SP-151084
(New)

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Polk County
STBG-SWAP-8260(651)--SG-77

Effective Date
January 20, 2021

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

151084.01 GENERAL

A. This special provision includes the furnishing of all material and equipment necessary to complete, in place and operational, a traffic control signal(s) as described in the project plans.

B. The installation of the traffic control signals and appurtenances shall be in conformance with the MUTCD, latest edition.

C. A contractor's employee on the project shall have a Level II International Municipal Signal Association (IMSA) Traffic Signal Technician Certification.

D. The Contractor shall be responsible for ONE-CALL locates of the traffic and interconnect cables installed under this project until acceptance of the project by the City.

E. At the completion of the project, the Contractor shall provide the city with as-built drawings of the signal installation.

F. At the completion of the project, the Contractor shall mark the location of all conduits with paint and flags. The West Des Moines Public Services Department will then utilize their GPS equipment to map the conduit, footing, and handhole locations.

G. The Contractor shall provide a Communications Coordinator to facilitate with system integration and provide installation and fiber optic cable certification. The Communications Coordinator shall have experience in the preparation of cabinet fiber termination drawings, the West Des Moines fiber optic network, the installation of signal systems communications equipment, and fiber optic cable testing procedures.

151084.02 EQUIPMENT AND MATERIALS

A. Fabrication or assembly process materials shall comply with the applicable parts of Section 2525 of the Standard Specifications with the additions as stated herein.

B. Equipment and materials shall be of new stock unless the plans provide for the relocation of or the use of fixtures furnished by others. New equipment and materials shall be the product of reputable manufacturers of electrical equipment and shall meet Engineer approval.

C. A PDF file of shop drawings shall be furnished for steel mast arm poles to be furnished on the Project. A PDF file of catalog cuts and manufacturer's specifications shall be furnished for all standard "off-the-shelf" items.

D. Engineer review of shop drawings and catalog cuts shall not relieve the Contractor of any responsibility under the Contract documents.

E. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), and all material and work shall conform to the requirements of the National Electrical Code (NEC), the Standards of the American Society for Testing Materials (ASTM), the American Standards Association (ASA), and local ordinances. Miscellaneous electrical equipment and materials shall be UL approved.

F. Wherever reference is made in these specifications or in the standard provisions to the code, the safety orders, the general order, or the standards mentioned above, the reference shall be construed to mean the code, order, or standard that is in effect at the date of advertising of these Specifications.

G. Certification from the manufacturers of all electrical equipment, signal supports, conduit and cable shall be supplied by the Contractor stating said materials complies with these Specifications.

151084.03 SCHEDULE OF UNIT PRICES

Complete and forward to the Contracting Authority a list of unit costs for each item listed on the Schedule of Unit Prices by the preconstruction meeting. The Schedule of Unit Prices will be provided to the Contractor. The sum of the costs for each item shall equal the total Contract Lump Sum price for the traffic signal installation(s). The unit costs will be used to prepare progress payments to the Contractor. The unit costs will also be used to establish the total cost for any Extra Work Orders related to traffic signal installation work items unless otherwise negotiated.

151084.04 TESTING AND MAINTENANCE OF SIGNAL EQUIPMENT

A. Notify the Engineer the date the signal or signal system will be ready for testing once the project is open to traffic.

B. Upon authorization of the Engineer, place the signal or signal system in operation for a consecutive 30 day test period. The signal(s) shall not be placed into operation without prior notification and authorization of the Engineer. Any failure or malfunction of the equipment furnished by the Contractor, exclusive of minor malfunctions (such as lamp burnouts) occurring during the test period, shall be corrected at the Contractor's expense and the signal or system tested for an additional 30 consecutive day period. This procedure shall be repeated until the signal equipment has operated satisfactorily for 30 consecutive days.

C. A representative from the manufacturer and/or supplier of signal controller shall be at the project site when the signal controllers are ready to be turned on, to provide technical assistance including, as a minimum, programming of all necessary input data. All required signal timing data shall be provided by the Engineer. After signal turn on and prior to final acceptance of the completed traffic signal system, the Contractor shall respond, within 24 hours, to perform maintenance or repair of any failure or malfunction reported.

151084.05 GUARANTEE

The Contractor shall transfer all required equipment warranties on the date of final acceptance to the Contracting Authority.

151084.06 HANDHOLES

A. Handholes shall be installed at the locations shown on the plans, and at such additional points, as the Contractor, at his own expense, may desire to facilitate the work.

B. The body of the precast hand hole shall meet the requirements for Class 1500D concrete pipe insofar as applicable.

C. Cast iron ring and cover (Neenah R-5900E) may be rated light duty for non-traffic areas (145 pounds minimum); but shall be rated heavy duty for traffic areas (320 pounds minimum) where shown on the plans. Deviations in weights shall not exceed plus or minus five percent.

D. The cover shall have the words TRAFFIC SIGNAL cast on the top of the cover.

E. Cable hooks - Four cable hooks shall be provided in all handholes as detailed on the plans. Cable hooks shall be galvanized steel with a minimum diameter of 3/8 inch and a minimum length of 5 inches and anchored in the wall of the hand hole utilizing appropriate anchoring devices.

F. Handholes shall be installed in a neat and workmanlike manner. When the use of forms is required they shall be set level and of sufficient thickness to prevent warping or other deflections from the specified pattern. A means shall be provided for holding conduit runs rigidly in place while the concrete is placed. All conduits shall enter the hand hole at a depth of 12 inches from the top of the hand hole. Any deviations from this requirement shall be approved by the Engineer. The ends of all conduit leading into the hand hole shall fit approximately 2 inches beyond the inside wall. A coarse aggregate drain of 1 inch clean stone or gravel conforming to the dimensions shown on the plan details shall be provided. Cast iron rings and covers for handholes shall be set flush with the sidewalk, pavement, or the surface of the ground.

G. Type 2 Handholes shall be Quazite 30 inch by 48 inch “PG” Style (Stackable) Assembly Model # PG3048BB36, or approved equal. The handhole shall have a two-piece cover rated for heavy-duty loading. The legend “Traffic Signal” shall be on both pieces of the lid and be secured by two stainless steel bolts. A minimum of four cable hooks will be installed in each handhole to support the signal cables.

151084.07 CONDUIT SYSTEM

A. The number, type, and size of conduit shall be as shown on the plans. Conduit shall meet the requirements of Article 4189.01.B of the Standard Specifications.

B. Conduit shown on the plans as rigid steel shall be galvanized steel meeting the requirements of ANSI Standard Specification C80.1, latest revision.

C. Conduit shown on the plans as polyvinyl chloride (PVC) conduit shall meet the requirements of NEMA TC-2, Type 2, and applicable UL Standards. HDPE conduit, orange in color, with and SDR of 13.5 will be allowed to be used in place of PVC conduit.

D. Conduit shall be placed as shown on the plans. Change in direction of conduit shall be accomplished by bending such that the conduit will not be injured or its internal diameter changed. Bends shall be of uniform curvature and the inside radius of curvature of any bend shall not be less than six times the internal diameter of the conduit.

E. When it is necessary to cut and thread steel conduit, no exposed threads will be permitted. All couplings shall be tightened until the ends of conduits are brought together so that an electrical connection will be made throughout the entire length of the conduit run. All conduit and fittings shall be free from burrs and rough places and all conduit runs shall be cleaned, swabbed, and reamed before cables are installed. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Damaged galvanized finish on conduit shall be painted with zinc rich paint. All fittings used with rigid steel conduit shall be galvanized steel only.

