SP-090007
(NEW)

Iowa Department of Transportation

SPECIAL PROVISIONS

FOR

TRAFFIC SIGNALIZATION

Linn County

NHSX-100-1(59)--3H-57 and

ESP-100-1(61)--2S-57

Effective Date

October 20, 2009

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

TRAFFIC SIGNALIZATION SPECIAL PROVISIONS
1ST AVENUE (IA 922/U.S. BUS. 151) / MARION BLVD & COLLINS ROAD

TABLE OF CONTENTS

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).

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

The Contractor shall deliver all salvaged materials (including existing temporary span wire signal system) to the Cedar Rapids Traffic Engineering Division, 1201 6th Street S.W., 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. Traffic Signalization: Traffic Signalization as indicated on the plans, complete in place and accepted, will be measured as a unit lump sum quantity for all work necessary.

2. Fiber Optic Cable, Install Only: The number of linear feet of fiber optic cable installed by the Contractor shall be measured by the Engineer, including slack in handholes and cabinets.

3. Conduit, 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.

4. Handhole to Junction Box: The number of handholes or junction boxes installed for the fiber optic interconnect system (designated with an “F” prefix on the N-sheets in the plans) shall be counted by the Engineer.

5. Fiber Optic Cable Terminations and Splices: The number of fiber optic cable terminations and splices shall be counted by the Engineer.

B. Basis of Payment

1. Traffic Signalization: Traffic Signalization, measured as provided above, 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 traffic control signal installation including, but not limited to, poles, bases, cabinets, conduit, wiring, signal heads, detectors, video equipment, cameras, power service, battery back-up, Ethernet communications system, fiber hub, cabinet and for all equipment, tools, labor, and incidentals necessary to provide a fully functioning traffic signal system.

2. Fiber Optic Cable, Install Only: The price per linear foot shall be full compensation for picking up and delivering fiber optic cable spools from the City yard, to the site, testing the cabe, 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.

3. Conduit, 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, couplings, testing, and all other labor, equipment, and materials to complete the conduit per the plans.

4. Handhole and Junction Box: The price per each handhole or junction box installed shall be full compensation for supply and installation of the box, cut existing longitudinal 2” HDPE conduit (placed by others), and supply and splice 2” HDPE 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. Fiber Optic Cable Terminations and Splices: 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.

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.

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.

D. General Considerations
The cable shall be supplied by the City. Contractor shall arrange with the City to pick up the cable from the City yard and Contractor shall deliver the cable to the site.

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. Signal cable shall be stranded and conform to the requirements of IMSA 191 or 201, or latest revision thereof. The number and size of conductors shall be as specified on the plans.

C. Loop detector lead-in cable shall conform to the requirements of IMSA 502, latest revision thereof.

D. Detector loop wire shall conform to the requirements of IMSA 515, latest revision thereof. The encasing tube shall be polyvinyl chloride.

E. 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.

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

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)

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

Conduit shall be DR 9 and shall be made with Prime Resins for conduit.

Conduit shall have #18 AWG tracer wire co-extruded onto the exterior of the 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 POLES AND CONTROLLERS

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).

D. The painted surface of any equipment damaged in shipping or installation shall be retouched or repainted in a manner satisfactory to the Engineer.

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. 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” X 18” depth, 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 OPTIC”, as appropriate, and satisfy loading requirements of ANSI Tier 8. 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. All conductor cable combinations shall be shown on the plans. No substitutions will be permitted. Each signal head shall be wired separately from the handhole compartment in the pole base to the signal head.

B. The signal cable color codes shall be as follows:

Pedestrian Signals

Walk -	Green
Don't Walk -	Red
Sig. Common -	White
Pushbutton -	Black
PB Common -	Orange

5 Section Traffic Signals

Green Ball -	Green
Yellow Ball -	Orange
Red Ball -	Red
Green Arrow -	Black
Yellow Arrow -	W/BK
Sig. Common -	White
Spare -	Blue

3 Section Traffic Signals

Green Ball -	Green
Yellow Ball -	Orange
Red Ball -	Red
Sig. Common -	White
Spare -	Black

C. One electrical splice in the handhole compartment of the pole base will be allowed for the signal circuit wiring. All signal circuit cable runs shall be one continuous length of cable from the connections made in the handhole compartment of the signal pole bases to the terminal compartment in the controller base.

