SP-097015
(NEW)

Iowa Department of Transportation

SPECIAL PROVISIONS

FOR

TRAFFIC SIGNAL INTERCONNECT

Linn County

STP-A-1187(754)--86-57

Effective Date

June 15, 2010

THE IOWA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS, SERIES OF 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS. THESE ARE SPECIAL PROVISIONS AND SHALL PREVAIL OVER THOSE PUBLISHED IN 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 special provisions the traffic signal installed under this specification shall comply with:

A. Latest series of the Standard Specifications of the Iowa Department of Transportation.

B. Specifications of the Underwriters Laboratories Inc.

C. National Electrical Code.

D. Manual on Uniform Traffic Control Devices (MUTCD).

1.2 LOCAL REQUIREMENTS

Local requirements such as requiring the Contractor to be a licensed electrical contractor in accordance with Cedar Rapids City Ordinance and adherence to local Building Code shall be met.

1.3 CONTRACTOR'S RESPONSIBILITY

A. The Contractor will be responsible for incidental sidewalk removal and replacement necessary to complete the signal construction. All waste material and debris shall be disposed of at a sanitary landfill at no expense to the Contracting Authority.

B. The Contractor shall perform all work required and furnish all labor, materials, equipment, tools, transportation and supplies necessary to complete the work in accordance with the project contract documents. The Contracting Authority or their representative shall have full freedom to observe all phases of the work performed by the Contractor and to discuss all matters dealing with the quality and progress of the work. Should any misunderstanding arise as to the intent or meaning of the plans or specifications, or should any discrepancy appear, the decision of the Contracting Authority or their representative shall be final and conclusive.

C. The Contractor agrees to indemnify and hold harmless the City of Cedar Rapids, for all liability arising out of the negligent acts, errors or omissions of the Contractor, their employees, or agents as respects the project.

D. All work included under this contract shall be done in accordance with the Occupational Safety and Health Act of 1970 (Williams Steiger Act) as amended and enforced by the governmental authority responsible for the

enforcement of the Act. Enforcement and responsibility for fulfilling this provision of the specifications shall rest solely with the Contractor, their superintendents, and their foremen and in no way shall rest with the Contracting Authority or the Engineer. The presence of the Engineer, the Contracting Authority, or their representatives shall not obligate the Engineer, Contracting Authority, or their representatives to the Contractor's responsibilities. The Contractor shall inform their subcontractors to this also.

1.4 TRAFFIC CONTROL

A. Through traffic shall be maintained at all times.

B. Existing traffic signal installations shall be kept in effective operation, if required, except for shutdown to allow for alterations. The Contractor shall notify the local traffic enforcement agencies prior to any operational shutdown of a traffic signal installation. Any and all operational shutdowns will be coordinated with the Traffic Engineering Division, and the Contractor may be required to provide temporary electrical service, and it will be considered incidental. The Contractor shall schedule their work such that not more than one intersection at a time is operationally shut down.

C. The Contractor shall be responsible for appropriate traffic control, which may include flaggers, off duty police officers, or other traffic control as specified by the Traffic Engineering Division.

D. All traffic control shall be in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways, as adopted by the Department per 761 of the Iowa Administrative Code (IAC), Chapter 130.

1.5 ORDER OF WORK

A. The order of work shall be determined by the Contractor, subject to the approval of the Engineer.

B. Upon completion of the work the Contractor shall thoroughly clean the site and restore it to a condition at least equal to that existing prior to construction.

1.6 SALVAGE

A. The Contractor shall deliver all salvaged materials to the Cedar Rapids Traffic Engineering Division, 1825 Edgewood Road SW, Cedar Rapids, Iowa, unless otherwise specified in the plans.

1.7 UTILITIES

A. The location of all utilities indicated on the plans is approximate only. The Contractor must determine the exact location and elevation of all public utilities. It shall be the duty of the Contractor to ascertain whether any additional facilities other than those shown on the plans may be present.

B. The Contractor shall replace or repair any existing utilities damaged by their operations at their own expense.

1.8 EQUIPMENT AND MATERIALS

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

B. Before beginning work on the project, the Contractor shall submit six copies of catalog cuts for all equipment and materials supplied by the Contractor.

C. Prior to ordering any materials the Contractor shall provide certification from the manufacturers of all electrical equipment, conduit, and cable stating said material complies with the specifications.

D. All miscellaneous electrical equipment shall be UL approved.

1.9 MEASUREMENT AND PAYMENT

A. Method of Measurement

1. CONC CONTROLLER BASE: The number of concrete controller bases installed shall be counted by the Engineer.

2. FIBER OPTIC CABLE TERMINATIONS: The number of fiber optic cable terminations shall be counted by the Engineer.

3. FIBER OPTIC FUSION SPLICE: The number of fiber optic fusion splices, as indicated on the plans, complete in place and accepted, shall be measured by the Engineer.

4. HANDHOLE, POLY, 24x36 (TYPE II): The number of 24”x36” handholes or junction boxes installed shall be counted by the Engineer.

5. HANDHOLE, POLY, 30x48 (TYPE III): The number of 30”x48” handholes or junction boxes installed shall be counted by the Engineer.

6. PAN TILT ZOOM (PTZ) VIDEO CAMERA: The number of pan tilt zoom video cameras, as indicated on the plans, complete in place and accepted, shall be counted by the Engineer.

7. SIGNAL CABINET MODIFICATION: The number of signal cabinet modifications, as indicated on the plans, installed shall be counted by the Engineer.

8. SIGNAL CONTROLLER: The number of signal controllers installed, as indicated on the plans, complete in place and accepted, shall be counted by the Engineer.

9. BATTERY BACK-UP SYSTEM: The number of battery back-up systems, as indicated on the plans, complete in place and accepted, shall be counted by the Engineer.

10. FIBER HUB CABINET W/ RISER: The number of hub cabinets with risers, as indicated on the plans, complete in place and accepted, shall be counted by the Engineer.

11. SWITCH, ETHERNET EDGE: The number of Ethernet edge switches, as indicated on the plans, complete in place and accepted, shall be measured by the Engineer.

12. SWITCH, MANAGED: The number of Ethernet edge switches, as indicated on the plans, complete in place and accepted, shall be measured by the Engineer.

