SP-091015
(New)

Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Polk County
City of West Des Moines

Project No.
STP-U-8260(626)--70-77

Effective Date
April 19, 2011

THE STANDARD SPECIFICATIONS, SERIES 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER PROVISIONS OF THE STANDARD SPECIFICATIONS.

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PART I
GENERAL REQUIREMENTS

This part consists of the general provisions necessary when furnishing a traffic signal installation complete, in place and operational as described in the project plans and these special provisions.

1.1 RELATED SPECIFICATIONS AND STANDARDS

Unless otherwise specified in the project plans and the special provisions the traffic signal installed under this specification shall comply with the Specifications of the Underwriters Laboratories, Inc., the National Electrical Code, and the Manual On Uniform Traffic Control Devices.

1.2 LOCAL REQUIREMENTS

All work on the project will be supervised on-site or performed by an International Municipal Signal Association (IMSA), Level II Certified Traffic Signal Technician. This work includes the installation of conduit, handholes, pole footings, wiring, traffic signal poles, traffic signal heads, traffic monitor units, and traffic signal controller/cabinets.

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.

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

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

The Contractor shall measure the distance from the bottom of mast arm mounted signal heads and signs to the roadway surface beneath the signal or sign. The measurements shall be provided to the Engineer.

1.3 COORDINATION WITH UTILITIES

The Contractor shall be responsible for determining the exact location and elevation of all public utilities in the proximity to any construction work and shall conduct all activities to ensure that public utilities are not disturbed or damaged.

The Contractor shall be fully liable for any and all expenses incurred as a result of failing to obtain required clearances, locations of utilities, and any damage to the public utilities caused by construction.

1.4 CONTRACTOR SUBMISSIONS

Schedule of Unit Prices: The Schedule of Unit Prices will be provided to the successful Bidder. Complete and forward to the Engineer three (3) copies of a list of unit costs for each item listed on the Schedule of Unit Prices by the preconstruction meeting. 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.

IMSA Certification: The Contractor shall submit the name and contact information of the IMSA Level II Certified Traffic Signal Technician(s) working on the project and a copy of their IMSA certificate.

Shop Drawings, Catalog Cuts, and Certifications: Six (6) copies of shop drawings shall be furnished for steel mast arm poles to be furnished on the Project. Six (6) copies of catalog cuts and manufacturer's specifications shall be furnished for all standard "off-the-shelf" items. Manufacturers shall certify electrical equipment, signal equipment, and materials to ensure compliance with these project documents. Upon request, the Contractor shall provide material certifications to the Engineer.

1.5 SUBSITIUTIONS

Use only materials conforming to these specifications unless permitted otherwise by the Engineer.

Obtain approval of the Engineer for substitutions prior to use.

1.6 SCHEDULING AND CONFLICTS

Schedule work to minimize disruption of public streets and facilities. Develop traffic control in accordance with the MUTCD. Submit a schedule of planned work activities.

Immediately notify the Engineer of any conflicts discovered or any changes needed to accommodate unknown or changed conditions as shown as found.

1.7 REPLACING DAMAGED IMPROVEMENTS

Improvements such as sidewalks, curbs, driveways, roadway pavement and any other improvements removed, broken, or damaged by the Contractor shall be replaced or reconstructed with the same kind of materials found on the work or with materials of equal quality. The new work shall be left in serviceable condition satisfactory to the Engineer. Whenever a part of a square or slab of existing concrete sidewalk, driveway, or pavement is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed.

1.8 TESTING OF TRAFFIC SIGNAL INSTALLATOIN

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

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.

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.

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.

1.8 GUARANTEE

The Contractor shall fully guarantee the traffic control signal installation furnished as part of the contract against defective equipment, materials, and workmanship for 12 months. Should any defect develop under normal and proper operating conditions within these specified periods after acceptance of the completed installation by the Engineer, this malfunction shall be corrected by, and at the expense of the Contractor, including all labor, materials, and associated costs.

Provide guarantee in writing on Company or Corporation letterhead stationary to the Contracting Authority prior to final acceptance. The Contractor shall transfer all required equipment warranties on the date of final acceptance to the Contracting Authority.

PART II
INSTALLATION REQUIREMENTS

2.1 FOUNDATIONS

The concrete bases shall conform to the dimensions shown on the plans. 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.

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

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.

The top of the base shall be finished level and the top edges shall be rounded with an edger having a radius of ½ inch. In sidewalk areas, adjacent to sidewalks, or in other paved areas, the top 18 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.

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.

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.

2.2 HANDHOLES

When precast concrete sections are used for handholes, the conduit entrances shall be neatly grouted between the conduit and the precast concrete. The handhole ring shall fit snugly inside the precast concrete section.

Additional handholes may be installed at the Contractor's expense, to facilitate work.

Provide four (4) cable hooks in all handholes. Anchor to the wall of the handhole utilizing appropriate anchoring devices.

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 24 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" 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.

2.3 CONDUIT

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 (6) times the internal diameter of the conduit.

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.

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 P.V.C. or HDPE conduit. In all bases, conduit shall extend a minimum of 4 inches above the finished surface.

Conduit buried in open trenches shall be placed a minimum of 24 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 24 inches below the finished pavement surface or as directed by the Engineer.

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.

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.

"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 (2) feet to the back of curb unless otherwise directed by the Engineer.

All PCV conduit installed shall include a 1 conductor #10 AWG Tracer Wire. 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.** The Contractor shall install, splice, and test the tracer wire for continuity. Every tracer wire shall be grounded at one end. All conduits will be proofed upon completion to verify continuity and integrity of the duct.

2.4 ELECTRICAL

All conductor cable combinations and cable conductor wiring shall be installed as specified on the Plans. Circuits shall be properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables.

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 emergency vehicle preemption cables shall be continuous from the unit to the control cabinet.

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.

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

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.

Loop detectors, connected to the controller by a 2-conductor shielded cable, shall be continuous from the terminal compartment in the controller cabinet to a splice made with the detector loop leads in the first

handhole or pole base provided adjacent to the detector. The drain wire of the shielded cable shall be attached to earth ground in the controller cabinet.

2.5 BONDING AND GROUNDING

All conduit, steel poles, and pedestals shall be bonded to form a continuous system, and be effectively grounded. Bonding jumpers shall be No. 6 A.W.G. 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.**

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 A.W.G. or equal.

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

A No. 6 A.W.G. bare copper ground wire shall be installed in all P.V.C. conduits that carry 120-volt signal cables.

2.6 TRAFFIC SIGNAL DISPLAYS

All overhead traffic signal heads shall have backplates and be centered over their respective lanes, unless otherwise noted on the plans.

All traffic signal displays shall be installed as indicated on the plans. All overhead displays located on each mast arm shall have the traffic signal head centered on the mast arm, unless otherwise directed by the Engineer.

During the course of 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.

2.7 CABINETS

The controller and hub cabinets shall be installed at the location and orientation indicated on the Plans, unless otherwise directed by the Engineer.

After the cabinet is installed in place the Contractor shall also place caulking material around the base of the cabinet.

2.8 PAINTING

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

2.9 LOOP DETECTORS

The location of each loop shall be marked on the pavement with crayon or spray paint. **The Contractor shall obtain the approval of the Engineer prior to cutting the saw slots.**

The saw shall be equipped with a depth gauge and horizontal guide to assure proper depth and alignment of the slot. The blade used for the saw cut shall provide a clean, straight, well-defined three-eights (3/8) inch wide saw cut without damage to adjacent areas. The depth of the saw cut shall be 2 inches. Where the loop changes direction, the saw cuts shall be overlapped to provide full depth at all corners. Right angle or corners less than 90 degrees shall not be used.

Before installing the loop wire, the saw cuts shall be checked for the presence of jagged edges or protrusions. Should these exist, they must be removed. The slots must be cleaned and dried to remove cutting dust, grit, oil, moisture or other contaminants. Cleaning shall be achieved by flushing clean with a stream of water under pressure, and following this, the slots should be cleared of water and dried using oil-free compressed air.

Detector loop wire shall be installed using a three-sixteenth (3/16) inch to one-fourth (1/4) inch thick wood paddle. If the wire does not lie close to the bottom of the saw cut, it shall be held down by means of a material such as tape or doubled-over pieces of the plastic tubing.

The detector loop wire shall be placed into the slot with the number of turns specified. The tubing shall be of a continuous length from the point of splicing of the loop wire to the lead-in cable. The field loop conductors installed in the pavement shall run continuously from the terminating handhole or base with no splices permitted. The field loop conductors shall be spliced to the lead-in cable and the lead-in cable shall run continuously from the terminating hand hole or base to the detector-sensing unit except on multiple loop installations where additional loop conductors may be spliced to the lead-in cable as directed by the Engineer. At the time of placing the loop wire in the sawed slots, the ends of the tubing shall be sealed to prevent any entrance of moisture into the tubing.

Each loop shall be coiled as indicated by the Engineer and the beginning conductor banded in the terminating hand hole or base with a symbol "S" to denote start of conductor. Each loop shall be further identified by phase or function as shown on the project plans, with durable tags, or as directed by the Engineer. Loops which are physically adjacent in an individual lane or adjacent lanes shall be wound with opposite rotation (i.e. #1 CW, #2 CCW, #3 CW, etc.). Rotation reversal can be accomplished by reversing leads at the hand hole.

Farthest away loop in the home run shall have one band of the appropriate color; the next closest loop shall have two bands of the appropriate color.

Home runs that are in medians (islands) shall have the appropriate color for where it is, i.e.: island on the west leg would have red/orange bands and the farthest away loop would have one band of the appropriate color and so on.