F. Approved conduit bushings shall be installed on the exposed ends of rigid steel conduit. Bell end fittings shall be installed on the exposed ends of PVC or HDPE conduit. In all bases, conduit shall extend a minimum of 4 inches above the finished surface.

G. Conduit buried in open trenches shall be placed a minimum of 36 inches deep unless otherwise directed by the Engineer or on the plans. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Conduit in pavement areas shall be placed to a minimum depth of 36 inches below the finished pavement surface or as directed by the Engineer.

H. The backfill material in open trenches shall be deposited in layers not to exceed 6 inches in depth and each layer shall be thoroughly compacted before the next layer is placed. Backfill material shall be free of cinders, broken concrete, or other hard or abrasive materials. All surplus material shall be removed from the public right-of-way.

I. Whenever excavation is made across parkways, driveways or sodded areas, the sod, topsoil, crushed stone or gravel shall be replaced or restored as nearly as possible to its original condition and the whole area involved shall be left in a neat and presentable condition. Concrete sidewalks, pavements, base courses, and bituminous surfaces shall be replaced with new materials. Surface restoration shall be completed in accordance with the current edition of "Specification Standards for Public Improvements" of the City of West Des Moines and shall be considered incidental to the bid items of the project and will not be paid for separately.

J. "Pushed" conduit shall be placed by jacking, pushing, boring, or any other means necessary to place the conduit without cutting, removing, or disturbing existing pavement. The size of a bored hole shall not exceed the outside diameter of the conduit that is to be placed. Tunneling under the pavement or water jetting will not be permitted. Pits for boring shall not be closer than two feet to the back of curb unless otherwise directed by the Engineer.

K. All conduit openings in the controller cabinet, hub cabinet, hand holes, and bases shall be sealed with an approved sealing compound. This compound shall be readily workable soft plastic. It shall be workable at temperatures as low as 30°F, and shall not melt or run at temperatures as high as 300°F.

151084.08 WIRING

A. Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, yellow to yellow, and green to green. Circuits shall be properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables.

B. All vehicle and pedestrian signal cable runs shall be continuous from connections made in the handhole compartment of signal pole bases to the terminal compartment in the controller cabinet. Splicing will not be allowed in underground hand holes unless specifically called for on the plans. Cable runs for video detection cables and emergency vehicle preemption cables shall be continuous from the unit to the control cabinet.

C. Power lead-in cable runs shall be continuous from the Power Company service point to the meter socket and from the meter socket to the controller cabinet.

D. Slack for each electrical cable shall be provided by a 4 foot length in each hand hole and a 2 foot length in each signal pole, pedestal and controller base (measured from the handhole compartment in the pole to the end of the cable). Coil cable slack in hand hole and place on the hooks.

E. Cables shall be pulled through conduit by means of a cable grip designed to provide a firm hold upon the exterior covering of the cable or cables, with a minimum of dragging on the ground or pavement. This shall be accomplished by means of reels mounted on jacks, frame mounted pulleys, or other suitable devices. Only vegetable lubricants may be used to facilitate the pulling of cable.

151084.09 ELECTRICAL CABLE

A. General

1. Electrical cable for intersection signalization shall be rated 600 volts minimum.

2. The number of conductors and size of all electrical cable shall be as shown on the plans.

3. All wire shall be plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.

4. Home runs for cables shall be labeled as follows:
- NW corner is red
- SE corner is blue
- NE corner is green
- SW corner is orange

B. Power Lead-In Cable

Power lead-in cable shall be 600 volt, single conductor, stranded copper, Type USE, with UL approval and size as shown on plans.

C. Signal Cable and Street Light Cable

Signal cable shall be 600 volt, multi-conductor copper wire. Signal cable shall meet the requirements of the International Municipal Signal Association (IMSA) Specification 19-1, latest revision thereof for polyethylene insulated, polyvinyl chloride jacketed signal cable. All signal cable conductors shall be No. 14 AWG unless otherwise specified on the plans. The conductors shall be solid and not stranded. All street light cable conductors shall be as specified on the plans.

D. Tracer Wire

1. A tracer wire shall be installed in all conduits with the exception of conduits between detector loops and hand holes.

2. The tracer wire shall be a No. 10 AWG, single conductor, stranded copper, Type THHN, with UL approval and an orange colored jacket.

3. The tracer wire shall be spliced in the hand holes and controller to form a continuous network. The splice shall be a soldered connection and then covered with a wire nut.

E. Traffic Monitor Unit Cable

The cable shall be Belden 7937A multi-conductor, waterblocked, shielded Cat5e cable. Ethernet cable run outside of the traffic cabinet shall be environmentally hardened, shielded, and outdoor rated 350 MHz Category 5e cable. The cable shall be riser rated, No. 24 AWG solid copper, have Polyolefin insulation, UV and oil resistant LLPE jacket. Pair 1 shall be Blue, White/Blue, Pair 2

shall be Orange, White/Orange, Pair 3 shall be Green, White/Green and Pair 4 shall be Brown, White/Brown. The operating temperature shall be from -40°C to +75°C. The cable shall conform to the following standards: ISO/IEC 11801 Category 5e, NEMA WC 63, and ANSI/TIA/EIA 568-B.2 Category 5e. The cable shall be without splicing or joints for any single run.

151084.10 CONCRETE BASES

A. Concrete bases for poles and controllers shall be poured to form a monolithic foundation and shall conform to the dimensions shown on the plans. Excavations for these bases shall be made in a neat and workmanlike manner. The bottom of all foundations shall rest securely on firm undisturbed ground. The material for the forms shall be of sufficient thickness to prevent warping or other deflections from the specified pattern. The forms shall be set level or sloped slightly to blend with the adjacent ground level and means shall be provided for holding them rigidly in place while the concrete is being deposited. All conduits shall be installed and held rigidly in place before concrete is deposited in the forms. A ground rod (s) shall be placed at each pole and controller base as shown on the plans. Anchor bolts for the signal poles or the controller cabinet shall be set in place by means of a template constructed to space the anchor bolts in accordance with the manufacturer's requirements. The center of the template and the center of the concrete base shall coincide unless the Engineer shall direct otherwise. Concrete shall be consolidated by vibration during placement.

B. The top of the base shall be finished level and the top edges shall be rounded with an edger having a radius of 1/2 inch. In sidewalk areas, adjacent to sidewalks, or in other paved areas, the top 10 inches of the base shall be formed square and shall be flush with the surrounding paved area. Preformed expansion material shall be provided between the base and the other paved area. When installed in an earth shoulder away from the pavement edge, the top of the concrete base shall be approximately 2 inches above the surface of the ground. The exposed surface of the base shall have a rubbed surface finish.

C. After the foundation or base has been poured, absolutely no modification of any sort may be made. If the anchor bolts, conduit, or any part of the foundation or base is installed in an incorrect manner as determined by the Engineer, the entire foundation or base shall be removed, and a new foundation or base installed at the Contractor's expense.

D. Prior to setting poles, the anchor bolts shall be covered in such a manner as to protect them against damage and to protect the public from possible injury. The foundations must be given a minimum of seven days to cure before poles are erected.

E. Footings shall be Class C structural concrete meeting the requirements of Section 2403 of the Standard Specifications.

F. Reinforcing steel shall be the type and size as shown on the plans and shall conform to the requirements of Section 2404 of the Standard Specifications.