13. TORPEDO TUBE: The number of torpedo tubes, as indicated on the plans, complete in place and accepted, shall be counted by the Engineer.

14. CONDUIT, 2” HDPE: The Engineer shall measure the number of linear feet of HDPE installed (by either boring or trenching) from center of handhole or cabinet to center of handhole or cabinet.

15. CONDUIT, 2” RSC: The Engineer shall measure the number of linear feet of RSC installed from center of handhole or cabinet to center of handhole or cabinet.

16. CONDUIT, 1” RISER: The Engineer shall measure the number of linear feet of RISER (RSC) installed from base of pole to end point at top of pole.

17. CONDUIT ATTACHMENT TO BRIDGE: None. Lump sum item.

18. FIBER OPTIC CABLE, 144 SM: The Engineer shall measure the number of linear feet of 144 SM FIBER supplied and installed, including slack in handholes and cabinets.

19. FIBER OPTIC CABLE, 48 SM: The Engineer shall measure the number of linear feet of 48 SM FIBER supplied and installed, including slack in handholes and cabinets.

20. FIBER OPTIC CABLE, 24 SM: The Engineer shall measure the number of linear feet of 24 SM FIBER supplied and installed, including slack in handholes and cabinets.

21. FIBER OPTIC CABLE, 24 SM, AERIAL: The Engineer shall measure the number of linear feet of AERIAL 24 SM FIBER supplied and installed, including slack in handholes and cabinets.

B. Basis of Payment

1. CONC CONTROLLER BASE: The price per concrete controller base shall be full compensation for, but not limited to, conduit, grounding, reinforcement, concrete, stone, finishing, excavation, testing, and documentation, and all other labor, equipment, and materials necessary to complete the concrete controller base in place.

2. FIBER OPTIC CABLE TERMINATIONS: The price per each termination shall be full compensation for terminating the fiber optic cables per the plans including, but not limited to, fanout kits, breakout kits, connectors, patch cords, mechanical terminations, heat cured or epoxy terminations, factory pigtails, couplers, trays, shrink tube, termination housing, and all other labor, equipment, and materials necessary for proper fiber termination.

3. FIBER OPTIC FUSION SPLICE: The price per each splice shall be full compensation for permanent fusion splices including, but not limited to, splice trays, splice enclosures, heat shrink tubing, buffer tubing, patch cords, automatic splicer device, termination splice quality testing and documentation, and all other labor, equipment, and materials necessary to complete the splices in place.

4. HANDHOLE, POLY, 24x36 (TYPE II): The price per each handhole or junction box installed shall be full compensation for supply and installation of the box, cut longitudinal 2” HDPE conduit or PVC or RSC if necessary, and supply and splice 2” HDPE or RSC conduit elbows and conduit extensions to each handhole and Junction Box, excavation, backfill, gravel drainage material, sealants, lids and covers, lid imprinting, cable hooks and racks, and all other labor, equipment, and materials necessary to complete the handholes or junction boxes in place.

5. HANDHOLE, POLY, 30x48 (TYPE III): The price per each handhole or junction box installed shall be full compensation for supply and installation of the box, cut longitudinal 2” HDPE conduit or PVC or RSC if necessary, and supply and splice 2”

HDPE or RSC conduit elbows and conduit extensions to each handhole and Junction Box, excavation, backfill, gravel drainage material, sealants, lids and covers, lid imprinting, cable hooks and racks, and all other labor, equipment, and materials necessary to complete the handholes or junction boxes in place.

6. PAN TILT ZOOM (PTZ) VIDEO CAMERA: The price per each pan tilt zoom video camera shall be full compensation for furnishing equipment, camera supports, sealant, materials, cables, and all other work necessary to provide a pan tilt zoom video camera.

7. SIGNAL CABINET MODIFICATION: The price per each signal cabinet modification shall be full compensation for supply and installation of any materials, conduit, elbows, extensions, sealants, drilling holes, and all other labor, equipment, and materials necessary to complete the signal cabinet modification as indicated on the plans.

8. SIGNAL CONTROLLER: The price per each signal controller shall be full compensation for furnishing equipment, materials, and all other work necessary to provide a fully functioning traffic signal controller.

9. BATTERY BACK-UP SYSTEM: The price per each battery back-up system shall be full compensation for providing the system, housing, and all labor, equipment, and materials necessary to complete in place.

10. FIBER HUB CABINET W/ RISER: The price per each hub cabinet with riser shall be full compensation for providing the cabinet with riser, conduit, elbows, extensions, sealants, drilling holes, and all other labor, equipment, and materials necessary to complete in place.

11. SWITCH, ETHERNET EDGE: The price per each Ethernet Edge switch shall be full compensation for furnishing equipment complete in place and accepted, and shall include all other labor, equipment, and materials necessary to complete the managed switch.

12. SWITCH, MANAGED: The price per each managed switch shall be full compensation for furnishing equipment complete in place and accepted, and shall include all other labor, equipment, and materials necessary to complete the managed switch.

13. TORPEDO TUBE: The price per each torpedo tube shall be full compensation for providing the torpedo tube and all labor, equipment, and materials necessary to complete in place.

14. CONDUIT, 2” HDPE: The price per linear foot shall be full compensation for boring or trenching (as specified) the HDPE conduit, including supply and installation of the conduit, trenching/excavating for bore pits or for conduit, backfilling, surface restoration, fittings, conduit supports, band clamps, conduit hangers, expansion fittings, epoxy resin, couplings, testing, tracer cable, and all other labor, equipment, and materials to complete the conduit per the plans.

15. CONDUIT, 2” RSC: The price per linear foot shall be full compensation for installing (as specified) the RSC conduit, including supply of the conduit, surface restoration, fittings, couplings, testing, and all other labor, equipment, and materials to complete the conduit per the plans.

16. CONDUIT, 1’ RISER: The price per linear foot shall be full compensation for installation (as specified) the RISER RSC conduit, including supply and installation of the conduit, trenching/excavating for bore pits or for conduit, backfilling, surface restoration, fittings, couplings, testing, and all other labor, equipment, and materials to complete the conduit per the plans.

17. CONDUIT ATTACHMENT TO BRIDGE: Payment for Conduit Attachment to Bridge will be paid for at the lump sum contract price. Payment is full compensation for the conduit attachment work required for the project as let, including all labor and materials needed as indicated on the plans.