Multiple loop configurations, spliced to a single lead-in loop, to be connected in series shall have the "S" conductor of one loop connected to the unbanded conductor of the adjacent loop.

All lengths of loop wires and tubing that are not embedded in the pavement shall be twisted with at least five (5) turns per foot, including lengths in conduits and hand holes.

The electrical splice between the loop lead-in cable to the controller and the loop wire shall be soldered using resin core solder and provided with a watertight protective covering for the spliced wire, the shielding on the loop lead-ins and the end of the tubing containing the loop wires. **The use of open flame to heat the wire connection will not be permitted. The Contractor shall use a soldering iron, gun, or torch equipped with a soldering tip.** The splice shall be made by the following method:

Remove all lead-in cable coverings leaving four (4) inches of insulated wire exposed.

Remove the insulation from each conductor of a pair of lead-in cable conductors and scrape both copper conductors with knife until bright.

Remove the plastic tubing from the loop wires for one and one-half (1-1/2) inches.

Remove the insulation from the loop wires and scrape both copper conductors with knife until bright.

Wash the exposed copper conductors with turpentine spirits to clean the conductors.

The conductors shall be connected by a soldered "Western Union" type splice, wrapped with waterproof tape and coated with a watertight protective covering.

Cover the exposed shielding, ground wire and end of any unused loop lead-in where the sheathing was cut, with liquid silicone rubber. Apply Butyl Rubber Polymer Tape sealant between the wires and completely cover the silicone rubber.

After the installation of loops, the Contractor should meter the loops by test instruments capable of measuring electrical values of installed loop wires and lead-ins to measure induced AC voltage, inductance in microhenries, high-low "Q" indication, leakage resistance in megohms, and the resistance of the conductors in ohms. Provide the Engineer with a report on company letterhead indicating the inductance and leakage to ground test values for each loop. The test shall be conducted from the curbside hand hole. An inductance and leakage to ground test shall also be conducted and reported for the total detector lead-in and loop system with the test being conducted at the controller cabinet. Before beginning the required test period, the Engineer may independently meter any or all loops. Should any loop be found unacceptable, the Contractor may be required to complete additional tests, as required, at their own expense. The values indicated are for tests on a single loop at curbside.

An acceptable loop installation shall be defined as follows:

Inductance: The inductance reading on the loop tester is approximately the calculated value.

Leakage to Ground: Deflection of the pointer to above 100 megohms.

Any unusual reading on the above shall be reported to the Engineer before sealing the loop in the pavement.

An unacceptable loop installation shall be defined as follows:

Inductance: The inductance reading is below the calculated value.

Leakage to Ground: Deflection of the pointer to below 100 megohms.

Any loop not meeting the requirements for an acceptable loop installation shall be repaired or replaced as directed by the Engineer. The Contractor shall bear all costs of replacing loop installations deemed unsatisfactory by the Engineer.

2.10 TRAFFIC AND STREET NAME SIGNS

Traffic and street name signs shall be mounted on the mast arms utilizing an aluminum universally adjustable mast arm mounted sign bracket.

Street name signs shall be fastened to the mounting bracket using the number of attachment points recommended by the manufacturer of the street name sign mounting bracket.

PART III
MATERIAL REQUIREMENTS

This part consists of material requirements necessary for the construction of a traffic signal installation complete, in place, and operational as described in the project plans and these special provisions.

3.1 TRAFFIC SIGNAL CABLE

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

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

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

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

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 conductors shall be #14 A.W.G. unless otherwise specified on the plans. **The conductors shall be solid and not stranded.**

Loop Detector Wire (With Plastic Tubing) shall meet the requirements of the International Municipal Signal Association (IMSA) Specifications 51-5, latest revision thereof for polyvinyl chloride insulated, nylon jacketed, loosely encased in a polyvinyl chloride or a polyethylene tube loop detector wire. The conductor shall be #14 A.W.G. unless otherwise specified on the plans.

Detector Lead-In Cable shall meet the requirements of the International Municipal Signal Association (IMSA) Specifications 50-2, latest revision thereof for polyethylene insulated, polyethylene jacketed loop detector lead-in cable. All conductors shall be #14 A.W.G. unless otherwise specified on the plans.

Tracer Wire shall be a #10 AWG, single conductor, stranded copper, Type THHN, with UL approval and an orange colored jacket.

Emergency Vehicle Preemption Optical Detector Cable shall meet the requirements of IPCEA-S-61-402/NEMA WC 5, Section 7.4 600-volt control cable 167 degrees Fahrenheit, Type B. The cable shall contain 3 conductors, each of which shall be #20 AWG stranded, tinned copper with a 25-mil minimum average thickness low-density polyethylene insulation. Insulation shall be color coded 1-yellow, 1- blue, 1-orange. The shield shall be aluminized polyester film with a nominal 20% overlap. A #20 AWG stranded, tinned, bare drain wire shall be placed between the insulated conductors and the shielded in contact with

the conductive surface of the shield. The jacket shall be black PVC with a minimum rating of 600 volts and 176 degrees Fahrenheit and a minimum thickness of 45-mil. The jacket shall be marked as required by IPECA/NEMA.

Cat5E Cable shall be Cat5E outdoor use rated cable.

3.2 SIGNS

Signs shall conform to the requirements of Section 4186 of the Standard Specifications and shall meet all requirements of the latest edition of the “Manual On Uniform Traffic Control Devices” (MUTCD).

The background sheeting used on all signs, with the exception of pedestrian pushbutton signs, shall be a microprismatic lens retroreflective sheeting with pressure sensitive adhesive. Any other applied material, including legends, letters, numbers, or borders, again with the exception of pedestrian pushbutton signs, shall also be microprismatic lens retroreflective sheeting with pressure sensitive adhesive.

The street name signs shall be white letters, Series C Modified, 12-inch high upper case and 9-inch high lower case on a green background. The sign shall have a white border, 0.75 inches wide. The thickness of aluminum sign blanks shall be 0.125 inches and the height shall be 18 inches. The corners of the sign blank shall have a 1.5 inch radius.

Mast arm mounted traffic and street name signs shall be attached to the signal mast arm by means of a universally adjustable, aluminum, mounting bracket assembly.

3.3 HANDHOLES

TYPE 1 HANDHOLES shall be precast concrete handhole, or poured in place concrete handhole, each with cast iron ring and cover. The body of the precast hand hole shall meet the requirements for Class 1500D concrete pipe insofar as applicable.

Cast iron ring and cover (Neenah R-5900E or equal) 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. The cover shall have the words TRAFFIC SIGNAL cast on the top of the cover. The cover shall have concealable pick holes.

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.

TYPE 2 Handholes shall be 30 inch x 48 inch manufactured with polymer concrete. 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 (4) cable hooks will be installed in each handhole to support the signal cables.

A Marker Ball, with a 101.4 kHz telephone marker, shall be installed in each Type 2 Handhole.

3.4 CONDUIT

The number, type, and size of conduit shall be as shown on the plans. Conduit shall meet the requirements of Sections 2523.01 and 4185.10 of the Iowa DOT Standard Specifications.

Conduit shown on the plans as rigid steel shall be galvanized steel meeting the requirements of ANSI C 80.1, latest revision.

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.

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 degrees F, and shall not melt or run at temperatures as high as 300 degrees F.

3.5 LOOP DETECTOR SEALANT

The sealant shall be a rapid cure, high viscosity, liquid epoxy, or approved equal, formulated for use in sealing inductive wire loops and leads embedded in asphaltic concrete and Portland cement concrete. The sealant shall be usable on grades of 15 percent or less without excessive flow of material, unless otherwise approved by the Engineer.

The epoxy sealer shall be a two-component system that consists of a resin constituent identified as pourable and a hardener identified as quick setting. The sealer shall be epoxy: Bondo, Preco Gold Label Flex, or equal, as approved by the Engineer. Approval of other sealants shall be based on specifications and/or test data regarding physical properties, performance properties, and chemical resistance.

The cured sealer shall be unaffected by oils, gasoline, grease, acids and most alkalis. The mixing of components and the filling of the cut shall be in accordance with the directions of the manufacturer.

3.6 FIBER OPTIC CABLE

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

General Requirements

Materials and Equipment
Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. The fiber optic cable shall be OFS BrightWave or Corning conforming to the following specifications. 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.

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.

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.

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.

General Considerations

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

Fiber Characteristics

All fibers in the cable must be usable fibers and meet required specifications.
Single-Mode Fiber

Typical core diameter: 8.3um
Cladding diameter: 125 +1.0um by fiber end measurement
Core-to-cladding offset: <1.0um
Coating diameter: 250 +15um
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.

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.

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.

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.

Fiber Specification Parameters
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.

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.

Optical fibers shall be placed inside a loose buffer tube, minimum six (6) fibers per tube, normally twelve (12) fibers per tube. Actual number of fibers per tube shall be twelve fibers per tube unless specified differently on the Plans.

Single-mode only – each buffer tube shall contain 12 or 6 fibers.

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

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

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

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.

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.

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

All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 0.055 inches. 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.

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 or MM) and sequential feet or meter marks. The markings shall be repeated every one-meter or 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 0.098 inches. 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.

The maximum pulling tension shall be 600 pounds (2700 N) during installation.

Wherever possible, six (6) buffer tubes with twelve (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

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

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 with each spool. The Contractor shall indicate the location where each spool has been installed and provide this data to the Engineer.