D. Conductor groupings and splicing may be made in the terminal compartment in the controller cabinet.

E. The loop detector lead-in cable shall be one continuous length of cable from the terminal compartment of the controller cabinet to a splice made with the loop detector wires in the first handhole or pole base handhole compartment provided adjacent to the loop detector.

F. 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 or other suitable devices. Frame mounted pulleys or other suitable devices shall be used for pulling the cable out of conduits into handholes. Only vegetable lubricants may be used to facilitate the pulling of cable.

G. Each signal cable shall be identified with an identification tie in the controller cabinet, handholes, pole base handhole, pedestal handhole and at any splice or junction location. Identification ties shall be provided both on the cable from the controller and the cables leading to the heads for a splice in a pole base handhole. Ties shall be of an opaque nylon material arranged to include a marker board, nonreleasing holding device, and cable fastening tail markers. The marking board shall be not less than 3/8 inch wide by 3/4 inch long, and 25 mils thick, roughened on one side to hold indelible black nylon marking ink. Identification shall be permanent and waterproof. Once installed, the tie shall not be removable except by cutting it loose from the cable.

Identification ties shall be marked as follows:

i. Heads Head number, number of sections
ii. Loops Loop number, direction and location (stop lines, advance, or left turn loop)
iii. Push Button Location, street crossing

H. Cable slack shall be as follows:

Four (4) feet in handholes

Two (2) feet in signal bases

Two (2) feet in the terminal compartment of the controller base

No additional slack will be allowed in the loop detector leadin cable after the initial splice.

I. Connectors shall be of the proper size for the number and size of the wires being connected.

J. Wire ends must be thoroughly cleaned after the insulation is stripped off to insure complete contact with another wire, or the connector. If strands are damaged when the insulation is removed, the section of the cable must be discarded. Nicked or damaged conductor strands will not be permitted inside of connectors. Loose wire ends shall not be used as "shims" to make a connection.

K. Electrical tape shall not be applied to the finished connections. Signal cable insulation shall extend beneath the insulated portion of the connector. The contractor shall redo any connection with exposed bare wire.

L. Covered connections must be arranged so that they will not be in contact with the metal poles. Connections in the poles shall be pointed up to prevent accumulation of moisture in the connection.

M. Loop detector splices shall be capable of satisfactory operations under continuous immersion in water.

N. Cable connections in signal heads and controller cabinets shall be made at the terminal blocks provided for this purpose. All stranded wires inserted under a binder head screw shall be equipped with a solderless pressure type spade connector with a preinsulated shank. All solid wire shall have an eye and shall not have a terminal connector.

O. Service cable shall be continuous from the disconnect switch located on the service pole to the terminal compartment of the controller cabinet.

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

Q. 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 POLE ERECTION

A. All poles are to be erected vertically and securely bolted to the cast-in-place concrete foundations at the locations shown on the plans.

B. Leveling shall be accomplished by the use of nuts on each anchor bolt. One nut shall be turned on each anchor bolt and the pole placed in position on these nuts. The top nuts shall then be placed loosely and the pole adjusted to the vertical position by adjusting both the upper and lower nuts.

C. After the pole is securely fastened, install the metal strips in the area between the pole and the base. The metal strips will be supplied by the Traffic Engineering Division and the method of attachment shall be approved by the Traffic Engineering Division.

D. Each pole shall be grounded from the pole to the foundation ground rod by a No. 6 AWG bare copper ground wire.

E. Poles shall be placed so that modifications and/or attachments are correctly oriented, as indicated on the plans.

F. The foundations must be given seven days to cure before poles are erected. The center of the poles are to be set back from the curb, a distance shown on the plans. Poles shall be erected so that they are plumb with traffic signals installed, in line, and all the same relative height

above the centerline of the street and with the mast arms correctly oriented as shown on the plans.

G. Poles must be erected so that they are plumb with traffic signal heads. The manufacturer recommendation for raking should be observed when setting the pole to assure that it is plumb when the load is applied.

3.7 LOOP DETECTORS

A. Loop detectors shall be installed in accordance with the plans. Adjustments in the locations shall be made to minimize the location of the loop wire across construction joints. Locations of the loops shall be subject to the approval of the Engineer. The cabinet end of the cable shall be clearly tagged identifying the loop.

B. The slot for the loop shall be constructed per plan. The slot shall be dry and completely clean of all loose debris and have a smooth bottom. Each change of direction, or crossing of pavement joint or crack, shall be drilled and loop slack provided.