18. FIBER OPTIC CABLE, 144 SM: The price per linear foot shall be full compensation for providing fiber optic cable, testing the cable, temporary splices for testing, pulling equipment and lubricants, test documentation, installation, coiling and securing slack, and all other labor, equipment, and materials necessary to complete the fiber optic cable installation.

19. FIBER OPTIC CABLE, 48 SM: The price per linear foot shall be full compensation for providing fiber optic cable, testing the cable, temporary splices for testing, pulling equipment and lubricants, test documentation, installation, coiling and securing slack, and all other labor, equipment, and materials necessary to complete the fiber optic cable installation.

20. FIBER OPTIC CABLE, 24 SM: The price per linear foot shall be full compensation for providing fiber optic cable, testing the cable, temporary splices for testing, pulling equipment and lubricants, test documentation, installation, coiling and securing slack, and all other labor, equipment, and materials necessary to complete the fiber optic cable installation.

21. FIBER OPTIC CABLE, 24 SM, AERIAL: The price per linear foot shall be full compensation for providing fiber optic cable, testing the cable, temporary splices for testing, pulling equipment and lubricants, test documentation, installation, coiling and securing slack, and all other labor, equipment, and materials necessary to complete the fiber optic cable installation.

1.10 FIBER OPTIC CABLE

THIS WORK SHALL CONSIST OF INSTALLING A FIBER OPTIC CABLE OF THE TYPE, SIZE AND NUMBER OF FIBERS SPECIFIED.

A. 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.

B. 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.

C. 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.

PART II MATERIAL REQUIREMENTS

2.1 ELECTRICAL

A. Service Conductor (Power Cable) shall be 600 volt, single conductor cable and shall comply with 4185.12 of the Standard Specifications and shall be U.L. listed for type "USE." The sheath shall be black for the positive cable and white for the negative cables.

B. Connectors shall be insulated setscrew connectors.

The setscrew connectors shall be Ideal, Series 30200; Holub, Catalog No. 10307, Model SS2 or approved equal.

The Engineer prior to incorporation in the work shall approve connectors.

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

D. Fiber optic cable shall be OFS Brand, Fortex DT Cable:
- 144 strand: AT-3BE12YT-144-H
- 48 strand: AT-3BE12YT-048-H
- 24 strand: AT-3BE12YT-024-H

E. Torpedo tube shall be Tyco FOSC 400B-2 torpedo tube, with up to 96 fusion splices and up to two drop ports.

2.2 CONDUIT

A. Galvanized rigid steel conduit (RSC) where called for on the plans shall meet the requirements of ANSI Standard Specification C 80.1, latest revision. Conduit fittings shall conform to the requirements of ANSI Standard Specification C 80.4, latest revision. The number and size of conduits shall be as called for on the plans.

B. If called for in the Plans, Polyvinyl Chloride (PVC) conduit shall be Schedule 80. The number and size of the conduits shall be as called for on the plans. Installation of ground wire in the conduit to complete the grounding system shall be incidental.

C. Unless otherwise specified all conduit used for the electrical system shall be galvanized rigid steel having the Underwriters Laboratories approval. Conduit shall be of standard lengths with each length bearing the UL approved label.

D. All fittings used with rigid steel conduit shall be galvanized steel. Fittings of aluminum or zinc alloys are not acceptable.

E. Conduit sizes are as shown on the plans. These are the minimum sizes permitted for the application, the Contractor may, at their own expense, substitute a larger size.

F. HDPE Conduit (Fiber Optic Interconnect)

High Density Polyethylene (HDPE) conduit conforming to ASTM F2160.

Conduit shall be schedule 40, SDR 13.5, and shall be made with Prime Resins for conduit.

Conduit shall have tracer wire and pullrope installed, incidental to installation of HDPE.

Conduit fittings and couplings shall conform to the requirements of ASTM F2176, latest revision. Couplings shall be e-loc type couplings. When connecting to risers, use double e-loc couplings.

Conduit shall be tested in accordance with ASTM D2122 “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”.

Minimum elongation at break shall be 400% when tested according to Test Method D638 “Standard Test Method for Tensile Properties of Plastics”.

The conduit and couplings shall not fail when tested at the low-temperature conditions of -4° F as specified in ASTM F2160 and using the test apparatus as described in Test Method ASTM D2444 “Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)”.

The manufacture of couplings shall be in accordance with good commercial practice, uniform in color and free of visual defects such as burns, cracks, holes, foreign materials or voids so as to produce fittings meeting the requirements of ASTM F2176.

The coupling/conduit joint shall not fail by leakage when subjected to sustained internal and sustained external pressure testing as noted in ASTM F2176. The coupling/conduit joint assemblies shall comply with tensile loading requirements, and shall not fail by pullout when loaded to axial tensile load requirements as specified in ASTM F2176.

2.3 GROUND RODS AND GROUND WIRE

A. Ground rods shall be high strength steel rods with chemically bonded copper coverings to provide high conductivity and to prevent electrolytic action. Rods shall be full length as shown on the plans and shall have a nominal diameter of five eighths inch unless otherwise specified. Ground rods shall conform to the requirements of IMSA specification No. 621956. Ground wires shall be connected to ground rods with one-piece nonferrous clamps which employ setscrews as tightening devices. Connections to ground rods need not be taped.

B. All ground wires shall be #6 AWG, bare, solid annealed copper wire unless otherwise specified on the plans. Each steel pole or pedestal shall be firmly connected to the ground rod provided, by means of the grounding terminal specified in these special provisions. Placing the ground wire under an anchor bolt nut, anchor bolt cover, or similar device will not be permitted.

2.4 CONCRETE BASES FOR HUB CABINETS

A. Concrete for bases shall be Class "C" structural concrete, C4 mix.

B. Reinforcement for bases shall meet the requirements of Section 2404 of the Standard Specifications.

PART III INSTALLATION REQUIREMENTS

3.1 GENERAL

A. The Contractor shall be prepared to furnish, upon request from the Engineer, a sample for evaluation, of any item or material, which they propose to furnish for this project.

B. The installation of all traffic signal equipment will be as shown in the plans. Any modifications of the installation are subject to the approval of the Engineer.