Cable Installed in Ducts and Conduits
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 1Handhole – 20 feet
Type 2 Handhole – 100 feet

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 3 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 (1) #10 AWG THHN, 600-volt single conductor cable (identifier conductor), orange in color, shall be pulled with ten feet (10') 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.

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 twenty times the diameter of the cable outside diameter or as recommended by the manufacturer.

After the Fiber Optic Cable Installation
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. **Multimode fiber shall be tested using 1300 nm and single mode fiber shall be tested at 1310 nM. The results of the OTDR test shall be provided on an electronic media (disk) 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.**

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	.60 MM & .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	

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.

Cable Termination

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 Siecor UniCam connectors, or be a wide temperature (-40 to +170 degrees Fahrenheit) 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.**

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 MIC-024 or WDC-024 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 zero degrees to +150 degrees Fahrenheit. 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.

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 SC 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 Siecor CamLite, UniCam, or NEMA temperature rated epoxy type, or Engineer approved equal.

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 .03 to .05 dB loss but shall be less than a 0.08 dB loss.

Light Source

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).

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.

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.

Launch Reference Attenuator

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 hundred 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.

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). For measured values recorded in excess of the above (0.25 MM and 0.10 SM) listed values, refer to the paragraph 12.2 specification as hereinbefore defined. The Engineer reserves the right to spot test fiber terminations, splices, or re-testing of all fibers in a section to insure 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.

Testing

General

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.

Attenuation

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.

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.

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

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.

Continuity

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.

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.

OTDR Testing

An Optical Time Domain Reflectometer (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.

An Optical Time Domain Reflectometer (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.

Documentation

The result 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.

PART IV
EQUIPMENT REQUIREMENTS

This part consists of equipment requirements necessary for the construction of a traffic signal installation complete, in place, and operational as described in the project plans and these special provisions.

4.1 TRAFFIC SIGNAL CONTROLLER

The local intersection controller shall be an EPAC3108 M52 Series controller unit manufactured by Siemens Traffic Control Systems. The controller shall be fully compatible and interchangeable with the existing local controllers in the City of West Des Moines System operating as an ACTRA ATMS System. Two controllers shall be supplied with each cabinet. One controller will operate the intersection signals and the other will be delivered to the City of West Des Moines Public Works Facility. The controller in the signal cabinet shall be provided with two each 6KQ Series Managed Switches with a minimum of two each 1 GB line drivers, two each 10/100 MM line drivers and six each copper 10/100 MBPS ports; and, one each 6K25 Series Managed Switch with four each 1 GB line drivers, eight 10/100 MBPS copper ports, four each 10/100 SM Port line drivers, four each 10/100 MM Port line drivers as manufactured by GarrettCom. The exact port configuration for each switch shall be as specified above unless modified in the wiring diagrams. All Switches will be delivered to the City of West Des Moines Public Works Facility for programming and installed as specified by the Engineer. The signal cabinet controller assembly shall be provided with two each RTS units, Model Number 99550-0 and associated power supply.

The controller to be provided shall provide two through eight-phase operation. The controller unit shall be provided with the NEMA defined “A”, “B”, “C”, and manufacturer specific “D” connectors, an RS-232 Serial Port that allows controller unit programming without referencing the controller unit system address, an RS-232 Serial Port that allows controller unit programming requiring reference to the controller unit system address, an SDLC Serial Port as defined by NEMA TS-2 and a communications port that is designed for fiber optic interconnect.

The controller shall provide fully prompted, menu driven programmability.

The controller shall provide the following internal functions:

Software compatible to the control and data protocol of the on-street master and central office computer.

Provision of a local time base scheduler including automatic accommodation for day light savings time.

Provision for local coordination control.

Provision for local preemption control with at least six (6) programmable internal preemption sequences.

Provide data uploading and down loading capability.

Process system and local intersection detector activity and accumulate samples of vehicle count, occupancy, and speed.

Provide local control of remotely selected NEMA and special functions.

Ability to handle up to 80 detectors. Detectors shall include the ability to have a single detector input be assigned to phase extension, system volume and occupancy, and lane count concurrently. Lane count shall include as a minimum 24 isolated detector assignments for the purpose of accumulating 15-minute volume counts for each detector. Controller memory shall allow accumulation of a minimum of sixteen hours of data, 15-minute counts for 24 detectors, before requiring data uploads to the central computer.

Perform local report generation with printer capability, including intersection status and performance.

Provide the capability to communicate with the Central Office ATMS ACTRA System by means of fiber optic interconnects. The controller shall be capable of operating in each type of system without additional modifications, other than installation of the appropriate modem and interface.

The controller shall be microprocessor type, modular, solid state providing the phasing and operation as shown on the plans. The controller shall be designed for use on nominal 120 volt, 60 Hz, single- phase alternating current.

The controller unit shall utilize digital timing concepts for interval settings for all phases and shall contain vehicular and pedestrian circuits and timing functions for all phases.

The controller equipment furnished shall be new, of the latest model, fabricated in a first-class workmanlike manner from good quality material. The manufacturer shall replace free of charge to the Contractor and/or Owner any part that fails in any manner by reason of defective material or workmanship within a period of 12 months from the date that the equipment was placed into operation following installation.

Components

The controller unit shall use modern integrated circuits and computer technology to the fullest extent feasible and incorporate digital timing techniques.

All component parts and terminals shall be readily accessible when the controller modules are removed from the enclosure for adjustments, testing, or service.

The controller unit shall be designed so that the length of interval, portion, and period or unit extension shall not deviate by more than plus or minus 100 milliseconds from its set value at a power source frequency of 60 Hz.

Chassis

The controller unit shall be modular in design. Modules or function boards shall be removable and inserted without the use of any tools. Modules of unlike function shall be mechanically keyed or electrically inter-locked to prevent insertion into the wrong opening. All modules of the same function shall be interchangeable.

The front panel of the unit shall be permanently marked to identify the fuses, indicators, switches, controls, etc. so that the operation of the controller shall be readily apparent. The option card slot panel section shall be provided with two each panels. The two panels shall allow insertion of one or more card devices and maintain a closed front chassis assembly.

The control devices, indicators, fuse holders, switches, input/output connectors, and other components required for the operation and adjustment of the timer shall be mounted on the front panel.

Certification of a manufacturer's controller assembly by an independent testing laboratory shall be provided to the Engineer. This certification shall indicate that the manufacturer's controller assembly is in accordance with the test procedures as specified in the NEMA Standard No. TS1-1983. Certification to NEMA Standard No. TS-2, current edition at the time of bid shall be acceptable.

All components shall be amply de-rated with regard to heat dissipating capacity and rated voltage so that, with maximum ambient temperatures and maximum applied voltage, a material shortening of life or shift in values shall not occur.

The design life of all components under 24 hours a day operating conditions in their circuit applications shall be not less than five (5) years.

Controller timing shall be set by means of a front-panel keyboard. Momentary contact push buttons shall be used for entering numeric data.

Interval Programming
The controller unit shall provide for setting of the timing of each interval or period by means of keyboard.

The controller unit shall utilize fully prompted, menu programmability to input controller data.

The keyboard shall be on the front panel of the unit. They shall be easily identifiable and it shall not be necessary to remove or change wires or contacts or to use any tools in making interval adjustments.

Each phase shall have identical control parameters that may be independently set for each phase.

The controller unit shall be capable of providing functions with the minimum timing ranges and timing increments as defined in NEMA Standards TS-2.16.4.6

Indications shall be provided and appropriately labeled to facilitate the determination of the operation of the controller unit. These indications shall consist of the following, as a minimum:

Phase or phases in service.

Phase or phases next to be serviced.
Presence of vehicle call, including memory and detector actuations.
Presence of a pedestrian call.
Ring status indicators, including the following: Minimum Green; Passage; Yellow Clearance; Red Clearance; Walk; Pedestrian Clearance; Reason for Termination; and Rest State.

The controller unit shall be capable of programming each phase to operate in the following modes through the keyboard push button switches or separate function switches.

Nonlocking vehicle detector memory
Locking vehicle detector memory
Vehicle recall
Pedestrian recall
Recall to maximum green

All operator keyboard entered data shall be retained in a memory medium that does not require battery backup.

Means shall be provided to control the flashing of pedestrian signals during the pedestrian clearance interval(s), Yellow, and All Red or Yellow intervals only.

The signal phasing and interval sequence shall be as shown on the plans.

Operational Requirements
The controller shall provide multi-phase operation and shall be fully actuated with means for receiving actuation on all phases.

The controller shall permit a non-actuated mode of operation on any of the phases by assertion of the vehicle recall function of the desired phase.

The actuation of a vehicle detector during the extendible portion of an actuated traffic phase having the right-of-way shall cause the retention of right-of-way by the traffic phase for the set Passage Time from the end of the actuation but subject to the Maximum.

The actuation of any detector on a traffic phase not having the right-of-way shall cause the transfer of the right-of-way to that traffic phase at the next opportunity in the normal phase sequence.

The timing of the Maximum Green shall commence with one of the following:

With the first actuation or demand for right-of-way on a traffic phase not having the right-of-way.

At the beginning of the Green interval if an actuated or demand for right-of-way has been previously registered on a traffic phase not having right-of-way.

In the absence of detector actuations or assertion of recall switches, the right-of-way indications shall remain on the traffic phase on which the last actuation occurred.

The transfer of right-of-way to conflicting phases shall occur only after the display of the appropriate change clearance intervals.

An actuation received during a change clearance interval for a traffic phase shall cause the right-of-way to return to that phase at the next opportunity in the normal phase sequence.