151084.11 BONDING AND GROUNDING

A. All conduit, steel poles, and pedestals shall be bonded to form a continuous system and be effectively grounded. Bonding jumpers shall be No. 6 AWG bare copper wire or equal connected to the ground rod by Cadweld connectors. Bare copper ground wires shall be connected together by an approved mechanical crimp type of connector. Split bolt connectors will not be used.

B. Grounding of the conduit and neutral at the service point shall be accomplished as required by the National Electric Safety Code, except bonding jumpers shall be No. 6 AWG or equal.

C. Ground electrodes shall be provided at each signal pole and at the controller as detailed on the plans.

D. A No. 6 AWG bare copper ground wire shall be installed in all PVC conduit that carries 120 volt signal cables.

151084.12 SIGNAL APPURTENANCES

A. Signal Faces

1. All traffic signal displays shall be installed as indicated on the plans. All overhead displays located on each mast arm shall have each red indication set at approximately the same elevation, unless otherwise directed by the Engineer.

2. During construction and until the signals are placed in operation, signal faces shall be covered or turned away from approaching traffic. When ready for operation, they shall be securely fastened in position facing toward approaching traffic and plumb.

B. Controller and Hub Cabinets

1. The controller and hub cabinets shall be installed at the location indicated on the Plans with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller, unless otherwise directed by the Engineer.

2. The controller and hub cabinets shall be installed on pre-placed caulking material on the concrete base. After the cabinet is installed in place the Contractor shall also place caulking material around the base of the cabinet.

C. Pole Erection

1. All poles shall be erected to be vertical under normal load, with mast arms oriented at 90 degrees to the curb line, unless otherwise specified. The bases shall be securely bolted to the cast-in-place concrete foundations. Leveling shall be accomplished using metal shims and/or one nut or two nuts on each anchor rod or as directed by the pole manufacturer. One nut shall be turned on each anchor rod and the pole placed in position on these nuts. The top nuts shall then be turned into place loosely and the pole adjusted to the vertical position by adjusting both the upper and lower nuts.

2. After leveling the poles, expansive type grout shall be troweled between the pole base and the foundation for gaps of 1 inch or greater. Exposed edges of grout shall be neatly finished to present a pleasing appearance. A weep hole shall be placed in the grout.

3. Each pole shall be grounded by installing a No. 6 AWG bare copper ground wire between the pole and the ground rod at the foundation.

D. If the painted or galvanized surface of any equipment is damaged in shipping or installation, such equipment shall be retouched or repaired in a manner satisfactory to the Engineer.

151084.13 ACTUATED CONTROLLER

Provided by City.

151084.14 CONTROLLER CABINET AND AUXILIARY EQUIPMENT

Provided by City.

151084.15 MANAGED SWITCHES

Provided by City.

151084.16 VEHICLE TRAFFIC SIGNAL HEADS

A. This section of the specifications describes the minimum acceptable design and operating requirements for vehicular signal heads with 12 inch diameter lens openings, including all fittings and brackets as shown on the plans. All components of the vehicular signal heads furnished under this specification shall comply with the latest version of the Institute of Transportation Engineers Standard(s) for Adjustable Face Vehicle Traffic Control Signal Heads. All the indications of the vehicle signals will use 48 VDC LED modules and provide uniform appearance of the indications.

B. 48 VDC LED Modules

1. The low power 48 VDC LED vehicle signals shall be installed in traffic signal housings rated as a 12 inch signal housing commercially manufactured with a durable polycarbonate material and be compatible with traffic signal mounting brackets utilizing serrated locking between signal sections. The LED signal section shall be a self-enclosed, sealed unit, with electrical connections to be terminated on the standard terminal block, spade termination, mounted in the traffic signal section. The signals shall be 48 VAC rated and shall be operate at 36 to 60 VDC.

2. All electronics in the signal shall meet NEMA temperature rating of –40 ºC to +74ºC. The enclosure shall conform to NEMA Moisture Resistance Standard 250-1991 for Type 4 enclosures (ITE 6.4.6.2 Moisture Resistance). The signal electronics shall meet FCC Title 47, Subpart B, and Section 15 Regulations for Electrical Noise dissemination. The units shall have temperature compensated power supplies.

3. The traditional “ball” signal display shall have the following characteristics:

C. Red Signal Display (Dialight 433-1210-009XL)

- Luminous Intensity # (cd) 365
- Dominant Wavelength (nm) 625
- Lens Tint Tinted
- Typical Wattage at 25ºC 4

D. Yellow Signal Display (Dialight 433-3230-909XL)

- Luminous Intensity # (cd) 910
- Dominant Wavelength (nm) 590
- Lens Tint Tinted
- Typical Wattage at 25ºC 7

E. Green Signal Display (Dialight 433-2270-009XL15)

- Luminous Intensity # (cd) 475
- Dominant Wavelength (nm) 500
- Lens Tint Clear
- Typical Wattage at 25ºC 4

F. Signal Head Assembly

1. The housing for the individual signal sections shall be made of a durable polycarbonate. It shall be clean, smooth, and free from flaws, cracks, blowholes, and other imperfections. It shall be designed as a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together. It shall be equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane. Doors and lenses shall be provided with suitable watertight gaskets and doors shall be suitably hinged and held securely to the body of the housing by simple locking devices of non-corrosive material.

2. The visors for each signal section shall be durable polycarbonate not less than 0.10 inches in thickness. It shall be designed to fit tightly against the door and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be of the tunnel-type at least 9 1/2 inches long for 12 inch diameter signals, shall angle slightly downward, and shall be of the type specified on the plans.

G. Specialized Options

1. One section of each three-section signal shall be equipped with a six-position terminal block for termination of field wiring. Each five-indication signal shall be equipped with an eight-position terminal block.

2. The color of all polycarbonate signal heads, except door fronts and inside and outside of visors, shall be federal yellow. Door fronts and inside and outside of visors shall be black in their entirety. The color shall be an integral part of the materials composition.

3. Signal mounting hardware for side of pole-mounted signals shall consist of 1 1/2 inch aluminum pipe and appropriate fittings with a natural finish. Signals shall be secured to pole by using a minimum 5/8 inch wide stainless-steel banding material.

4. Mast arm signal head assemblies shall be rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes. The contractor shall use an Astro-Brac Galaxy Assembly, 1-Way Cable Mount AG-0125 manufactured by Pelco Products, Inc., for mast arm mounting.

5. Where shown on the plans, 5 inch back plates shall be furnished and attached to the signal faces to provide a dark background for signal indications. Backplates shall be constructed of one-piece durable black plastic capable of withstanding a 100 mph wind.

H. Miscellaneous Requirements

The signal heads shall be constructed of the highest quality materials. High-grade workmanship shall be used throughout. Each head shall have a smooth surface both inside and outside and shall contain no sharp fins or sharp projections of any kind.

I. Certification

The Engineer shall be furnished with a certification from the manufacturer of the signal head that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, a list of those exceptions must be detailed on the certification.

J. Warranty

The LED signal ball and arrow modules shall be replaced or repaired if it fails to function as intended due to workmanship or material defects within 5 years from date of operation.

151084.17 PEDESTRIAN TRAFFIC SIGNAL HEAD WITH COUNTDOWN DISPLAY

A. General Requirements

This section of the specifications describes minimum acceptable design and operating requirements for one-section, 16 inch by 18 inch pedestrian traffic signal head with LED "MAN" and "HAND" symbol messages on the left side of the module and an LED digital countdown display on the right side of the module including all fittings and brackets, as specified on the plans. The pedestrian signal head shall comply with the latest version of the Institute of Transportation Engineers Standards on Pedestrian Traffic Signal Heads and the MUTCD.