C. Unless otherwise specified in these contract documents, the installation of all signal equipment shall be in accordance with the Traffic Signal Manual of the International Municipal Signal Association (IMSA).

3.2 CONCRETE BASES FOR POLES, CONTROLLER, AND BATTERY BACK-UP

A. Concrete bases for poles, controllers, and battery back-up shall conform to the details shown on the plans.

B. Excavations for these bases shall be made in a neat and workmanlike manner. Whenever the excavation is irregular, forms shall be used to provide the proper dimensions of the foundations below grade.

C. 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 and means shall be provided for holding them rigidly in place while the concrete is being deposited. When located in a continuous sidewalk area, the top of the pole bases shall be set flush with the sidewalk or pavement surface.

D. All reinforcing bars, conduits, ground rods, and anchor bolts shall be installed rigidly in place before concrete is deposited in the forms.

E. Anchor bolts for the signal poles and cabinets shall be set in place by means of a template constructed to space the anchor rods in accordance with the manufacturer's requirements. The top of the bolts shall not vary more than 1/4 inch. Bolt projections shall be provided per manufacturer’s recommendations. The center of the template and the center of the concrete base shall coincide unless the Engineer shall direct otherwise.

F. The top of the base shall be finished level and the top edges shall be rounded with an edger having a radius of 1/2 inch. The exposed surface of the base shall have a wood floated surface finish. Exposed concrete surfaces shall be cured using white pigmented curing compound or plastic film meeting the requirements of Article 2403.11 of the Standard Specifications.

G. The bottom of the foundations and bases shall rest securely on firm undisturbed ground.

Where the foundation or base cannot be constructed as shown on the plans because of an obstruction, the Contractor shall use other effective methods of supporting the pole as may be designated by the Engineer.

H. Concrete shall be vibrated with a high frequency vibrator after it is placed in the form to eliminate all voids.

I. 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. The Contractor shall bear all costs of replacing work deemed unsatisfactory by the Engineer.

J. Anchor bolts for poles where arms are to be perpendicular to the centerline of the street shall be installed so that a line through the center of one anchor bolt farthest from the curb and extended through the center of the adjacent anchor bolt closest to the curb will be perpendicular to the centerline of the street to within two degrees of arc unless otherwise specified.

K. 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.

L. The Engineer prior to construction shall approve each base location. Base dimensions shown on the plans are minimum dimensions and based on stable soil conditions. Should extremely loose or sandy soil be encountered, the Contractor shall contact the Engineer for necessary base alterations.

M. Where shown on the plans, the contractor shall remove the top of existing mast arm footings, anchor bolts, and conduits to 36 inches below the existing top of curb or edge of pavement elevation. Waste materials shall be removed from the site and disposed in accordance with local regulations. Backfilling for the removal shall be performed with mechanical compaction equipment meeting the requirements for backfilling conduit. The upper 6 inches of the removal area, if outside the proposed pavement, shall be backfilled with black dirt.

3.3 HANDHOLES

A. Handholes shall be either built in place in an excavation made in a neat workmanlike manner or shall be a precast unit conforming to the requirements of the plans.

B. 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 them rigidly in place while the concrete is being placed.

C. The ends of all conduits leading into the handhole shall fit approximately 2 inches beyond the inside wall. A drain conforming to the dimensions shown on the plans shall be constructed in the bottom of the handhole unless otherwise specified.

D. Concrete handholes (Type 1) shall be 24” diameter. Frames and covers for traffic signal handholes shall be made of cast iron conforming to the

requirement of plans, and to the dimensions shown on the plans. Minimum weight of cover shall be 165 lbs. Lid shall have checkered top, with “TRAFFIC SIGNAL” legend and manufacturer’s name on top.

E. When installed in sidewalk or pavement, top of handhole cover shall be set flush with the sidewalk or pavement surface. When installed in an earth shoulder away from the pavement edge, the top surface of the handhole shall be approximately one inch above the surface of ground. When constructed in unpaved driveways, the top surface of the handhole shall be approximately level with the surface of the driveway.

F. All conduit openings in the handholes shall be sealed with an approved sealing compound after the cables are in place. This compound shall be a 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.

G. Precast polymer concrete handholes shall be stackable, have bolted covers, and be sized 24” X 36” (Type 2) or 30” X 48” (Type 3) with minimum depth 30”, unless otherwise specified in the Plans. The polymer concrete material shall meet or exceed all appropriate ANSI/ SCTE 77 tests and requirements. The bottom shall be “open” unless otherwise specified in the Plans. The lid shall be imprinted with the legend “TRAFFIC SIGNAL” or “FIBER”, as shown on the Plans, and satisfy loading requirements of ANSI Tier 15. A minimum of four cable hooks will be installed in each junction box to support cables.

3.4 CONDUIT

A. INSTALLATION

1. Conduit shall be placed as shown on the plans.
2. Conduit shall be installed without change in direction directly from one structure to another, unless approved by the Engineer. Change in direction may be allowed for physical restriction such as right-of-way restrictions, utilities, location of roadway slopes, retrofitting existing conduit stubs, and certain short sections of conduits.
3. Change in direction of rigid steel conduit, when approved, shall be accomplished by bending the conduit uniformly to a radius, which will fit the location (minimum radius 6 times the internal diameter of the conduit), or by the use of standard bends or elbows. Sharp kinks in the conduit will not be permitted.
4. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Where it is necessary to cut and thread steel conduit, exposed threads will be field galvanized.
5. All conduit and fittings shall be free from burrs and rough places. Standard manufactured elbows, nipples, tees, reducers, bends, couplings, union, etc. of the same materials and treatment as the straight conduit pipe shall be tightly connected to the conduit.

6. All conduit ends shall be provided with a bushing to protect the cable from abrasion, except for open ends of conduit being placed for future use. Bushings shall have grounding fittings, which shall be connected to the grounding system by a #6 ground wire as contained in these specifications.
7. All conduits placed for future use shall be plugged with a push penny cap and secured by electrical tape before backfill.
8. All conduits shall drain, except for specific locations approved by the Engineer. Contractor will not be allowed to bend conduits upward to accomplish the conduit clearances shown on the handhole details.