If the right-of-way is transferred by the operation of the Maximum or extension limit, the traffic phase losing the right-of-way shall again receive it without further actuation at the next opportunity in the normal phase sequence.

When pedestrian actuation is received a WALK interval shall be provided concurrently with the associated Green traffic phase interval. A flashing DON'T WALK Pedestrian Clearance interval shall follow the WALK interval during which the Green traffic phase continues to be displayed. A steady DON'T WALK shall follow the flashing DON'T WALK.

In absence of pedestrian actuation or the assertion of pedestrian recall function, pedestrian signals shall remain in a steady DON'T WALK condition.

Pedestrian actuations received by a phase during steady or flashing DON'T WALK indications of that phase shall be remembered and shall cause the controller to provide pedestrian timing functions for that phase at the next opportunity in the normal phase sequence. Successive pedestrian actuations shall not cause extension of pedestrian intervals.

During coordinated operation if phases are placed in a pedestrian recall mode of operation to operate the controller as a pretimed controller, the WALK intervals of the non-coordinated phases shall automatically adjust with changes in the timing plans to provide the maximum amount of WALK interval possible in the phase. The adjustment of the WALK interval for the non-coordinated phases shall be similar to the adjustment in the WALK interval for the coordinated phases with timing plan changes.

4.2 CONTROLLER CABINET AND AUXILIARY EQUIPMENT

The cabinet and auxiliary equipment shall conform to the requirements of the National Electrical Manufacturer’s Association (NEMA) Standard TS1, most current revision, and to these specifications.

The controller and all associated equipment shall be completely housed in a sturdy aluminum cabinet of clean cut design and appearance having no sharp edges, corners, or projections. The cabinet type (P or R) shall be specified on the plans. The size of the cabinet shall provide ample space for housing the controller and all associated electrical and auxiliary devices that are to be furnished with it as herein specified. A hinged door, with an approved doorstop assembly, shall be provided permitting complete access to the interior of the cabinet. When closed, the door shall fit closely to neoprene or other suitable gasketing material, making the cabinet weatherproof and dust-tight. The door shall be provided with a strong lock and two sets of keys. The door hinges and pins shall be of a non-corroding material.

In addition to the main door of the controller cabinet, there shall be an auxiliary police door provided in the main door provided with a strong lock and keys of different design than that of the main door of the cabinet. The panel behind the auxiliary police door shall contain a switch to change from normal function to flashing and vice versa. When placed in the flashing operation, the switch shall cause the signals to display the flashing indication identified in the signal sequence diagram. The signal control shall remain in full operation. A signal on-off switch shall also be provided to interrupt power to the signal heads only and continue controller operation.

The aluminum exterior surfaces of the controller cabinet shall be unpainted.

The cabinet shall contain strong mounting tables, sliding trays or other suitable supports for the controller, and associated equipment.

All field terminals shall be suitably identified and accessible without removal of equipment contained in the cabinet.

A heavy-duty three ring binder shall be provided for stowing cabinet electrical prints.

The base mounted cabinet shall be furnished with all of the hardware necessary for assembly and installation.

The cabinet shall contain two (2) ventilating fans controlled by thermostats and suitable dust filters for the capacity of the ventilating system. The filters shall be of the dry type and easily removed and replaced and be of standard dimensions commercially available.

The cabinet shall be provided with at least a 16-position back panel. The 16-position back panel shall be wired for 16 load switches to control 8 vehicle phases, 4 overlap movements, and 4 pedestrian phases consecutively from left to right.

The cabinet shall be mounted on an18-inch high aluminum riser manufactured from the material similar to the cabinet.

Electrical Design

The distribution of the 117 VAC throughout the cabinet shall not occur until the AC+ has first passed through the power protection devices.

The cabinet shall be provided with power protection devices that include the main AC+ power circuit breakers, radio interference suppressors, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controller and auxiliary equipment. The protection devices shall be mounted on a panel that is securely fastened to an interior wall of the cabinet.

The AC+ field service shall be connected directly to a circuit breaker. This circuit breaker shall be a single pole, nonadjustable, magnetic breaker rated for 117 VAC operations. It shall be equipped

with a solder less connector suitable for terminating the power lead-in wire. The circuit breaker shall be capable of manual operation and shall be clearly marked to indicate the "ON" and "OFF" positions.

Radio interference suppressors (RIS), adequate in number to handle the power requirements for the cabinet, shall be wired in series with and after the main AC+ circuit breaker. The RIS shall be designed to minimize interference in all broadcast, transmission, and aircraft frequency bands.

The controller cabinet shall be furnished with a lightning arrestor on the AC service. The surge suppressor shall meet or exceed the following requirements:

The unit must be capable of withstanding repeated 20,000-ampere surges (minimum of 25).

The unit must have internal follow current limiters (resistive elements).
The unit shall contain a minimum of three (3) active clamping stages.

The unit must self-extinguish within 8.3 milliseconds after trailing edge surge. Parallel impedance of limiters must be less than 15 ohms.

In the event of a power interruption, the controller shall be capable of automatic reorientation upon power resumption and shall require no manual initiation or switching. The controller and conflict monitor shall be wired on the same power terminal and be simultaneously controlled by a controller “On – Off” switch.

Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller or auxiliary device can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires. This may be accomplished by means of a multiple pin jack; a spring connected mounting or approved equivalent arrangement.

All cabinet wiring shall be neatly trained throughout the cabinet and attached to the interior panels using nonconductive clamps or tie-wraps. Bundles of cables shall be laced or tied or enclosed in a sheathing material. The cabinet wiring shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors.

Except where terminated by direct soldering, all wires shall be provided with terminal lugs for attachment to terminal blocks using screws. All wires shall be identified and labeled in accordance with the cabinet wiring prints.

All wire insulation shall have a minimum rating of 600 volts.

A maintenance panel containing test switches shall be located on the inside of the main door. These switches shall include the following:

Controller Power Switch

Detector Test Switches
Stop Time Switch
Signal Flash Switch

An AC+ convenience outlet with a 3-wire grounding type receptacle shall be provided and be easily accessible. This receptacle shall be separately fused from the main AC+ circuit breaker. The outlet shall be provided with ground fault protection.

The unit shall contain a power and flash transfer relay assembly to transfer the AC+ power and operation from the controller and load switches to the solid-state flasher. This transfer relay assembly shall be controlled by either the "AUTO-FLASH" mode switch located on the Police Panel or the conflict monitor. The flasher shall remain operational with the controller removed from the cabinet. The rate of flash shall be 50-60 flashes per minute with equal on and off intervals. The cabinet shall be wired to flash as shown on the plans.

The plug-in transfer relays shall be rated at a minimum of 10 amps per pole and shall be enclosed in a transparent case for protection against dust and for visual observance of operation.

The cabinet shall be furnished with two incandescent lamps. One lamp shall have a gooseneck assembly and be a Mini-Cylinder Lamp. The lamp shall be equipped with a 25 Watt, R14 bulb. The second lamp receptacle shall be mounted on the interior wall of the cabinet and accommodate a standard base light bulb. Manual switches mounted on the maintenance panel shall control these lamps. The lamp shall controlled by an on-off switch. The lamp shall be wired into the cabinet power circuit and not obtain power from the convenience outlet. Two LED light panels, top of cabinet and top of load bay, shall be installed on the same circuit as the lamp receptacle and shall provide general cabinet lighting and be controlled with the lamp switch.

The cabinet duct fan unit shall be fused separately and wired after the main AC+ circuit breaker.

Molded composition barrier type terminal blocks shall be used for termination of the incoming and outgoing signals within the cabinet assembly. Each terminal block shall be of one-piece construction with a minimum of twelve terminals. Each terminal shall have a threaded contact plate with a binder head screw. The terminal blocks shall have a minimum rating of 600 volts. All terminals shall be identified and labeled in accordance with the cabinet wiring diagram.

The terminal block facilities shall be arranged in function groupings and mounted to either panels or brackets fastened to the interior walls of the cabinet. Each terminal block shall be retained using either machine or self-tapping screws and shall be easily removed and replaced.

The minimum terminals are as follows:

Terminal with circuit breaker with integral power line switch for the incoming power line.

Terminal unfused for the neutral side of the incoming power line.

Terminals and bases for each vehicle and pedestrian signal circuit. A load resistor shall be installed for all odd signal phases.

Terminals for vehicle phase detector and pedestrian push button cables. Terminals for vehicle detectors include AC+, AC neutral, relay common, relay closure, and the loops or probes from the field.

Terminals for system detectors. This shall be a separate terminal block and labeled with the detector numbers.

Terminals and bases for signal flasher and outgoing signal field circuits.

Terminals for all controller input and output circuits including those circuits not used on the project.

Terminals and/or receptacles for all required auxiliary equipment.

Terminals for interconnect.

Adequate electrical clearance shall be provided between terminals. The controller, auxiliary equipment, panel(s), terminals, and other accessories shall be so arranged within the cabinet that they will facilitate the entrance and connection of incoming conductors.

The outgoing signal circuits shall be of the same polarity as the line (+) side of the power service. The incoming signal indication conductors shall be common and of the same polarity as the grounded (-) side of the power service. The neutral (-) side of the power service shall be connected to the cabinet in an approved manner to a copper ground bus located on the panel with the main AC+ circuit breaker. The cabinet shall, in turn, be connected to an earth ground through a ground rod, mounted external to the cabinet at the nearest hand hole or junction box.

All load switches shall conform to the triple-signal solid-state type load switch as specified in the NEMA Standard No. TS1-1983. Dual-signal type load switches shall not be allowed. LED indicator lights shall be provided on the front of the load switch to designate the active circuit.

