the entrance of gases from the conduit system into the controller cabinet, plug all duct openings into the controller foundation with duct-seal, or the equivalent, after all cables have been pulled in and connected.

Pull all cables into the controller cabinet with sheaths intact. Train cables across the bottom of the cabinet and at least 3 inches up the cabinet wall before the sheath is stripped.

Install cable entrance bushings in all wire entrance holes in standards and mast arms.

Make overhead traffic signal cable splices with crimp-type connectors; wrap each individual crimp connection with three layers of PVC (electrical) tape. Stagger the crimp connections and wrap the entire group with three layers of PVC (electrical) tape. Ensure proper crimping tools are employed.

Make underground traffic signal cable splices with crimp-type connectors; wrap each individual crimp connection with three layers of tape and enclose the splices in a heat-shrink case per manufacturer's specifications. Stagger the crimp connections within the encasement. Ensure proper crimping tools are employed.

Ensure salvaged signal suspension fittings (mast arm end fittings, span wire clamps, wire entrance fittings, clevises) are not reused without prior approval of the Engineer.

Furnish all mast arm and span wire mounted signal heads with safety chains as shown on the plans.

Ensure signals which cannot be placed in service on the day of installation are hooded or covered to avoid traffic confusion.

Pull the signal cable with sheath intact, into the lower framework member of bracket arm and pedestal signal. Do not strip the sheath any closer than 6 inches from the point of entry into the framework.

Aim the signal face as shown on the plans. In those cases where aiming instructions are not included on the plans, such information will be furnished by the City of Detroit Department of Public Works - Traffic Engineering Division prior to placing the signals in service.

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

**Pay Item Pay Unit**

Conduit, Encased, \_\_, \_\_ inch, Modified Foot

**Conduit, Encased, \_\_, \_\_ inch, Modified** of the size and number shown on the plans will be measured by the length in feet of in-place conduit, from the inside walls of manholes and the centers of handholes, foundations and cable poles. The contract unit price per foot will be payment in full for excavation, installing the conduit, reinforcement where called for, and encasement completed. Excavation, granular material backfill, disposal of waste excavated material, together with pavement, sidewalk, and curb removal and replacement is also included. Restoration to original condition of surfaces, pumping and cleaning manholes and handholes, disposal of waste excavated materials, and swabbing conduits after installation will be included in this item and will not be paid for separately.