B. TRENCHING AND BACKFILLING

1. Secure written approval of the City Forester prior to any trenching or excavation within the drip line of any tree.
2. Trenches shall be excavated to such depth as necessary to provide 12 inch to 18 inch cover over the conduit. All cinders, broken concrete or other hard abrasive materials shall be removed and shall not be used for backfilling. The trench shall be free of such materials before the conduit is placed. No conduit shall be placed prior to inspection of the trench by the Engineer.
3. All trenches shall be backfilled as soon as possible after installation of conduit. Backfill material shall be deposited in the trench in layers not to exceed 6 inches in depth and each layer shall be thoroughly compacted before the next layer is placed. Hard materials shall not be placed within 6 inches of the conduit.
4. Whenever excavation is made across parkways, gravel driveways, or sodded areas, the sod, topsoil, crushed stone and gravel shall be replaced or restored as nearly as possible in its original position and the whole area involved shall be left in a neat and presentable condition. Concrete sidewalk pavements, and base courses and bituminous surfaces shall be replaced with new materials and the cost shall be incidental to the work.

C. PUSHED OR BORED CONDUIT

1. When the term “pushed’ or “bored” is used in the plans, it is intended that all conduits be placed without disturbing the existing surface. Such conduit shall be placed by jacking, pushing, boring or any other means necessary to place the conduit without cutting or removing pavement or disturbing existing surfaces except at the bore pit or push equipment location.
2. Removal of pavement will require prior approval of the Traffic Engineering Division. Replacement of removed pavement will be done according to plan details and no additional payment will be made.
3. Plan quantities for pushed conduit include at least two feet of pushed conduit behind each curb.
4. The maximum conduit depth at handholes for all conduits, including pushed conduit, is as shown on the plans. Contractor

must push their mole (without conduit) at least four (4) times before consideration will be given to allowing an upward bend in the conduit.

3.5 ELECTRICAL

A. Interconnect cable shall be continuous from controller to controller.

B. A tracer wire shall be installed in all conduits with signal cables, detector lead-in cables, or communication cables. The tracer wire shall be identified in the controller cabinet, handholes, and poles by means of identification tags. The tracer wire shall be spliced in the handholes to form a continuous network.

3.6 CONTROLLER CABINET

A. The controller cabinet shall be mounted with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller.

B. All field wiring must be directly attached to the wiring lugs. Attachment of wiring shall be in a neat and workmanlike manner.

C. All conduit openings in the controller cabinet shall be sealed with an approved sealing compound. This compound shall be a readily workable at temperatures as low as 30 degrees F and shall not melt or run at temperatures as high as 300 degrees F.

D. All wiring diagrams, service manuals, instructions for installing and maintaining the equipment and advice as to timing and operation shall be returned to the Traffic Engineering Division in good condition.

E. The Engineer or their representative shall inspect the installation before activation and shall be present at the time the controller is activated to assure that the controller is installed in accordance with the manufacturer's recommendations.

3.7 EQUIPMENT TESTING

A. When the Contractor's work is complete and the project is open to normal traffic, the Contractor shall notify the Engineer in writing the date the signal will be ready for testing.

B. Initial traffic signal timings and timing adjustments will be provided and programmed by the Traffic Engineering Division.

C. Upon concurrence of the Engineer, the Contractor shall place any signal in operation for a consecutive 30 day test period. Any failure or malfunction of the equipment supplied or installation performed by the Contractor shall be corrected at the Contractor's expense and the signal tested for an additional 30 consecutive day period. This procedure shall

be repeated until the signal equipment has operated satisfactorily for 30 consecutive days.

D. If the signal is to operate independently of other signals or signal systems, it shall be tested as a single installation.

E. If the signal is part of a system, the test period shall not be started until all signals in the system are ready to be tested. The system shall be tested as a unit.

F. The Contractor shall initiate correction of any failure malfunction of the signal installation within 24 hours of notification by the Traffic Engineering Division. The Traffic Engineering Division will correct any failure or malfunction of the signal installation not investigated by the Contractor within the above time period, and will deduct its expenses from the Contractor's final payment.

3.8 FIBER OPTIC CABLE INSTALLED IN DUCTS AND CONDUITS

A. 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 100 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, post-termination or as shown in Plans, shall be as follows:

Hub cabinet – 100 feet
Fiber Handhole – 100 feet

B. 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 perimeter 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) tracer cable shall be pulled with ten feet (10’) slack in each pull box, except where existing tracer cable is installed.

C. All fiber cables shall be marked with a metallic 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

D. 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

E. 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, 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 FDPs shall be tested separately. Multimode fiber may be tested using 1300 nm and single mode may 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.

F. 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. Outdoor patch cords between FDP and controller units less than 151 feet do not need be OTDR tested.

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

Patch cords/Pigtails	0.60 MM & 0.15 SM dB each
Unicam Terminations	1.0 dB set of 2 [In and Out]
Splices	0.08 each

1 KM = 0.3077 KF where KF is 1000 feet

H. 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

I. Terminations shall be made using the method recommended by the connector manufacturer. All fibers shall utilize a fanout 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

J. 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 MIC024 or WDC012 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 or epoxy approved 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 MIC024048 or 067 series or preapproved equal.

CONNECTORS

K. 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

L. The fiber cable shall be installed in continuous runs between cabinets. No splices shall be allowed, unless shown on the plans or for testing. For testing of unterminated fibers, only mechanical splices may be used. Mechanical splices shall:

1. Use a fiber optic mechanical splice connector including a single connector element operable for providing optical fiber alignment and strain relief includes opposed splice components that define first and second grooves for receiving the bare glass portions of mating optical fibers, as well as the coated or buffered portion of at least one of the optical fibers when the splice components are biased together by an actuator.

2. The mating optical fibers are aligned while the coated or buffered portion of one of the optical fibers is retained within the same connector element, thus eliminating positioning problems that occur when separate connector elements are utilized for fiber alignment and strain relief.

3. The splice components may be unbiased to allow removal of at least one of the mating optical fibers without destroying the connector assembly or potentially damaging the optical fibers.

All other 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/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

M. 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).

POWER METER

N. 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

O. 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.

P. 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 with out

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 3.11 E. specification as hereinbefore defined. The Engineer reserves the right to spot test fiber terminations, splices, or retesting 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

Q. 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 Engineer as hereinbefore specified. The Engineer may perform or require supplemental testing at any time. The Contractor shall provide one copy of operating software to read and view all OTDR traces.