B. Signal Head Assembly

1. The mounting, housing, and visor for pedestrian signal heads shall conform to the provisions of "Vehicle Traffic Signal Heads" section in these specifications, and as shown on the plans.

2. The color of all polycarbonate signal heads, except door fronts and inside and outside of visors, shall be federal yellow. Door fronts and inside and outside of visors shall be black in their entirety. The color shall be an integral part of the materials composition. The pedestrian signal head shall be provided with a black, egg crate visor.

3. Signal mounting hardware shall consist of 1 1/2 inch aluminum pipe and appropriate fittings with a natural finish. Signals shall be secured to pole by using a minimum 5/8 inch wide stainless-steel banding material.

C. Pedestrian Signal LED Module

1. The LED "MAN" and "HAND" symbol messages on the left side of the module and an LED digital countdown display on the right side of the module. The module shall operate at 36 to 60VDC.

2. The LED module shall be Dialight 430-6479-009X.

D. Certification

The Engineer shall be furnished with a certification from the manufacturers of the signal head and LED module that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, a list of those exceptions must be detailed on the certification.

E. Warranty

The LED modules shall be replaced or repaired if it fails to function as intended due to workmanship or material defects within the first 5 years from date of operation.

151084.18 PEDESTRIAN PUSH BUTTONS

A. Pedestrian push button detectors shall be manufactured by Polara Engineering, Inc. The button shall be a BDL3-Y (Momentary LED Indication and Tone) and the push button cup shall be a PBC-Y.

B. The push button shall be weatherproof and of sturdy design. The entire assembly shall be weather tight, secure against electrical shock, and able to withstand continuous hard usage. The button shall us a piezo driven solid-state switch.

C. The housings shall be made of aluminum alloy and furnished with suitable mounting hardware. The pedestrian push button and mounting shall be yellow powder-coated aluminum.

D. Push button signs shall be furnished and shall conform to the requirements of the MUTCD. Signs shall be R10-3a. Sheeting material for the signs shall be 3M Diamond Grade DG3 Reflective Sheeting Series 4000.

E. The Engineer shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, then a list of those exceptions must be detailed on the certification.

151084.19 TRAFFIC SIGNAL POLES

A. General

1. This section of the Special Provisions described minimum acceptable design, material, and fabrication requirements for traffic signal poles. Poles shall be manufactured in accordance with the requirements of AASHTO 2013 Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals.

2. Use a 90 mph basic wind speed with a 50 year mean recurrence interval for strength design. Use Category II for fatigue design. Apply only natural wind gust loads (i.e. do not apply galloping loads, vortex shedding loads, or truck-induced gust loads) for fatigue design. Install vibration mitigation devices on all traffic signal pole mast arms over 60 feet in length. The vibration mitigation device shall be a Mitigator TR1 Traffic Damper manufactured by Valmont Industries. The poles shall be manufactured by Valmont Industries, Inc. or Millerbernd Manufacturing Co., in accordance with city of West Des Moines specifications.

3. The traffic signal mast arm and pole assemblies shall be designed to support the number of signal heads and signs as shown on the plans. The mast arm and pole assemblies shall be designed to support a minimum of two signal heads and a traffic control sign at the outboard end of the arm.

4. The mast arms and support poles shall be continuous tapered, round, steel poles of the transformer base type as shown on the plans. The poles shall be fabricated from low carbon (maximum carbon 0.30%) steel of U.S. Standard gauge. Transformer bases will not be used when the manufacturer's structural design calculations indicate that the loadings on the pole will not permit the use of the transformer base.

5. When a transformer base is not used, the pole shaft shall have a handhole 10 inches by 12 inches for cable access. The handhole shall be provided with a cover.

6. After manufacture, they shall have minimum yield strength of 48,000 PSI. The base and flange plates shall be of structural steel conforming to AASHTO M183 (ASTM A36) and cast steel conforming to ASTM A27, Grade 65-35 or better.

7. It may be permissible to fabricate poles and mast arms by welding two sections together. The method used for connecting the sections shall result in a smooth joint and shall be factory welded as follows:

8. All longitudinal butt welds, except within one foot of a transverse butt-welded joint, shall have a minimum 60 percent penetration for plates 3/8 inch and less in thickness, and a minimum of 80 percent penetration for plates over 3/8 inch in thickness.

9. All longitudinal butt welds on poles and arms within one foot of a transverse butt-welded joint shall have 100 percent penetration.

10. All transverse butt welds for connecting sections shall have 100% penetration achieved by back-up ring or bar.

11. All transverse butt welds and all specified 100% penetration longitudinal butt welds on poles and mast arms shall be examined 100% by ultrasonic inspection according to the requirements of AWS D1.1-80.AH.

12. Welding and fabrication shall conform to ANSI/AWS D1.1 except as modified by Article 2408.03, B of the Standard Specifications.

13. Personnel performing nondestructive testing shall be qualified in accordance with the American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A and applicable Supplements B (Magnetic Particle) and C (Ultrasonic). Evidence shall be presented for approval of the Engineer, concerning their qualifications. A report shall be

required showing that welds have been inspected and either found satisfactory or found unsatisfactory but repaired and reinspected and found satisfactory. The cost of all nondestructive testing shall be paid by the Contractor and will be considered incidental to other items in the contract.

14. Pole manufacturers shall certify that only certified welding operators in accordance with ANSI/AWS D1.1 except as modified by Article 2408.03, B of the Standard Specifications.

B. Mast Arm

The mast arms shall be designed to support traffic signals and/or signs as shown on the plans and indicated in these Specifications. The mast arms shall be of the length as shown on the plans. The mast arms shall be galvanized inside and out in accordance with ASTM A123, latest revision.

C. Poles

The pole shall be designed to support the traffic signals and/or signs as shown on the plans. The pole shall be galvanized inside and out in accordance with the requirements of ASTM A123, latest revision. The pole shall be equipped with a minimum 8 inch by 12 inch hand hole and cover located in the transformer base of the pole. Securing of the cover to the base shall be done with the use of simple tools. Hardware shall be corrosion resistant.

D. Combination Pole

1. Where a combination street lighting/signal pole is specified on the plans, the luminaire arm is to be mounted in the same vertical plane as the signal arm unless otherwise indicated on the plans.

2. The luminaire arm type shall be a single member tapered type arm unless specified otherwise on the plans.

3. The luminaire arm shall provide the spread and nominal mounting height as shown on the plans.

4. Where a combination street lighting/signal pole is specified on the plans, the pole shall be equipped with a minimum 4 inch by 6 inch hand hole and cover located opposite the signal mast arm.

5. The luminaire arm shall be arched.

E. Hardware

1. The mast arms and poles shall be equipped with all necessary hardware, shims, and anchor bolts to provide for a complete installation without additional parts.

2. The anchor bolts shall meet the requirements of ASTM A36 or better.

3. The anchor bolts shall be hot dip galvanized for a minimum of 12 inches on the threaded end.

4. The anchor bolts shall be threaded a minimum of 6 inches at one end and have a 4 inch long, 90 degree bend at the other end.

5. The fabricator shall submit drawings for anchor bolts and base design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A123, Class D or electrodeposited coated of the same coating thickness and so designed for this purpose.

F. Shop Drawings
All traffic signal poles shall be detailed on shop drawings by the manufacturer indicating pole and arm dimensions and attachment method along with signal weight, projected areas, and type of mounting that it is designed to accommodate.