The closing or opening of signal circuits shall be positive without objectionable dark intervals, flickering of lights or conflicting signal indications. Each switch shall have a capacity of not less than 10 amperes of incandescent lamp load at 120 volts AC.

A Solid State conflict monitor shall be provided and located within the cabinet external to and electrically independent of the controller unit and enclosed in a finished metal case. The monitor shall detect the occurrence of conflicting Green, Yellow, or Walk indications and shall cause the signals to go into predetermined flashing operation with stop timing applied simultaneously should conflicts be sensed. The conflict monitor shall conform to the specifications of NEMA TS1-1983 and shall be compatible with the controller. The conflict monitor shall be capable of monitoring the FLA protected/permissive left turn signal. The monitor shall be provided with an Ethernet Port for

remote monitoring from the Traffic Operations Center. The Communications Coordinator shall assign an appropriate IP address and place the monitor on-line at the Traffic Operations Center.

The conflict monitor shall utilize liquid crystal displays providing four indicators which display an active Red, Yellow, Green, and Walk input for each channel monitored.

Stop timing shall remain present during this operation. If the actual conflict has been cleared a reset switch (front mounted) on the conflict monitor shall return the controller to normal operation when depressed.

The cabinet shall be equipped with a separate solid-state flasher to permit substitution of flashing signal indications for normal vehicle or pedestrian actuated operation. The solid-state flasher shall have no contact points or moving parts and shall utilize zero-point switching. The flasher unit shall have a built-in effective radio interference filter. It shall be possible to completely remove the controller unit for inspection or maintenance when the flashing feature is energized, without disturbing the flashing feature. LED indicator lights shall be provided on the front of the flasher to indicate the active circuit.

Flashing shall be at the rate of not less than 50 nor more than 60 flashes per minute with approximately 50% on and 50% off periods. Flashing rate shall not vary so long as the power source remains within the specified limits.

Flashing of vehicular signal indications shall be obtained from one or more flashers, each of which is a self-contained device designed to plug into a panel in the controller cabinet. If the flashing is provided by two flashers, they shall be wired to assure that the flashing of all indications on the same approach is simultaneous.

The cabinet shall contain a door switch to provide the capability for a special function input and output of the controller to detect and log when the cabinet door is opened.

When specified in the plans for loop detectors, one card style detector mounting rack shall be shelf mounted in each controller cabinet. The rack shall provide a minimum of sixteen slots for two-channel, wired compatible for four-channel type of detectors. The phase assignment of the slots will be as specified on the plans. All detector slots shall be wired in the cabinet to provide for future use. In case of a failure in the power supply unit for the card rack, fail-safe operation will be provided in that a constant call will be placed on all detector channels. Durably label all card rack positions with phase and loop numbers.

All detectors shall provide two inputs which shall be diode isolated. One input shall be assigned to the phase. The other input shall be capable of being assigned in the field to any one of the eight system inputs or the local count detector inputs of the local controller. This connection shall be by a method approved by the Engineer. A separate terminal block shall be installed in the cabinet which will have all detector inputs terminated on the lower side of the block. The eight system wires can then be attached in the field to any detector input on the upper side of the block to obtain system inputs to the controller. The system detector input wires shall be labeled with the

detector number and the system detector terminal block shall be labeled with the system detector number for ease in field programming.

Controller cabinet wiring shall utilize a 24-pin connector to direct the diode isolated count detector inputs to the terminal facility point for input to the controller. The cabinet design shall assign all detector inputs into the controller based on six detectors per approach, left, through and right turn per the City design. Detector inputs 1-6 per approach shall always allocate directional 1 detector as a left turn and directional detectors 3, 4, and 5 as through movements. Directional detectors 2 and 6 shall be assigned by the City as left turn or right turn movements on a per intersection basis. The 24-pin connector shall be disconnected when the cabinet is operated by a controller that is not provided with the traffic count function. All detector inputs shall be accommodated via MEMA TS-1 type cabinet utilizing the standard A-B-C and manufacturer's specific D connectors. The disconnection of the 24 pin connectors shall revert cabinet operation to a standard NEMA TS-1 operation or a NEMA TS-2 Type 2 operation. The detector counting termination harness and detector assignment shall be as indicated in the following table.

Detector Counting Termination Harness
& Detector Assignment

Function	Intput/Female	Connector	Output/Male	Det. #
NB Left 1	N1	P1	Ped Omit 1	25
NB Left 2	N2	P2	Ped Omit 2	26
NB Thru 1	N3	P3	Ped Omit 3	27
NB Thru 2	N4	P4	Ped Omit 4	28
NB Thru 3	N5	P5	Ped Omit 5	29
NB Right	N6	P6	Ped Omit 6	30
EB Left 1	E1	P7	Veh Omit 1	11
EB Left 2	E2	P8	Veh Omit 2	12
EB Thru 1	E3	P9	Veh Omit 3	17
EB Thru 2	E4	P10	Veh Omit 4	18
EB Thru 3	E5	P11	Veh Omit 5	19
EB Right	E6	P12	Veh Omit 6	20
SB Left 1	S1	P13	Ph1 Hold	23
SB Left 2	S2	P14	Ph2 Hold	24
SB Thru 1	S3	P15	Ph3 Hold	9
SB Thru 2	S4	P16	Ph4 Hold	10
SB Thru 3	S5	P17	Ph5 Hold	13
SB Right	S6	P18	Ph6 Hold	14
WB Left 1	W1	P19	Ped Omit 7	31
WB Left 2	W2	P20	Ped Omit 8	32
WB Thru 1	W3	P21	Veh Omit 7	21
WB Thru 2	W4	P22	Veh Omit 8	22
WB Thru 3	W5	P23	Ph7 Hold	15
WB Right	W6	P24	Ph 8 Hold	16
Loop numbering from inside lane to outside lane				

Card Rack Assignments

EV preempt channel, shall be wired for a 4-channel optical preemptor card.

EV preempt channel assignments shall be PE1-Southbound (Phases 2&5), PE2-Westbound (Phases 4&7), PE3-Northbound (Phases 1&6), PE4-Eastbound (Phases 3&8)

Any railroad preemption input shall be wired to Preempt 1 or Preempt 2 inputs with other preempt inputs moved to Preempts 3 through 6.

Ped PB inputs shall be wired to Ped 2, 4, 6 or 8 detector inputs. Controller unit shall allow program change to assign any Ped detector input to any active phase.

Count detectors and system detectors shall be programmable for passage, count, and system functions concurrently in the controller unit software.

Each cabinet shall be equipped with a splice/termination enclosure. This enclosure shall be mounted under the controller unit shelf and above the back panel on the left side, opposite from the power source input. The enclosure shall be provided with two each 12 position splice trays and 24 each termination ST connectors, ceramic ferrule, in front panel mounted ST Couplers arranged in two rows. Each row of ST Couplers shall have two sets of 6 each coupler. The top row shall be for fiber incoming and the bottom row shall be fiber departing, or as shown on the Plans as terminated fibers. Space in the cabinet shall be provided to allow one additional splice/termination enclosure and one wall mount 24-position termination only enclosure.

Documentation

Complete system documentation shall be provided. Such documentation shall, as a minimum consist of:

Three (3) complete operations manuals for each controller and associated signal equipment including equipment wiring diagrams, schematics, and parts lists sufficient for ordering any parts.

Three (3) sets of cabinet wiring diagrams. The corresponding phase numbers for each movement shall be indicated on the intersection layout diagram on the cabinet wiring diagram.

The controllers shall be provided with the most current software and documentation. Future software and documentation revisions to the local system controller shall be provided without charge.

Cabinet wiring diagrams shall include two sheets. One sheet shall indicate the manufacturer point to point wiring of the terminal facility complete with all harnesses for the controller unit and the conflict monitor. This drawing shall be an unaltered generic drawing. The second drawing shall indicate the electrical connections of all equipment and terminal connections for the traffic control cabinet for each cabinet provided. The drawings shall include pictorial representations of the intersection geometrics and phasing. Detectors shall be positioned for each approach and lane,

being tagged with its harness (rack/slot) assignment. The controller cabinet shall be positioned and shown as a rectangle with the two crossing diagonal lanes. In addition to the three sets of wiring diagrams specified above, one Mylar copy shall be provided to the Engineer at the time of turn on at the intersection.

The Signal Equipment Supplier shall provide a customized intersection graphic (CPU) depicting the local intersection for each intersection provided. The customized intersection shall include the following: correct number of lanes by function for each approach; graphically correct orientation of the intersection layout; proper phase assignment by lane; proper pedestrian phase assignments; street names on the lanes; key landmark indicators shown in the graphics. The Engineer will provide an 8 ½ x 11 pictorial of the intersection geometrics and the key landmark indicators to be shown in the graphic. System detectors shall be shown on the graphic and labeled in accordance with the card rack/slot plus system detector assignment numbers. Orientation for all intersection displays shall be north as top of screen.

The addition of any local intersections requires the (CPU) Master Map to be modified. The Signal Equipment Supplier shall provide a corrected map graphic for each intersection added to the group. The map graphic shall include geometrically proportioned locations of the intersections plus locations of all system detectors for each location. A table shall be provided on the graphic which displays the current assignment of detectors by DR., DR2, CS1, CS2, NA1, and NA2. Modified maps shall be loaded into the computer system and viewed for proper operation. Orientation of the map shall be as selected by the Engineer to best display the System Operation.

Guarantee

The equipment furnished under this specification shall be new, of the latest model, fabricated in a first-class workmanship manner from good quality material.