R. 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.

S. 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.

T. 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

U. 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 subsectioned 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

V. 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.

W. 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

X. 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. 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.

Y. 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

Z. 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. (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

4.1 TRAFFIC ACTUATED TRAFFIC SIGNAL CONTROLLERS

A. PURPOSE. It is the purpose of Section A of these specifications to set forth minimum design and functional requirements for all actuated controllers included in this specification. Controllers shall be Eagle M50 series by Siemens, so as to be fully compatible and interchangeable with controllers on the City's existing ACTRA signal system and to support all features of the system including communication over Ethernet and fiber optic cable.

1. CABINET
   a) BASIC CONSTRUCTION. The controller and all associated equipment shall be provided in weatherproof metal cabinet of cleancut design and appearance.

      (1) CONSTRUCTION MATERIAL. The cabinet shall be constructed of sheet or cast aluminum.
      (2) DOOR. A hinged door shall be provided permitting complete access to the interior of cabinet. When closed, the door shall fit closely to gasketing material, making the cabinet weather and dust resistant. The door shall be provided with a strong lock and key. The

door shall be designed to be opened only with the standard controller cabinet key currently used by the City of Cedar Rapids. A sample key will be made available to the successful bidder.

(3) AUXILIARY DOOR. A small hinged and gasketed "door in door" shall be included on the outside of the main controller door. The auxiliary door shall not allow access to the controller, its associated equipment, or exposed electrical terminals but shall allow access to a small switch panel and compartment containing a signal shutdown switch, a flash control switch, and other specified functions.

The auxiliary door lock shall be equipped with a strong lock utilizing keys of a different design from those provided for the main cabinet door.

The auxiliary door lock shall be designed to be opened only with the standard auxiliary door key used by the City of Cedar Rapids. A sample key will be made available to the successful bidder.

(4) DOOR STOP. The controller cabinet door shall be provided with a stop and catch arrangement to hold the door open at angles of both 90 degrees and 180 degrees, ± 10 degrees.

(5) MOUNTING SHELVES. The cabinet shall contain strong mounting table(s) or sliding way(s) to accommodate the mounting of the controller and all included auxiliary equipment. The mounting facilities shall permit the controller and/or auxiliary equipment to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connections or interrupting operation of the controller.

(6) MOUNTING SCREWS. Screws used for mounting shelves or other mounting purposes shall not protrude beyond the outside wall of the cabinet.

(7) OUTLET AND LAMP. An electrical outlet shall be furnished and located in an accessible place near the front of the cabinet. Each cabinet shall be provided with a gooseneck with LED light mounted in the cabinet in a manner, which will provide adequate light to service all parts of the cabinet interior during nighttime hours. The light shall be controlled by a toggle switch mounted on the inside control panel.

b) SIZE, TYPE AND MOUNTING

(1) SIZE. The cabinet shall be of such size to adequately house the controller, all associated electrical devices and hardware, and other auxiliary equipment herein specified.

(2) MOUNTING. The cabinet shall be arranged and equipped for concrete base mounting on an aluminum riser. The riser shall provide 15 inch depth and shall be

constructed of the same material and finish as the cabinet. Sufficient galvanized anchor bolts, clamps, nuts, hardware, etc., as required for the specified mounting type shall be furnished with each cabinet.

c) VENTILATION. A thermostatically controlled duct fan unit with a minimum rating of 100 CFM in free air shall be installed in the cabinet to provide forced air ventilation through the cabinet. The fan unit shall be mounted to the inside top of the cabinet and shall be easily removed and replaced without having to dismantle any part of the cabinet or exhaust duct system. The thermostat controlling the fan shall be manually adjustable to turn on between 90 degrees F and 150 degrees F with a differential of not more than 10 degrees F between automatic turnon and turnoff. The fan shall intake air through filtered vents located near the bottom of the cabinet or cabinet door and exhaust it through a weatherproof, screened duct located near the top of the cabinet. Fiberglass type dry filters shall be used to cover the air intakes into the cabinet. These filters shall be easily removed and replaced and be of standard dimensions commercially available. The filters shall be provided with positive retainment on all sides to prevent warping and entry of foreign matter around the edges.

d) CONNECTING CABLES, WIRING AND PANELS
   (1) CONNECTING CABLES. Electrical connections from the controller (and auxiliary devices when included) 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 leading there from. This can be accomplished by means of a multiple plug, a spring connected mounting or approved equivalent arrangement. Correlation shall be made with connecting cable plug and controller jack as described in Subsection 2.2., Section A of this specification.
   In addition to the above, a mating plug/cable assembly shall be provided for all connectors on the controller (or auxiliary device).
   (2) PANELS AND WIRING. Each cabinet shall be furnished with suitable, easily accessible wiring panel(s). All panel wiring shall be neatly arranged and firm.

      (a). WIRING TERMINALS. Terminals shall be provided, as a minimum, for the following:

- Terminal with N.E.C. cartridge fuse receptacle, fuse, power line switch or magnetic 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 signal load switches, and outgoing signal field circuits.
- Terminals and bases for signal flasher and outgoing signal field circuits.
- Terminals for detector cables.
- Terminals for all required auxiliary equipment.
- Terminals for all conflict monitor inputs and outputs.
- Terminals for all NEMA defined inputs and outputs
- Terminals for all inputs and outputs defined by the controller manufacturer which may be in addition to the NEMA defined inputs and outputs.

(b). CLEARANCE BETWEEN TERMINALS. 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.

(i) SIGNAL CIRCUIT POLARITY. The outgoing signal circuits shall be of the same polarity as the line side of the power service; the common return of the same polarity as the grounded side of the power service.

(ii) GROUNDING CONDUCTOR BUS. An equipment grounding conductor bus shall be provided in each cabinet. The bus shall be grounded to the cabinet in an approved manner.

e) FUSING AND SURGE PROTECTION

(1) INCOMING AC LINE. Suitable over current protection, utilizing one of the methods described in Subsection A.13.4.2.1, shall be provided.