G. Certifications
The fabricator shall certify that the mast arms are capable of withstanding winds up to 80 mph with a 1.3 gust factor without failure; that only certified welding operators in accordance with ANSI/AWS D1.1 except as modified by Article 2408.03, B of the Standard Specifications were used; and that only electrodes as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel for Highway Bridges were used.

151084.20 TRAFFIC SIGNAL PEDESTALS

A. This section of the specifications describes minimum acceptable design, material, and fabrication requirements for aluminum traffic signal pedestals.

B. Materials

1. The length of the pedestal, from the bottom of the base to the top of the shaft shall be as shown on the plans.

2. The pedestal shaft shall be fabricated of aluminum tubing with a wall thickness of not less than 0.125 inches. It shall have a satin brush or spun finish. The top of the shaft shall have an outer diameter of 4 1/2 inches and be provided with a pole cap. A pole and base collar shall be installed on the pole to prevent loosening of the connection to the base.

3. The pedestal base shall be cast aluminum, square in shape, with a hand hole. The size of the hand hole shall be at least 4 inches by 6 inches and equipped with a cover which can be securely fastened to the shaft with the use of simple tools. Bases shall have a minimum weight of 20 pounds and shall have a four bolt pattern uniformly spaced on a 12 1/2 inch diameter bolt circle. The exterior of the base shall be smooth and have a neat appearance.

4. The base shall meet or exceed 1985 AASHTO breakaway requirements. Test reports from an FHWA approved independent laboratory shall be provided certifying tests have been accepted and approved by the FHWA as compliant to AASHTO breakaway requirements.

C. Anchor Bolts
Four 3/4 inch by 15 inch hot rolled steel anchor bolts shall be supplied, complete with all hardware required for installation. The anchor bolts shall have a right angle bend at the bottom end and be hot dip galvanized at the threaded end.

D. Certification
The fabricator shall certify that the pedestals are capable of withstanding winds up to 80 mph with a 1.3 gust factor without failure.

151084.21 TRAFFIC SIGNS

A. Traffic signs shall conform to the requirements of Section 4186 of the Standard Specifications.

B. The contractor shall use a PELCO AG-0142 ASTRO-BRAC with cable clamps, for mast arm mounting of traffic signs.

C. The street name signs shall be provided to the contractor for installation. The contractor shall provide the street name sign mounting bracket. The contractor shall use a PELCO AG-0144 ASTRO-BRAC with cable clamps, for mast arm mounting of street name signs.

D. The sheeting material for all signs shall be 3M Diamond Grade DG3 Reflective Sheeting Series 4000.

151084.22 TRAFFIC MONITOR SYSTEM

A. The Traffic Monitor System utilized on the Project shall be the Axis Q6075-E PTZ Dome Network Camera.

B. The traffic monitor system shall include camera in dome, dome, dome mounting bracket and hardware, cabling, and all accessories and hardware necessary for a complete operational unit. The traffic monitor system shall include all required lightening protection for the electronics control, power, and video outputs. Power for the camera shall be provided by High Power over Ethernet (High PoE).

C. The traffic monitor system shall be tested under the supervision of the city traffic personnel and certified as fully functional. Positioning of the camera dome on the pole shall be as directed by the Engineer.

D. The Contractor shall furnish and install all necessary miscellaneous cables, connectors and equipment to make a complete and operating installation in accordance with the plans, standard sheets, standard specifications, special provisions, and accepted good practice of the industry.

151084.23 COMMUNICATIONS AND NETWORK INTERFACE

A. The contractor shall provide all necessary auxiliary equipment and line drivers needed to implement traffic signal control, interface with conflict monitor units, interface with preemption units, interface with UPS battery backup devices, control video image detectors and capture and display the video at the Traffic Operations Center and other traffic monitoring sites, and view and control traffic monitor cameras installed at these locations and other locations as video is transmitted from traffic intersections to the Traffic Operations Center.

B. The contractor shall contact the city's Communications Coordinator (gba Systems Integrators, (309-428-3027 or 309-558-0165) to obtain services to facilitate the communications interface of field equipment with the Traffic Operations Center. The Communications Coordinator shall provide all IP addressing for all devices being installed compliant with the IP addressing scheme developed for the City of West Des Moines. All switches managed and unmanaged shall be programmed by the Communications Coordinator and tested for Ring and/or Mesh topology redundancy functionality. IP addressing is required for the traffic controller unit, conflict monitor, radar presence vehicle detection, video monitoring device, preemption device, UPS battery backup device and all managed switches.

151084.24 FIBER OPTIC CABLE

This work shall consist of furnishing and installing a fiber optic cable of the type, size, and number of fibers specified.

A. Materials and Equipment

1. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. The fiber optic shall be manufactured utilizing Corning glass fiber conforming to the following specifications. All materials and equipment furnished shall be completely free from defects and poor workmanship. All fibers shall be glass and be manufactured by Corning or pre-approved equal. The cable shall be rated for gigabyte data bandwidth. All fiber shall be loose tube construction for both indoor and outdoor installation. Indoor cabling shall use plenum rated conduit to within less than 50 foot of point of termination eliminating the requirement to convert to indoor cable. The Traffic Engineer will approve the cable specifications prior to installation.

2. Contractor Qualifications

Trained and experienced personnel shall supervise the fiber optic cable installation. Qualified technicians shall make the cable terminations and splices. The Contractor upon request of the Engineer shall provide documentation of qualifications and experience for fiber optic equipment installations. The Engineer shall determine if the Contractor is qualified to perform this work. The Contractor shall have attended a certified fiber optic training class mandated by these specifications prior to starting work.

3. Codes Requirements

The fiber optic cable installation shall be in accordance with or exceed all minimal requirements of State codes, National codes, and manufacturer codes as applicable.

4. Miscellaneous Equipment

The Contractor shall furnish and install all necessary miscellaneous connectors and equipment to make a complete and operating installation in accordance with the plans, standard sheets, standard specifications, special provisions, and accepted good practice of the industry.

5. General Considerations

- The cable shall meet all requirements stated within this specification.
- The cable shall be new, unused, and of current design and manufacture.

6. Fiber Characteristics

a. All fibers in the cable must be usable fibers and meet required specifications.

b. Single-Mode Fiber

1) Typical core diameter: 8.3um

2) Cladding diameter: 125 +1.0um by fiber end measurement

3) Core-to-cladding offset: <1.0um

4) Coating diameter: 250 +15um

5) Attenuation uniformity: No point discontinuity shall be greater than 0.1 dB, except terminations or patch cords, at either 1310nm or 1550nm. The coating shall be a layered UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically removable without damaging the fiber.

6) Factory cable rating shall be 0.35 dB/KM at 1310 nM and 0.25 dB/KM at 1550 nM. Installed tolerance shall be less than 0.44 dB/KM at 1310 nM and less than 0.33 dB/KM at 1550 nM, testing tolerance.

7) All fiber cables shall be Gigabyte rated, i.e. single mode shall be 28 KM for 1310 nM and 40 KM for 1550 nM based on a 10 dB power budget.

8) All Single mode fiber shall be rated for multi-frequency, four frequencies, equivalent to the AllWave OFS specification and shall be rated to withstand extended aging under water impregnation conditions.

B. Fiber Specification Parameters

1. All fibers in the cable shall meet the requirements of this specification. The testing tolerance attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable when installed.