The entire controller unit shall be warranted to be free from defects in workmanship and materials for a minimum of one year from date of acceptance. Any parts found to be defective shall, be replaced free of charge.

The Owner 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.

4.3 INDUCTIVE LOOP VEHICLE DETECTOR

This specification contains the minimum design and operating requirements for solid state, digital inductive loop vehicle detectors capable of detecting the presence of a moving or standing vehicle.

A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and a sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.

Sensor (Amplifier) Unit

The sensor unit shall be solid state, digital, providing detection channel(s) with a minimum inductance range of 50 to 1500 micro-henries. Output circuits of the sensor unit shall be provided by relays. Vehicle presence shall result in a continuous call indication.

The sensor unit shall have the following qualities:

Sensitivity adjustment to allow as a minimum the selection of high, medium, or low sensitivity.

Be capable of providing reliable detection of all licensed motor vehicles.

Provide an indicator light for visual indication of each vehicle detection.

Will not require external equipment for tuning or adjustment.

Provide operation in the pulse mode or presence mode. Mode to be switch selective on the front panel of the unit.

Provide a self-tuning system which is activated automatically with each application of power. Automatic and continuous fine-tuning shall be provided to correct for environmental drift of loop impedance.

Provide for fail-safe operation (continuous call) in the event of detector loop failure.

Each detector channel shall respond to a frequency shift in an increasing and/or decreasing value as occurs with temperature shifts in the pavement without requiring a locked call during the period of returning.

Detector units shall be provided with delay and extension timing. The delay feature shall be selected and adjusted externally on the sensor unit housing. Timing shall be digitally derived and be selectable in 1 second increments from 0 to 30 seconds. Delay timing shall inhibit detector output until presence has been maintained for the time selected. Each new detection shall restart the delay timer

The sensor unit shall be capable of normal operation without interference and false calls between sensor units ("crosstalk") when installed in the physical environment of the controller cabinet and the electrical environment of the associated electronic equipment installed therein, including other detectors.

It shall be possible to install the connecting cable in the same conduit as the signal cables, power cables and other detector cables without affecting the normal operation of the detector.

Loop detector sensor units shall conform to current requirements of NEMA Standard TS1-1983.

A documentation package shall be supplied with the sensor units which shall include two complete sets of schematic diagrams, descriptive parts lists, and instructions for maintenance and operation of the units.

Detector assignments shall be as defined on the plans.

Guarantee

The equipment furnished under this specification shall be new, of the latest model, fabricated in a first-class workmanship manner from good quality material.

The detector sensor unit shall be warranted to be free from defects in workmanship and materials for one year from date of shipment. Any parts found to be defective shall, be replaced free of charge.

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.

4.4 VEHICLE TRAFFIC SIGNAL HEADS

This section of the specifications describes the minimum acceptable design and operating requirements for vehicular signal heads with twelve (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 LED modules.

LED Modules

The low power 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 120 VAC rated and shall be compatible with either public utility or backup power sources of a 60-hertz, +/- 5-hertz with a voltage variance between 80 and 135.

All electronics in the signal shall meet NEMA temperature rating of –40 to +74 ºC. 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 electronics shall be provided with an operating power factor correction of a minimum of 0.9 and shall be provided with fuse and transient suppression incorporated for line and load protection.

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

Red Signal Display	
Luminous Intensity # (cd)	339
Dominant Wavelength (nm)	622
Lens Tint	Tinted
Typical Wattage at 25 ºC	6
Meet or exceed current ITE specification.	

Yellow Signal Display	
Luminous Intensity # (cd)	678
Dominant Wavelength (nm)	590
Lens Tint	Tinted
Typical Wattage at 25 ºC	12
Meet or exceed current ITE specification	

Green Signal Display	
Luminous Intensity # (cd)	678
Dominant Wavelength (nm)	505
Lens Tint	Clear
Typical Wattage at 25 ºC	14
Meet or exceed current ITE specification	

The traditional “arrow” signal display shall have the following characteristics:

Green Arrow Display	
Dominant Wavelength (nm)	505
Lens Tint	Tinted
Typical Wattage at 25 ºC	7

Yellow Arrow Display	
Dominant Wavelength (nm)	590
Lens Tint	Tinted
Typical Wattage at 25 ºC	9

Arrow signals shall have power factor correction and temperature compensation.

The LED modules shall be rated for low power consumption and for use in a backup power installation. LED modules shall be compatible with NEMA TS-2 requirements for traffic controller installations and be fully compliant and compatible with industry standard conflict monitors and malfunction monitor units. LED modules shall be at the rated power consumption, without exception, as backup power sources have been rated based on these design parameters. Charging circuit design shall preclude battery damage caused by continuous battery charge power availability.

LED modules shall be warranted for a minimum field life of 36 months, repair, or replacement; and, be designed for a minimum life of seven (7) years non-degrading for illumination output caused by lens deterioration or LED degrading.

Signal Head Assembly

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.

The optical system shall be so designed as to prevent any objectionable reflection of sunrays even at times of the day when the sun may shine directly into the lens.

Lenses shall be twelve (12) inches in diameter as specified on the plans. Lenses shall be polycarbonate. Glass lenses are not acceptable.

The visors for each signal section shall be durable polycarbonate not less than 0.10" 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 8" long for all 12" rectangular pedestrian signals, at least 9 1/2" long for 12" diameter signals, shall angle slightly downward, and shall be of the type specified on the plans.

Specialized Options

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 (8) position terminal block.

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.

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.

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 a universally adjustable signal head mounting bracket for mast arm mounting.

Where shown on the plans, 5" 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 M.P.H. wind.

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.

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.

4.5 PEDESTRIAN TRAFFIC SIGNAL HEADS WITH COUNTDOWN DISPLAY

This section of the specifications describes minimum acceptable design and operating requirements for two-section, pedestrian traffic signal heads with LED "MAN" and "HAND" symbol messages in the top section and an LED digital countdown display in the lower section 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.

Signal Head Assembly

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

A 12-inch combination HAND/MAN symbol LED module will be installed in the upper section of the pedestrian signal head. A 12-inch Numeric Countdown Display LED Module shall be installed in the lower section of the pedestrian signal head.

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.

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.

Pedestrian Signal LED Module

The upper section of the housing shall be equipped a HAND/MAN combination LED module. The LED Pedestrian module designed as retrofit for existing signal lamps shall not require special tools for installation. The LED modules shall fit into existing 12-inch traffic signal housings built to VTCSM standards without modification to the housing.

The module shall have a fuse and transient suppressor incorporated for line and load protection.

The LED signal module shall be a single, self-containing device, not requiring on-site assembly for installation into existing traffic signal housing. The assembly of the LED module shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

The measured chromacity coordinates for the lunar white MAN and Portland orange HAND shall conform to the chromacity requirements of Section 8.04 and Figure 1 of the VTCSH standard. The chromacity measurements shall remain unchanged over the input line voltage range of 80 VAC to 135 VAC.

The LED signal module shall consist of a double message overlay combining the symbols of a filled hand and outline walking man. The LED's shall be arranged in a manner to form an outline of the symbols. The shape of the outline shall conform to the standard symbols for pedestrian signals. The size HAND/MAN symbols shall comply with the Institute of Transportation Engineers Standards on Pedestrian Traffic Signal Heads. The LED's shall be distributed evenly along the message outline. The distance between each LED shall not vary more than 10%. The individual light sources shall be interconnected so that a catastrophic failure of a single LED will result in a total loss of not more than 3 LED's or 5% of the total light output. There shall be no electronic components visible on the front panel of the display face. The display face shall consist solely of LED's mounted on a mat black PCB.

The driver board shall drive the LED's at a DC current not exceeding the maximum rating recommended by the LED manufacturer. The driver board shall regulate the LED drive current on both HAND/MAN messages to compensate for the line voltage fluctuations over the range of 80 VAC to 135 VAC. The luminous output shall not vary more than 10% over the voltage range and shall not be perceptible to the human eye. The drive circuitry shall include voltage surge protection to withstand high-resolution noise transients and low-repetition high-energy transients as stated in Section 2.16 NEMA Standard TS-2, 1992. The on-board circuitry shall meet FCC Title 47.Sub-Part 8.Section 15 regulations concerning the emissions of electronic noise. The circuitry shall ensure compatibility and proper triggering and operation of load switches and conflict monitors in signal controllers currently in use by the City.

The module shall conform to NEMA Moisture Resistance Standard 250-1991 for Type 4 enclosures (ITE 6.4.6.2 Moisture Resistance).

Pedestrian Countdown Display LED Module

The lower section of the housing shall be equipped a Pedestrian Countdown Display LED module. The LED countdown module designed as retrofit for existing signal lamps shall not require special tools for installation. The LED modules shall fit into existing 12-inch traffic signal housings built to VTCSM standards without modification to the housing.

The LED countdown module shall be rated for use in the ambient operating temperature range of –40 degrees F to +165 degrees F. The module shall also be completely sealed against dust and moisture intrusion per requirements of NEMA Standard 250-1991 sections 4.7.2.1 and 4.7.3.2 for Type 4 enclosures to protect all internal components.

The measured chromacity coordinates for the Portland orange digits shall conform to the chromacity requirements of Section 8.04 and Figure 1 of the VTCSH standard. The chromacity measurements shall remain unchanged over the input line voltage range of 80 VAC to 135 VAC.

The LED signal module shall consist of two seven-segment digits. The LED's shall be distributed evenly along the message outline. The distance between each LED shall not vary more than 10%. The countdown digits shall be at least eight-inches high and shall be made of at least 88 LED's. There shall be no electronic components visible on the front panel of the display face. The display face shall consist solely of LED's mounted on a mat black PCB.