(2) BRANCH AC CIRCUITS. Suitable over current protection devices shall be provided for each of the following AC power line input circuits:

- • Controller mechanism
- • Cabinet fan
- • Conflict monitor
- • Detector amplifiers

- • Flash transfer

(3) LIGHT & OUTLET FUSE. A 15 ampere fuse and indicating type of fuse holder, wired in advance of the main circuit breaker for protection of the AC power input circuits to the cabinet light and the convenience duplex receptacle shall be provided.

(4) SURGE PROTECTION. High energy transient surge protection shall be provided on the incoming AC power lines in order to minimize potential controller damage. This shall be a gas discharge lightning arrestor 200400 volts. A second such device shall be provided on the AC power line to the controller unit.

f) PAINTING. The cabinet shall be natural, unfinished aluminum. All mounting attachments shall be natural, unfinished aluminum or finished with two coats of high grade aluminum colored paint.

g). PLASTIC ENVELOPE. A heavy duty clear plastic envelope shall be securely attached to the inside wall of the cabinet door. Minimum dimensions shall be 9 inches wide x 11 inches deep.

2. GUARANTEE. The 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 purchaser any part that fails in any manner by reason of defective material or workmanship within a period of 18 months from date of shipment from the supplier's factory, but not to exceed one year from the date that the equipment was placed in operation after installation.

3. WIRING DIAGRAMS AND DOCUMENTATION. One documentation package shall be supplied in each controller cabinet and three additional copies will be supplied for office use. Each package will consist of the following list of items for the cabinet and load facility and for each model of controller, conflict monitor, load switch, and flasher: a) Complete schematic diagram, accurate and current for unit supplied. b) Complete physical description of unit. c) Complete installation procedure for unit. d) Specifications and assembly procedure for any attached or associated equipment required for operation. e) Complete maintenance and troubleshooting procedures. f) Warranty and guarantee on unit, if any. g) Complete performance specifications (both electrical and mechanical) on unit. h) Complete parts list - listing full names of vendors and parts not identified by universal part numbers such as JEDEC, RETMA, or EIA. i) Pictorial of components layout on chassis or circuit boards. j) Complete stage-by-stage explanation of circuit theory and operation.

4.2 ETHERNET COMMUNICATIONS SYSTEM

A. This specification sets forth the minimum requirements for an Ethernet based traffic signal interconnect and communications system. All work, equipment, and materials to provide a properly functioning Ethernet communications system is included.

The fiber optic Ethernet communications equipment shall include:

- Heavy Duty Field Switch shall be GarrettCom Magnum 6K Series with 1 Gb transmitters
- Ethernet to FSK Converter shall be electronically coupled Ethernet-Serial-FSK process with data transmission framing synced to the traffic controller FSK modem. The converter shall be a Comtrol RTS series device linked to an equivalent Siemens AAZ11681P002. The converter will link Ethernet to twisted pair FSK communications.
- Device server shall be 4-port, premium rated Comtrol RTS Series, Ethernet to serial
- Ethernet Access Device (EAD) shall be Actelis ML620/ ML688 series with add/ drop circuitry allowing up to four (4) twisted pair
- Unmanaged switches shall be ES42 PD as manufactured by GarrettCom without fiber optic line driver

B. The system shall be primarily fiber optic cable based, but may include interface equipment to change from fiber optic communication to twisted pair copper wire communication as shown in the plans. The system shall also include interface equipment and cabling for CAT-5 communications, except cable installed in conduit external to controller cabinet shall be CAT-6E.

C. All equipment, terminations, connectors, terminal blocks, and any other hardware to construct the system shall be designed for outdoor use in typical traffic signal system conditions. All equipment shall include mounting brackets to secure the equipment in the cabinet.

4.3 SERVICE PEDESTAL AND BACK-TO-BACK BATTERY BACK-UP SYSTEM

If set forth in the Plans, the Contractor shall supply and install a TESCO 1400 combination battery back-up, electrical service with meter and lighting controller. Additional features must include transfer switch for generator power (lockage in use), metered disconnect for traffic signal, and un-metered disconnect for street lighting. Dedicated conduits shall connect the unit with the fiber hub cabinet, the adjacent signal pole base (for street lighting) and the designated polymer concrete handhole (for traffic signal cabinet). The service pedestal shall be part of the continuously grounded system discussed in this specification.

A. The underground service distribution and control pedestals shall be constructed of anodized aluminum. The system shall provide

uninterrupted, conditioned power (true pure sine wave) for the Traffic Controller Cabinet and fiber hub cabinet to eliminate Black-outs, Brown-outs, and Spikes on the signals and the control equipment. A typical intersection with a power outage, will operate as normal for 2 hours of run time and 8 hours of flash. Upon normal power resumption, the system shall recharge to 95% within 6 hours. Batteries shall be quick, hot swap replacement with no exposed terminals. The system shall monitor and record transient events and self-test the batteries, and provide local and remote data.

B. Service pedestal will include:

- Small and low profile with no exposed fasteners.
- Fabricated from anodized aluminum.
- Durable all welded construction.
- Vandal proof doors with hasp stress rated to 2,000 lbs.
- The cabinet shall be factory wired and tested before shipment.
- UL approved copper cable busing and control wiring.
- Meets EUSERC requirements.
- Shall provide both unmetered and metered circuits up to 200 Amps.

C. Cabinets and power specifications:

- Dual Cabinets external dimensions: 20.5” wide x 50’ high x 19.25” deep, excluding door handles.
- Cabinet shall be fabricated from 1 1/8” anodized aluminum.
- Internal parts shall be fabricated from 14 gauge cold rolled steel.
- Cabinet shall be all welded construction with welding materials specifically designed for the material used.
- All fasteners, latches, and hardware shall be of stainless steel and all hinges shall be continuous piano style.
- There shall be no exposed nuts, bolts, screws, rivets, or other fasteners on the exterior.
- Removable backpan shall be mounted on 4 welded 1/4” studs.
- Cabinet doors shall have 2,000 lb. stress rated hasp, welded to the cabinet and door.
- Cabinets shall have fully framed side hinged outer doors with swagged close tolerance sides for flush fit with top drip lip and closed cell neoprene flange compressed gaskets.
- Base mounting detail shall be identical to existing cabinets for emergency replacement.

  Deadfront Safety Door

  - Distribution and control panel shall have a hinged deadfront panel with 1/4 turn latch and knurled knobs.
  - Deadfront shall be hinged on the same side as the front door and shall open a minimum of 120°.