2. The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.20 dB/km at 1550 nm, with 80 percent of the measured values no greater than 0.10 dB/km at 1550 nm.

3. Optical fibers shall be placed inside a loose buffer tube, minimum six fibers per tube, normally 12 fibers per tube. Actual number of fibers per tube shall be 12 fibers per tube unless specified differently on the plans.

4. The buffer tubes will meet EIA/TIA-598, “Color coding of fiber optic cables.”

5. All fiber cables shall be Gigabyte rated, i.e. 5000 Meter for 1310 and 1550 nM.

6. Fiber count, tubes of fiber, shall be as specified on the plans.

7. Fillers shall be included in the cable core to lend symmetry to the cable cross-section where needed.

8. The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

9. The cable shall use a completely dry cable design without the use of gels and filling compounds. Dry water blocking material shall be used around the buffer tubes as well as internal to the tubes. Water blocking gels shall not be acceptable on this project.

10. Buffer tubes shall be stranded around a central member. Acceptable techniques include the use of the reverse oscillation, or “SZ”, stranding process.

11. All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.3 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. Cable jacketing shall utilize the newer designs to provide maximum flexibility without loss or appreciable dB attenuation. Cable diameter shall not exceed 0.50 inch.

12. The jacket or sheath shall be marked with the manufacturer’s name, the words “optical cable”, the year of manufacture, number of fibers, type of fiber (SM) and sequential feet marks. The markings shall be repeated every three feet. The actual length of the cable shall be within –0/+1% of the length marking. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm. A copy of the manufacturer fiber definition and shipping sheet identifying all tests, results and fiber indexes shall be provided to the Engineer on delivery of cable to the City or shall be included with a contractor’s listing of place(s) of installation when installed by a Contractor.

13. The maximum pulling tension shall be 600 pounds during installation.

14. Wherever possible, six buffer tubes with 12 fibers each, or subsets specified, shall be provided and designated as follows:

Buffer Tube/Fiber	Tube/Fiber Color
#1, 1st tube or fiber	blue
#2, 2nd tube or fiber	orange
#3, 3rd tube or fiber	green
#4, 4th tube or fiber	brown
#5, 5th tube or fiber	slate
#6, 6th tube or fiber	white
#7, 7th tube or fiber	red
#8, 8th tube or fiber	black
#9, 9th tube or fiber	yellow
#10, 10th tube or fiber	violet
#11, 11th tube or fiber	rose
#12, 12th tube or fiber	aqua

C. Quality Assurance Provisions

1. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.

2. All optical fibers shall be 100% attenuation tested at the manufacturer. The attenuation of each fiber shall be provided with each cable reel. The measured attenuation shall be for both 850 and 1300 frequency for multimode and 1310 or 1550 frequency for single mode. This documentation shall be provided to the Engineer with each spool. The Contractor shall designate on the plans and on this documentation the location where each spool has been installed and provide this data to the Engineer.

D. Cable Installed in Ducts and Conduits

1. A suitable cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct off the reel. It shall be carefully inspected for jacket defects. If defects are noticed, the pulling operation shall be stopped immediately, and the Engineer notified. Precautions shall be taken during installation to prevent the cable from being "kinked" or "crushed". A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. A pulling swivel shall be used to eliminate twisting of the cable. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Dynamometers or breakaway pulling swing shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed on a cable during installation shall not be such that the cable is twisted or stretched. The pulling of cable shall be hand assisted at each controller cabinet. The cable shall not be crushed kinked or forced around a sharp corner. If a lubricant is used it shall be of water-based type and approved by the cable manufacturer. Sufficient slack shall be left at each end of the cable to allow proper cable termination, minimum of 30 feet. This slack shall be in addition to installation slack as hereinafter specified. Additional slack cable shall be left in each hub cabinet, handhole, and at the top of each conduit riser. Excess slack at hub cabinets shall be re-pulled into the nearest handhole to provide a neat and orderly installation. The minimum slack amounts shall be as follows:

- Hub cabinet – 30 feet
- Type 1 Round Handhole – 20 feet
- Type 2 Rectangular Handhole – 100 feet

2. Storage of minimum slack cable in controller cabinets and additional slack at pull boxes shall be coiled. The slack coils shall be bound at a minimum of three points around the coil parameter and supported in their static storage positions. The binding material and installation shall not bind or kink the cable. Storage of additional slack cable adjacent to conduit risers and support poles shall be as visibly marked/tagged as "CAUTION – FIBER OPTIC CABLE". Maximum length of cable pulling tensions shall not exceed the cable manufacturer's recommendations. Along with the fiber optic cable, one No. 10 AWG THHN, 600 volt single conductor cable (identifier conductor), orange in color, shall be pulled with 10 feet slack in each pull box. All fiber cables shall be marked with a metallic, or preapproved identifier in the handhole adjacent to the traffic signal cabinet or hub cabinet and on the cable in the traffic signal cabinet or hub cabinet at the point of termination. The identifier, both in the cabinet and in the handhole, shall indicate the direction the cable is going, cable contents [SM or SM/MM], and the abbreviated location for the other end destination. Fiber cabling between traffic controllers and adjacent hub locations shall be outdoor rated, loose tube fiber, when not linked by a direct, continuous conduit installation.

3. All fiber cable shall be placed a minimum of 36 inches deep unless otherwise directed by the Engineer or on the plans. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Conduit in pavement areas shall be placed to a minimum depth of 36 inches below the finished pavement surface or as directed by the Engineer.

E. Minimum Bend Radius

For static storage, the cable shall not be bent at any location to less than ten times the diameter of the cable outside diameter or as recommended by the manufacturer. During installation, the cable shall not be bent at any location to less than 20 times the diameter of the cable outside diameter or as recommended by the manufacturer.

F. After the Fiber Optic Cable Installation

1. Each section of the cable shall be tested for continuity and attenuation as a minimum. If the attenuation is found not to be within the acceptable nominal values, the Contractor shall use an optical time domain reflectometer (OTDR) to locate points of localized loss caused by bends or kinks. If this is not successful the Contractor shall replace the damaged section of cable with no additional payment. Splices will not be allowed to repair the damaged section. After all fiber cable is installed between traffic controller cabinets and fiber links between fiber distribution points (FDP) complete links, all fibers, whether terminated or non-terminated, shall be tested with an OTDR. All fibers terminated shall be tested with a power meter. The Contractor may jumper termination points at controller cabinets to minimize the number of tests and run a single OTDR test between several controller cabinets, subject to the range of the OTDR. Links between FDP's shall be tested separately. Each OTDR trace, for documented test result submittal, shall be displayed individually and not be combined with other fiber traces as overlays. Single mode fiber shall be tested at 1310 and 1550 nm. The results of the OTDR test shall be provided on an electronic media (disk or memory stick) and paper printout. The OTDR wave, pictorial diagram of dB loss over the length of fiber tested, shall be provided along with the measured data values. The printout shall contain the manufacturer's fiber optic Index of Refraction to the third decimal point for the fiber provided. The Contractor shall provide the Engineer with a written report showing all the values measured compared to the calculated values for length and coupler/connector losses at the completion of these tests. Outdoor patch cords between FDP and controller units less than 151 feet do not need be OTDR tested.

2. The engineer will be provided with documentation showing the manufacturers name and model of OTDR with documentation of the equipment latest calibration date

3. The engineer will be given a copy of trace viewing software compatible with the latest version of windows operating system in use by the city.