The driver board shall drive the LED's at a DC current not exceeding the maximum rating recommended by the LED manufacturer. The drive circuitry shall include voltage surge protection to withstand high-resolution noise transients and low-repetition high-energy transients as stated in Section 2.16 NEMA Standard TS-2, 1992. The on-board circuitry shall meet FCC Title 47.Sub-Part 8.Section 15 regulations concerning the emissions of electronic noise. The circuitry shall ensure compatibility and proper triggering and operation of load switches and conflict monitors in signal controllers currently in use by the City.

The countdown module shall be compatible with all types of traffic controllers in existence. The countdown timer module shall have a microprocessor capable of setting its own time when connected to a traffic controller. When connected, the module shall continuously monitor the traffic controller for any changes to the pedestrian phase time and re-program itself automatically if needed.

The countdown module shall register the time for the walk and clearance intervals individually and shall begin counting down from the sum of both interval times.

When the walk interval is preempted, the countdown module shall also preempt and skip directly to the clearance interval and countdown to reach 0 at the same time as the solid hand. In the cycle following the preemption call, when the module completes the walk interval countdown and the clearance interval has not yet started, the module shall display the clearance time and wait for the flashing hand to resume the countdown. When the flashing hand becomes solid, the module shall display 0 for one-second and then blank out.

The countdown module shall have an internal conflict monitor to prevent any possible conflicts between the HAND/MAN signal indications and the time display. When the HAND is solid, it shall be impossible to display any time on the display.

When the countdown module is installed in a coordinated system and the walk interval time changes at every cycle, it shall be possible to blank out the walk time and only display the clearance time.

The countdown module shall have dipswitches for the following selectable options:

1-display 0 during standby; 2-turn on all LED's for testing; 3-Coordinated mode, displays clearance time only; 4-disables dimming feature; 5-disables 30 second delay on dimming; 6-disables countdown display.

The module shall have a spare input for special applications such as extending or reducing time on demand.

Certification

The Owner shall be furnished with a certification from the manufacturers of the signal head, pedestrian signal LED module, and the pedestrian countdown display 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.

Warranty

The LED signal modules shall be replaced or repaired if it fails to function as intended due to workmanship or material defects within the first 60 months from date of operation.

4.6 PEDESTRIAN PUSH BUTTONS

Pedestrian push button detectors shall have a momentary LED indication and tone, oval housing, and moveable directional arrow.

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.

The housings shall be made of aluminum alloy and furnished with suitable mounting hardware. The oval pedestrian pushbutton and arrow assembly shall be yellow powder-coated aluminum. The body of the pushbutton shall have a natural finish.

Push button signs shall be furnished and shall conform to the requirements of the Manual on Uniform Traffic Control Devices (M.U.T.C.D.). Signs shall be R10-4A or R10-3A, as indicated on the plans.

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.

4.7 TRAFFIC SIGNAL POLES

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 the latest Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals as approved by the American Association of State Highway and Transportation Officials. The poles shall be manufactured in accordance with city of West Des Moines standard shop drawings.

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 or in the standard shop drawings. 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.

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.

When a transformer base is not used, the pole shaft shall have a handhole 10"x12" for cable access. The handhole shall be provided with a cover.

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 M 183 (ASTM A 36) and cast steel conforming to ASTM A 27, Grade 65-35 or better.

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:

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.

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

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

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

Welding and fabrication shall conform to the Structural Welding Code AWS D1-180, as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel Highway Bridges and by Supplemental Specifications No. 969.

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.

Pole manufacturers shall certify that only certified welding operators in accordance with AWS D1.1-80 were used and only electrodes as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel for Highway Bridges were used.

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. They shall be certified by the fabricator that the mast arms are capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure. 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 A 123, latest revision.

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"x 12" 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.

Combination Pole

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.

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

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

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

The luminaire arm shall be arched.

Hardware

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.

The anchor bolts shall meet the requirements of ASTM A 36 or better.

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

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.

The fabricator shall submit drawings for anchor bolts and base design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A 153, or electrodeposited coated of the same coating thickness and so designed for this purpose.

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.

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 AWS D1.1-80 or latest revisions were used; and that only electrodes as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel for Highway Bridges were used.

4.8 TRAFFIC SIGNAL PEDESTALS

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

Materials

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

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 four and one-half (4-1/2) inches and be provided with a pole cap. Supply a base collar with the pole.

The pedestal base shall be cast aluminum, square in shape, with a hand hole. The size of the hand hole shall be at least four (4) inches by six (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 twenty (20) pounds and shall have a four (4) 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. The base shall meet or exceed AASHTO breakaway requirements

Anchor Bolts

Four (4) three-fourths (3/4) inch by fifteen (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.

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.

4.9 TRAFFIC MONITOR SYSTEM

The Traffic Monitor System-TM utilized on the Project shall be the Axis Q6032-E PTZ Dome Network Camera or approved equal and be fully compatible with the City of West Des Moines' traffic monitor system network.

The traffic monitor system shall include camera in dome, dome, dome mounting bracket and hardware, camera controller, cabling from the camera controller to dome electronics, and all accessories and hardware necessary for a complete operational unit. An additional set of the aforementioned equipment shall also be provided. 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).

The image sensor shall be a ¼" Ex View HAD progressive scan CCD. The minimum illumination for color shall be 0.5 lux at 30 IRE F1.4 and for black/white 0.008 lux at 30 IRE F1.4

The dome electronics shall provide E-flip and 100 preset positions. Camera pan shall be 360 degree endless, 0.05 degrees – 450 degrees/s. Camera tilt shall be 220 degrees, 0.05 degrees –

450 degrees/s. Camera zoom shall be 35x optical zoom and 12x digital zoom, total 420x zoom.

Camera pan shall be 360 degree endless, 0.05 degrees – 450 degrees/s. Video compression shall be H.264 (MPEG-4 Part 10/AVC). Image settings shall provide wide dynamic range (WDR), electronic image stabilization (EIS), manual shutter time, compression, color, brightness, sharpness, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, rotation, aspect ratio correction, text and image overlay, privacy mask, and image freeze on PTZ.

The traffic monitor unit shall be environmentally hardened capable of operating at -40 degrees F to 122 degrees F. Artic temperature control shall enable camera start-up at -40 degrees F.

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.

The traffic monitor system shall be provided with the ability to control the camera, PTZ, and see video from the traffic signal control cabinet at the intersection at which the system is located.

4.10 EMERGENCY VEHICLE PREEMPTION SYSTEM

The Emergency Vehicle Preemption System shall be fully compatible with the existing Emergency Vehicle Preemption System being used in the city of West Des Moines. A cable shall be utilized to provide data from the optical signal processor card to the RTS unit hereinbefore specified controller unit. The processor card will have four-channel detection.

The system will employ optical communication to identify the presence of designated priority vehicles and cause the traffic signal controller to advance to and/or hold a desired traffic signal display selected from set phases normally available. The system provided shall properly receive and decode the strobe pulse, and provide a NEMA defined ground true input to the traffic signal controller. This communication is a line-of sight path of up to 2500 feet. The system requires no attention of the vehicle operator other than an "Emitter On" switch located in the vehicle that is to remain "On" until the end of the emergency run. The system shall operate on a first come first serve basis. The system shall interface with existing traffic signal controllers, without compromising normal operation or existing safety provisions. The Optical Control System shall consist of Optical emitter Assemblies, Optical Detectors and Controller Interface Assemblies, and Optical Detector Cables.

To assure desired performance, the system will provide components matched and proven through integrated testing and functional experience at several intersections. The matched component system shall offer compatibility with all types of Optical Emitters. Optical Detectors and Controller Interface Assemblies shall properly decode either a single bulb or a dual bulb emitter tuned per the above specifications. Optical Detectors and Controller interface Assemblies shall decode a band of 14.035 Hz. +/- 0.050. Matched components shall provide future system compatibility of all priority control devices.

One RTS serial to IP interface connection shall be installed in the signal cabinet to connect the optical signal processor card to the IP Network. This interface shall include all connectors, power supplies, or additional equipment necessary for a complete and functional interconnected installation providing communications from the Traffic Operations Center to this controller site.

The Contractor shall work with the Communications Coordinator to have the optical signal processor card on-lined into the preemption system, verify proper programming, and address the assignment.

System Operation

The priority control sequence shall be activated by an optically transmitted signal of 14.035 Hz +/- 0.05 or upon actuation of a test switch.

The system shall provide a NEMA defined ground true, steady state input to the controller.

System Component Specifications

The Optical Preemption Detector shall be a lightweight, waterproof device capable of receiving optical pulses transmitted by vehicle emitters.

The Optical Preemption Detector shall be capable of being mast arm mounted.

The Optical Preemption Detector must be responsive to the Optical Emitter at a distance of 2500 feet. The range adjustment shall be accomplished by the front panel on the Optical Signal Processor Card.

The Optical Signal Processor Card shall be equipped to receive four channels of preemption inputs.

System Equipment

The system design shall, when used in conjunction with appropriate auxiliary devices, be capable of providing basic, high priority and low priority service.

The system shall be capable of recognizing the following pulse rates as delivered by the Optical Emitter.