Power Distribution Panel

- Main breakers shall be 1 pole, 2 pole, 3 pole, or 4 pole, as appropriate for this installation, and in accordance with the local utility.
- Provide separate metered main, unmetered lighting main, and disconnects as required.
- There shall be no plug-in circuit breakers. Circuit breakers shall be industrial grade.
- All branch circuit breakers shall be installed in a vertical position, handle up for 'On', handle down for 'Off'.
- All busing shall be U.L. approved copper THHN cable busing, fully rated.

Battery Back-Up System

- Vandal-resistant construction.
- 1400 VA, 950 Watts, Industry Standard run time 3 hours - all LED Intersection.
- Typical Intersection (700 watts) run time 2 hours, with 6-8 hours of selected flash.
- Inverter Tit-out housing for easy maintenance.
- No tools required for inverter 110 contact connections and simple slide-in installation, weights 28 lbs.
- Full power bypass and isolation switches.
- Transient voltage protection.
- Power Analyzer with triple redundant Bypass
    - Conditioned power
    - Power Conflict Monitor with isolation and transfer module
    - Watchdog timer with redundant 5 ms delay and hard transfer to utility power
- Smart slot communications I/O module.
- RS 232 and USB ports for local or remote monitoring.
- Intelligent battery management system with microprocessor controlled smart battery charger, automatic self test, cell guard for longer life and faster recharge times.
- 24V 18AH batteris AGM/VRLA (absorbed glass mat/valve regulated lead acid), compact, lightweight only 25 lbs.
- Seismically rated fixed position framed battery trays.
- Quick swap hot battery replacement system.
- Heavy duty smart safety battery connection system, 30A silver plated plugs.
- Battery Manufacturer's 2 year warranty.

Control Compartment

- All components shall match existing components in use for maintenance of spare parts and known reliability.

- The cabinet shall be completely prewired in the factory.
- All control wiring is 19 strand #14 AWG THHN.
- All terminals shall be permanently labeled.
- Battery back-up shall be provided with Ethernet communications for remote monitoring and control.

Nameplates and Drawings

- The function of circuit breakers, switches and other components as required shall be identified by laminated engraved plastic nameplates fastened with minimum of two 1/4", #4-40 machine screws.

14.4 FIBER OPTIC DATA HUB CABINET

A. All hub cabinets, complete with all electronics specified, shall be provided by the system integrator/ manufacturer or the designated representative and shall be complete with all enclosures and electronics as specified herein. Cabinets shall be Caltrans Model 332, two-door (66" height x 24" width x 30" depth), heavy duty 0.125 thick aluminum. All cabinets shall be provided with a ground lug for external grounding. The cabinet shall be aluminum with a natural finish. The cabinet, where specified, shall be mounted on an aluminum riser.

B. The cabinet shall contain the following items:

- Data hubs shall be provided with power as defined hereinafter.
- One circuit breaker, 10 amps for general circuits for highly filtered circuits shall be provided. The cabinet fans and heater, when specified, will be wired with the general circuit breaker. The cabinet shall include noise filter and surge protection, EDCO SHA-1210, that has the main circuit plus the 10 amp high filter protection. A 10 amp circuit breaker shall be installed in the controller cabinet. Supplying power to the hub cabinet(s), where specified on the plans, for cabinet power and lights.
- Two cabinet fans – a standard cabinet fan, thermostat controlled, to bring in outside air and a second fan to blow air, circulation, inside the cabinet.
- A cabinet heater with 350-watt capacity shall be provided on the data hub. The heater shall be on a thermostat with a 32-degree of lower setting to turn on the heater. If the heater activates, the second can inside the cabinet will turn on to circulate air in the cabinet.
- A minimum of two MIC-024 units with a minimum of four each splice trays and 24 each termination hubs, complete with 24 hub mounts, per closure. See hub cabinet diagrams for specific information.
- A minimum of two CCH-04U termination enclosures shall be provided with 72 each terminations (ST series)
- Two gooseneck mini-cylinder lights meeting signal cabinet specifications. One flex light in front and one flex light in back.

- A circuit breaker protected power strip with three sets of six outlet power plugs, 3 prong, GFI protected.
- Contractor shall furnish and install additional terminations/ splice enclosures as shown on the fiber wiring diagrams.

C. Modifications to existing hubs where space does not permit additional enclosures to be installed may have enclosures removed where such enclosures are not being used. All removed enclosures shall be returned to the City. Modifications to any hub installation shall be performed by the traffic system equipment supplier under the direction of the Engineer. Terminations and/ or splices in hubs shall be by the Contractor or their designated representative and shall be consistent with the design or final revised drawings provided.

D. Wiring Diagrams – Fiber optic wiring diagrams are provided to define the electrical wiring of all traffic cabinets, hubs, and facilities. Discrepancies between any wiring diagrams shall be resolved with the Engineer prior t o installation. Changes to the wiring diagrams may occur during the project based on user demand and future projects interacting with this project. The Contractor shall maintain accurate quantities of splices and terminations at each location during the project. Wiring diagrams shall be red-lined as part of the “normal As-Built” records provided to the Engineer.

14.5 PAN, TILT, ZOOM (IP DOME PTZ) CAMERA

A. Weather Resistant Dome Network Camera. The PTZ Camera shall have the following features

1 Auto Image Stabilizer
2 35x optical zoom, f=3.4 (wide) to 119mm (tele), F1.4 to F4.2
3 Horizontal resolution greater than 530 TVL (PAL)
4 Digital zoom 12x (420x total zoom)
5 Angle view 55.8° (wide end) to 1.7° (tele end)
6 Minimum illumination 0.5 lux, 0.05 lux (IR filter removed)
7 Signal to noise ratio greater than 50dB
8 Electronic Image Stabilization up to 12dB suppression
9 Electronice shutter speed 1/2 to 1/30,3000 sec
10 Operation temperature -40° C to 50° C
11 Angular travel: Horizontal - 360° continuous
Tile - 5° above horizontal to 90° down
12 Manual mode speed: Pan variable from 0.10° to 480°/sec
13 150 presets per dome
14 Simultaneous M-JPEG and MPEG-4. MPEG-4 constant or variable bit rate