4. Documentation provided to the Engineer shall include a written indication of every splice, termination, patch cord, etc. for cable being measured. Power meter measurement recordings shall indicate the exact measured distance [OTDR or field measurement with cross reference for oscillation multiplier] on the sheet showing the power meter readings. Any deviations between fiber readings in the same tube shall be notated for OTDR graphs as well as deviations greater than 5% on power meter readings. Rated values for acceptable installation shall be based on the following parameters:

- Patch cords/Pigtails 0.15 SM dB each
- Unicam Terminations 1.0 dB set of 2 [In and Out]
- Splices 0.08 each
- 1 KM = 0.3077 KF where KF is 1000 feet

5. Data documentation shall include for each test between cabinets or between FDP sites, the length of fiber as measured by OTDR, frequency used in test on OTDR by each fiber type, distance to each splice, termination or patch cord jumper, dB loss rating by manufacture from spool documentation, index of refraction by type of fiber in section, and the dB loss of each section as measured in the final test for each fiber. A special test shall be made on all continuous spliced fiber from start to end that includes the total dB loss measured and the OTDR plot on electronic disk. Splice points shall be identified on the trace.

G. Cable Termination

1. Terminations shall be made using the method recommended by the connector manufacturer. All fibers shall utilize a fan-out kit of the size and type recommended by the manufacturer and of the number of fibers provided in each fiber tube. All fibers terminated shall utilize a ceramic ferrule (outdoor connections), ST, mechanical termination equal to Corning UniCam connectors, or be a wide temperature (-40°F to +170°F) epoxy. Heat cured or epoxy type connections meeting the full temperature ratings are acceptable for this Project, including factory manufactured pigtails. The Contractor shall be required to provide proof of purchase of sufficient quantities of ceramic terminations for outdoor terminations to verify ceramic connector usage or temperature ratings on epoxy or heat cured processes prior to terminating any fibers. The Contractor may terminate fibers by splicing factory pigtails to the fiber ends and then connecting the pigtail to the fiber coupler in the fiber tray. When splicing pigtails to terminate, all splices shall be provided with the metal reinforced shrink tube protector. The contractor may terminate fibers by the use of UniCam mechanical termination connectors. All termination ST couplers shall be rated for dual fiber application, MM and SM.

2. Use of any connector other than Unicam will be approved by the Engineer prior to installation.

H. Breakout Kits

The breakout kits or termination boxes used to terminate each fiber cable in the cabinet shall provide for the separation and protection of the individual fibers with the buffer tubing and jacketing materials. The termination housing shall be installed within a wall or shelf mountable interconnect housing which shall provide for storing fibers, ample room for feed through cable, strain relief for multiple cables within unit, and accommodate ST compatible connectors. All fiber pigtails shall be terminated through ST connectors on the wall or shelf mounted interconnect panel. All terminations shall be ST type, ceramic core (outdoor connections), and plug into the provided controller unit internal fiber optic modem. Acceptable enclosures for combination termination/splice points shall be Corning Pretium series Connector Housing Series enclosures or pre-approved equal. Splices to pigtail fiber, where used, shall utilize fan out kit protection to the fiber, heat shrink tubing with metal bar reinforcement and 900 micron rated pigtail insulation. Splices to factory pigtails shall use pigtails that are rated for a minimum temperature range of 0°F to +150°F. In the absence of pigtails meeting this temperature rating, fibers shall utilize loose tube fiber in fanout kit tubes and UniCam mechanical ST connectors. These splices, fiber cable to pigtails, may be external to splice trays mounted internally to the enclosure, when shown on the wiring diagrams. All other splices, not specified to be installed external to the fiber splice tray, shall be installed in splice trays and be supported with heat shrink tubing. Acceptable splice trays include MIC-024-048 or 067 series or pre-approved equal.

I. Connectors

Connectors shall be mechanical ST (ceramic ferrule-outdoor connections) compatible, field installable, and self-aligning and centering or factory fabricated pigtails. Connectors to the special devices used for Ethernet network connections shall utilize a factory converter cable of LC to ST or manufacturer specified converter patch cord. Fiber optic equipment, used for terminating fibers, shall be rated for the type of connectors used. Connectors shall be Corning UniCam, or NEMA temperature rated epoxy type, or Engineer approved equal.

J. Splices

The fiber cable shall be installed in continuous runs between cabinets. No splices shall be allowed, unless shown on the plans or for testing. Only mechanical splices, Siecor CamLite, or approved equal will be allowed, when specified, such as testing of non-terminated fibers. Splices, where specified, shall be by fusion splice and shall be installed using an automatic fusion splicer. Splices between two fibers leaving the cabinet shall be supported in splice trays installed in splice enclosures. All splices shall be protected by heat shrink tubing designed for fiber optic splicing applications. Fibers being terminated in two separate termination or splice enclosures shall be supported between enclosures by the use of buffer tubing or approved equal support material or

shall be pigtail patch cords. Termination / splice enclosures shall be separated by less than 12 inches unless a conduit is installed between enclosures. All splices shall be performed by an automated splicer device that verifies the final splice termination quality. All splices shall be nominally 0.03 to 0.05 dB loss but shall be less than a 0.08 dB loss.

K. Light Source

1. An LED light source with a wavelength that is the system wavelength, 850 and 1300 nm for multimode and 1310 and 1550 nm for single mode, shall be used. The LED shall be stable within 0.1 dB in intensity over a time period sufficiently long to perform the measurement. The output of the LED shall overfill the input end of the launch fiber/cable in both numerical apertures (NA) and core diameter. The accuracy of the combined light source and power meter shall be less than .05 dB and be temperature compensated stabilized to 0.01 dB over the operating range of the meter(s).

2. The Contractor shall provide one each Light Source and Power Meter and/or one each 650 nM visible light source, Model VF13 or approved equal, to the Fiber Optic Coordinator or City Technician complete with all attachments for measuring individual fibers of multimode at both 850 and 1300 nanometers and single mode at both 1310 and 1550 nanometers for spot testing/inspecting of installed and terminated fibers. This test kit shall include one each 200X power zoom scope for observing fiber ends for smoothness and fractures. AC power adapters shall be provided with all light and power meters as well as battery operation. This test kit shall remain the property of the Contractor. This test kit shall be made available from the beginning to completion of the project and be on-site at all times.

L. Power Meter

The detector in the power meter shall have an effective numerical aperture and active region that is larger than the receive reference cable and/or the fiber under test. The power meter shall have a minimum range from +3 DBMS to –40 DBMS. The power meter shall have an accuracy of +/- 0.5 dB through the operating temperature and minimum resolution of 0.1 dB.

M. Launch Reference Attenuator

1. The launch attenuator, two each for single and multimode fiber testing, shall be utilized for all OTDR tests such that one launch cable shall be at the beginning of the fiber being tested and the second launch cable shall be on the end of the fiber being tested past the final connector. Only one launch cable shall be required when testing non-terminated fiber. The launch attenuator(s) shall be of the same fiber core size and type as the fiber under test. The attenuator shall emulate 300 foot fiber length, minimum, for multimode and 900 feet length, minimum, for single mode fiber or as specified by the OTDR manufacturer for stabilization of the pulse generation. Launch cables shall be of identical length for incoming and outgoing light during tests. ST connectors shall be utilized with each attenuator to connect the device to the test device, OTDR. One launce cable shall be installed on the start of the fiber being tested and one launch cable shall be installed on the end of each terminated to view the dB loss of the final connector.