1. 9.63 Hz +/- 0.110 as low priority
2. 14.035 Hz +/- 0.05 Hz as high priority

Reliability

All equipment supplied as part of these specifications shall operate under the following environmental condition: Temperature Range: -40 degrees F to +167 degrees F.
The manufacturer and/or manufacturer's representative shall provide quality service before, during, and after installation of the priority control system. The manufacturer and/or manufacturer's representative must provide certified, trained technicians, traffic systems industry

experience, and operational knowledge of priority control systems. The manufacturer shall on-line the preemption location on the central computer system after installation and verify a valid communications link and programmability of the intersection.

The manufacturer shall warrant that, provided the control system has been properly installed, operated, and maintained, component parts that prove to be defective in workmanship and/or material for a minimum of one year from the date of operation for the manufacturer shall be covered in a documented system protection plan. The warranty period normally offered by the manufacturer shall apply if the offered warranty period is greater than one year.

4.11 COMMUNICATIONS AND NETWORK INTERFACE

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.

The contractor shall contact the city's Communications Coordinator (gba Systems Integrators, 309-428-3027) 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, video monitoring device, preemption device, UPS battery backup device and all managed switches.

4.12 UPS BATTERY BACKUP SYSTEM

Each traffic controller shall be provided with an uninterruptible power supply and be integrated into a UPS Battery Backup System. The UPS Battery Backup System shall include a minimum of an Uninterruptible Power Supply [UPS], Transfer Switches, Batteries, and electrical connections necessary to provide a complete and operational system. The UPS Battery Backup System shall be installed in a separate cabinet to be base mounted adjacent to the traffic controller cabinet and electrically connected to the traffic controller cabinet.

The UPS shall be a line-interactive type and provide voltage regulation and power conditioning when using utility power source. The UPS shall provide reliable emergency power to the traffic signals in the event of a power failure or interruption. The transfer of power source from the utility power to the battery power, and reverse to normal operation, shall not interfere with the normal operation of the traffic controller, conflict monitor, or other peripheral devices within the traffic controller cabinet. The traffic controller cabinet shall not default to FLASH Mode during the transition from utility power to battery power or from battery power to utility power. Cabinet wiring shall be designed to exclude traffic video monitoring operation from functioning during power transition to battery power and shall re-energize normal traffic video monitoring when power is restored to utility power. All other functions within the controller cabinet including network operation shall retain functionality on battery backup operation.

The UPS shall support an input voltage from 85 VAC to 175 VAC based on a nominal input voltage of 120 VAC. The UPS shall have the ability to provide input line regulation to increase or decrease line voltage operation. Low voltage input shall have two voltage boost modes; boost mode 1 shall increase an incoming voltage from 94 VAC to a nominal voltage of 115 VAC, and mode 2 shall increase an incoming voltage from 85 VAC to 101 VAC. High voltage input shall have two voltage "buck" [decrease] modes; buck mode 1 shall decrease an incoming voltage from 154 VAC to a nominal voltage of 124 VAC, and mode 2 shall decrease an incoming voltage from 175 VAC to a nominal voltage of 142 VAC. Additionally, a Hysteresis voltage range shall be provided such that the UPS shall reject VAC above the 130 VAC level and below the 100 VAC levels and accept voltage levels within the 105 VAC to 128 VAC. Output of the UPS shall be 120 VAC when operating on line voltage at a range of plus/minus 10% and shall be 120 VAC when operating in backup mode at a range of plus/minus 6%. Output frequency shall be maintained at 60 hertz in both on line and backup modes. Line qualification shall be users selectable to values of 3, 10, 20, 30, and 50-second intervals as a minimum. Default line qualification shall be 3 seconds.

The UPS shall be provided with a current limiter capability of limiting incoming current up to 16 amperes to the output set at 10 amperes. The UPS shall automatically sense line frequency and set operation to 60 hertz. The unit shall be provided with an EMI [Electro-Magnetic Interference] filter and transient suppression. UPS output shall be sinusoidal with a total harmonic distortion of less than 3%, based on resistive load.

The UPS shall have an efficiency of greater than 98% when operating on line voltage and be greater than 84% when operating in backup mode. Total transfer time between line voltage and backup modes or between backup to line voltage shall be less than 6 ms.

The UPS shall be provided with a battery backup charger with operation being at the 48 VDC and with a charger current user programmable for 3, 6, and 10 amperes. The battery charger shall have a maximum float voltage of 56 VDC. The battery charger shall automatically cease charging operations when the battery temperature is 122 degrees Fahrenheit. The battery charger shall be temperature compensated controlled with user selectable settings for millivolt/degree Celsius/Cell of -2.5, -4, and -6 as a minimum. A minimum low battery warning setting of 47 VDC [40%] shall be provided and a low battery shutdown set for 42 VDC based on a 10.5 VDC per battery.

The UPS power supply shall be provided with operation safety protection for both the hardware and users functions. This protection shall include an input circuit breaker rated at 250 VAC @ 20 Ampere, and a 50-Ampere battery circuit breaker and electronic short circuit protection when the UPS is operating in the backup mode. The UPS shall be provided with load monitoring and overload warning complete with automated shutdown for loads in excess of design capacity. Alarm shall be set when the active load is at 95 to 105 % rated output; shut down and alarm shall commence and be complete when actual load is above 106 % within two minutes, and be complete within one minute when actual load is above 115% of rated load. The fault alarm shall be cleared when the overload condition is removed and the power line service returns for both levels of overload. The UPS shall cease operation when the actual load exceeds 115 % rated load and the UPS is in the backup mode. The UPS shall be provided with a surge suppression protection device that shall have a clamping voltage of 150 VAC., with a response time of less than one nanosecond. This surge suppression device shall be a plug-in module that is field replaceable and shall be provided with an LED indicator that turns off [is deactivated] when the module

protection is no longer valid. The surge protection device shall be provided for protection against incoming surges from the power line [Utility Service].

The UPS shall provide battery protection and alarm when operating conditions exceed acceptable levels. A temperature alarm shall be provided when the battery ambient level exceeds 167 degrees Fahrenheit and shall clear when the ambient temperature is reduced below 158 degrees Fahrenheit. The battery operation [backup mode] shall cease when the internal ambient temperature of the battery exceeds 230 degrees Fahrenheit and stay off line until the battery ambient temperature is reduced below 194 degrees Fahrenheit and power line voltage is restored.

The UPS shall provide over voltage protection for excessive output voltage from the UPS. The UPS shall electronically shutdown if the measured output voltage of the UPS exceeds 132 VAC. The UPS shall automatically protect the battery, when battery probe is not installed, at a charger level of 52 VDC. The UPS shall disable the battery charger in two seconds when the battery voltage exceeds 59 VDC and automatically resume charge when the battery voltage level reduces to a level below 57 VDC. An alarm condition shall be reported for battery levels in excess of 59 VDC. The UPS battery shall be provided with a user field replaceable variable speed fan, microprocessor and PWM controlled, that shall operate when ambient temperature is equal or greater than 104 degrees Fahrenheit. The fan shall have an alarm function when the fan is set to operate and is not physically turning.

The UPS shall be provided with safety locks to prevent improper installation. This protection shall include a reverse polarity protection and protection against electrical backfeed to the utility service that complies with UL 1778 and CSA C22.2 No. 107.1.3 requirements and safety standard EN50091-1-1-2 and EN60950. Besides passing Immunity Standards, EN61000-4-2, 3, 4, 5, 6 and 8 and EN61000-3-2 Standards, the manufacturer’s nameplate label shall display agency approval mark “cCSAus”.

The UPS shall be provided with an SNMP Ethernet port for remote programming and monitoring, complete with password and remote operation software or browser application. Additionally, the UPS shall be provided with an RS-232 port for local programming and a LCD display and local control and monitoring of alarm logging events. The UPS shall be provided with a minimum of five SPDT relay contacts for user programming of alarms or other controls for operation. A sixth SPDT relay contact set shall be provided to output the alarms for a secondary remote alarm system that is programmed by the factory.

The UPS shall be provided with a Manual Bypass Switch Operation and Automatic Transfer Switch. The UPS shall be provided with a Battery Heater Mat that shall function when power line voltage is present and temperature ranges indicate the advantage of heating the batteries for enhanced performance, activating at 41 degrees Fahrenheit, and deactivating at temperatures at or above 59 degrees Fahrenheit. The Manual Bypass Switch shall be provided for manual connection or disconnection and testing. The Automatic Transfer Switch shall automatically transfer the load from line power to UPS power and back when the incoming line voltage is impaired and then corrected for proper operation. The battery heater mat shall be sized for the battery array installed.

The batteries shall be Gel Cell Valve Regulated Lead Acid (VRLA) type specifically designed for outdoor application using a “Float Service” to provide 100% runtime capacity without initialization charging. Batteries shall be constructed using Silver Alloy positive plates and shall have a five-year full replacement

warranty, non-prorated. Battery capacity rating at 20 hour shall be 94 Amp Hours, 12 VDC – each battery. Battery design for the UPS shall be either four or eight units per design application. Batteries shall be installed and connected to operate at the 48 VDC design. The battery design and sizing shall provide a minimum of four hours backup time for full operation [signals in color] and nine and one half hours of backup operation in Flash mode. Full operation is defined as 500 W for signals in color and 125 W for signals in Flash Mode per each four-battery unit installation. The contractor shall furnish either the four or the eight battery design based on the signalized intersection design and power requirements for each intersection. The UPS shall be provided with a Battery Charge Maintenance Management System to equalize charging of batteries with different battery life ratings and to allow adding new batteries to existing installation sites without changing all existing batteries at a single time. This management system shall comply with CSA C22.2 No. 107.1 and UL 1778 Standards for safe operation of batteries under unattended applications.

PART V
BASIS OF PAYMENT

5.1 BASIS OF PAYMENT

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.

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.

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.