2. The OTDR shall have the Threshold Loss set at a value to show each splice or termination junction of a single fiber in each tube without showing the extraneous noise caused by handhole coils or turns into the cabinets. This level is normally a value [Threshold Loss] between 0.3 and 0.8 on the OTDR. This trace shall be provided for one fiber in each tube tested and each “event” shall be marked as to splice, jumper or patch cord. The Threshold Loss shall then be set to a value of 0.25 for multimode fiber tests and to a value of 0.10 for single mode fiber tests. The test of each fiber installed shall be conducted and any recorded events above this threshold shall be identified, such as jumper or patch cord. Events that are in excess the provided values shall be corrected prior to documentation submittal, such as terminations in excess of the rated value or bends in the fiber at the point of a splice entering

of leaving the splice tray (See Testing). The Engineer reserves the right to spot test fiber terminations, splices, or re-testing of all fibers in a section to ensure proper quality assurance both during and after installation and testing. Deviations from Engineer testing and report documentation shall be reviewed and the Contractor shall be able to retest any or all challenged measurements to verify a valid test. Inconsistent test results, in the sole opinion of the Engineer, shall be cause for the Contractor to retest the entire fiber installation.

N. Testing

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. All testing shall be performed in an accepted manner and in accordance with the testing equipment manufacturer's recommendations. All data shall be recorded and submitted to the Traffic Engineer as hereinbefore specified. The Contractor shall provide one copy of operating software to read and view all OTDR traces.

O. Attenuation

1. The end-to-end attenuation shall be measured for each fiber for each link after installation and termination. A patch cord jumper cable shall be connected to both the light source and the receive cable to the power meter by the use of a connector (barrel). The two reference cables shall then be connected via a termination coupler and the power meter "zeroed" to eliminate the line loss. This process results in a reading of the actual line loss (dB) of the input connector, fiber cable, exiting connector and any other splices or jumpers installed in the measured test link. The calculated "loss" shall not include the input or departing cables in the loss calculation. The calculated fiber loss measured shall list the number of terminations, including the input and departing connectors, the number of splices and the number of patch cords used to jumper the link(s) into the measured final link. The measured values for each terminated fiber in each tube shall include the Tube number, fiber number, number of feet in the link, the number of splices, the number of patch cords, and the number of connectors, if any. The length of optical cable shall be as measured by the OTDR rather than the fiber cable jacket as the fiber is a reverse oscillation process resulting in a greater optical distance than the fiber cable jacket. The value for both the OTDR length and the cable jacket shall be provided in the recorded documentation for each link distance. All distances shall be recorded in feet rather than meters for both recorded lengths.

2. Fibers that are not continuous from beginning of the link to the end of the link shall be noted in the documentation; otherwise, all fibers in a single tube may be listed with a single data entry for all required data listed above for all fibers in the tube. The fiber documentation for each fiber shall identify the fiber being tested by either fiber number or fiber coating color and be recorded by complete tube, Tube 1 through Tube 6, fiber 1 through fiber 12. The direction of the test shall be recorded for information purposes only to resolve discrepancies in replicating the test during inspections of the final installation. The power meter reading recordings shall log total dB loss over the length of the fiber measured, equivalent to a dB loss budget.

3. The output power levels at the network hardware transmitters and receivers shall be measured and recorded for system documentation. The power meter shall be connected to the transmitter side of the equipment with a system jumper. The transmit power level shall then be read and recorded

4. Each tube of a cable shall be in the same file divider where the tube cover OTDR page shows the overview of all splices, patch cords, terminations from start to end. The second section shall include all Power Meter readings and the mandated documentation to show the calculated line loss (losses). The third section shall contain all OTDR traces, one trace per screen. The fourth section shall include the spool sheet for the fiber installed on the test section. An "explanation" sheet may be included where required to clarify an unusual reading that is valid but difficult to be explained through traditional data presentation, such as a video

feed fiber that is attached to a jumper to provide continuous feed from the start to end of the tube length where other fibers in the same tube are simply spliced. The above format shall be repeated for each tube of a cable. Traffic multimode fiber measured in sections marked by traffic controller cabinets between Hub Sites may be sub-sectioned in an easy to understand format or may be jumpered using patch cords as a single OTDR Link with each section separated for power meter readings.

P. Continuity

1. Continuity tests shall be used to determine whether a test or system jumper does or does not pass light. A continuity test shall also be used to assure the fibers have not been crossed over in the jumper and that the transmit fiber goes to the receiver fiber. The visible light tester shall be utilized to illuminate faulty terminations or fibers with excessive bends failing to pass light.

2. To perform continuity test, a high-intensity red light (Visible Fault Identifier) light source shall be aimed into the connector at one end, while an observer watches for a flicker of light at the other end. One each 650 nm red NFL light source shall be furnished to the Engineer by the Contractor on request during the testing of the fiber by the Contractor for spot testing. This device shall be made available during testing of continuity to the Engineer to assist in verifying fault locations and connector bleeding.

Q. OTDR Testing

1. An OTDR shall be used to evaluate the quality and length of cable reels prior to their use on the project. A minimum of one fiber per tube per reel shall be tested if payment for stored goods is requested. The fiber loss in dB/km and the length of each reel shall be recorded in the documentation. The maximum attenuation of the cable shall be as hereinbefore specified. This test does not require an electronic document; but is provided to insure that the fiber has been received in useable quality without shipment damage. The test results of the Contractor OTDR tests of received spools shall be provided to the Engineer, in a minimum of hard copy print, prior to receiving payment for stored goods.

2. An OTDR shall be used to evaluate the quality and length of cable installed on the project. This test shall be conducted on all fibers, terminated and not terminated, and shall be conducted after all terminations on the fibers for a link have been completed. The fiber loss in dB/km and the length of each reel shall be recorded in the documentation. The index of refraction, minimum of three decimal points, provided by the manufacturer on the spool documentation shall be used for the test on the OTDR. The maximum attenuation of the cable shall be as hereinbefore specified. A hard copy of OTDR signature traces, electronically and in printed form, for all fiber links shall be made and provided in the documentation as specified. The data provided shall be in easy to understand format and of sufficient detail to verify the results. Fiber testing shall include only one fiber trace per graph. One copy of the operating system software to view the fiber graphs shall be provided with the final documentation.

R. Documentation

The results of all testing shall be recorded along with date of test, name of person performing test, brand name, model number, serial number of equipment used during test, and any other pertinent information and data. The Contractor shall be responsible to provide input to the Engineer reviewing the recorded data documentation to resolve all questions or data discrepancies. A copy of the evaluation calculation equations to be used may be obtained by the Contractor by request and by supplying a floppy disk. (The evaluation FO Calculator is an EXCEL program worksheet that calculates design dB Loss based on required inputs.) Documentation shall be considered incidental to bid items and no additional compensation shall be provided.

151084.25 BATTERY BACKUP SYSTEM

Provided by City.

151084.26 BASIS OF PAYMENT

A. No separate payment will be made for work covered in this part of the Specifications except as set forth below. Contract Unit Prices shall include all costs for each item of work.

B. If items, for which no Unit Prices are shown on Proposal, or Schedule of Unit Prices, are required during construction, Contract Price shall be adjusted on basis of Unit Price negotiated with Contractor.

C. The Traffic Signal Installation(s) will be paid for at the contract lump sum price bid, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete signal installation and for all equipment, tools, labor, and incidentals necessary to complete the work.

D. The Communications Coordinator system integration, installation certification, and fiber optic cable certification shall be considered incidental to the contract lump sum price for the Traffic Signal Installation(s).