C. Saw cuts and holes made in the roadway for installation of vehicle detectors shall be sealed with two-part detector loop sealant, such as Chemque, Bondo 575 or equivalent, per manufacturer's instructions.

D. Each loop detector shall be connected to the controller with shielded cable. No splices will be allowed in this cable. No loops shall be connected in series, unless directed by the Engineer.

E. Upon completing the loop installation in the field cabinet and prior to sealing the loop in the pavement, the Contractor shall notify the Traffic Engineering Division who may meter the loops by test instruments capable of measuring electrical values of installed loop wires and leadins to measure induced AC voltage, inductance in microhenries, highlow "Q" indication, leakage resistance in megaohms, and the resistance of the conductors in ohms.

An acceptable load installation shall be defined as follows:

- Induced voltage test: No deflection on the pointer of a volt meter
- Inductance: The inductance reading on the loop tester is approximately the calculated value or with approval of the Engineer is between 100 mh and 200 mh.
- Loop Q: Deflection of the pointer to the upper side of the scale.
- Leakage to Ground: Deflection of the pointer to above 100 mega ohms.
- Loop Resistance: The resistance reading on an ohmmeter is approximately the calculated value.

An unacceptable loop installation shall be defined as follows:

- Inductance: The inductance reading is below 90 mh or above 250 mh.
- Leakage to Ground: Deflection of the pointer is below 100 mega ohms.
- Loop Resistance: The resistance reading is 50% more than calculated.

3.8 SIGNALS

A. All signal faces and indicators shall be installed as shown on the plans. Pole mounted signal heads and pedestrian push buttons are shown on the plans and schematic drawings in schematic form only. Pole mounted signal heads are generally intended to be mounted on the face of pole with respect to oncoming traffic. Modifications to this are required when the view of the pole mounted signal indication is blocked. (See Paragraph 3.8 E). Pedestrian push buttons shall be installed on the face of the pole in 90° increments with respect to the mast arm. The push button shall be located on the pole face so the arrow on the R104 sign directs pedestrians to the appropriate crosswalk.

B. All optically limited signal heads shall be properly masked to limit their field of view as directed by the Engineer.

C. Backplates shall be installed and properly secured for the traffic signal heads.

D. All signal heads shall be kept securely covered until such time as the signals are put into operation.

E. The Engineer shall approve the location of signal heads in which the view of the indications is blocked or partially blocked by utility poles, trees or other physical obstructions. Standard heights and locations shown on the plans are typical for unobstructed locations. Signal heads installed without approval of the Engineer, which in the opinion of the Engineer are obstructed, shall be relocated at the Contractor's expense. Holes in the poles due to this signal relocation shall be plugged in a manner acceptable to the Engineer.

3.9 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.

3.10 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 performed 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.

3.11 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 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 – 50 feet
Fiber Handhole – 50 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 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) #14 AWG THHN, 600 volt single conductor cable (tracer), orange in color, shall be pulled with ten feet (10’) slack in each pull box, except where rigid metallic conduit or other metallic conductors are 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 and a power meter. 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	.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

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

12.2 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.

V. 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.

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 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.

AERIAL FIBER

AA. Existing communications cable, installed as span wire installation, shall be utilized to relash the aerial fiber optic cable and shall not be removed unless shown on the Plans or approved by the Engineer in writing. Where existing infrastructure does not exist, the Contractor shall furnish and install new span wire messenger cable for lashing the fiber cable. Snap ties or cable ties for lashing shall not be permitted on this project. All costs incurred in removing, disposing or reusing the existing communications cable shall be considered incidental to the cost of installing the new fiber optic cable.

BB. Installations, where all fiber optic cable is aerial before entering the controller, building or underground conduit system, shall be provided with a minimum of one hundred (100) feet coiled at the pole prior to going to the cabinet and one hundred feet coiled at the pole when exiting the cabinet. This one hundred foot section is in addition to the 20 feet minimum required for termination inside cabinets, buildings or other termination areas. Additional storage shall be required as specified on the Plans.

CC. Overhead Enclosures

The overhead shall be a six port enclosure capable of supporting a minimum of 48 fibers, loose buffer tubes, single fiber splices in trays of 12 splices each. The splice enclosure shall be fully waterproof, corrosion resistant, reentry capable and have gasketing for the entire length of the body as well as for each cable entry. The enclosure housing shall be sealed by the use of a permanent neoprene gasket and shall not require a flame to break the seal or to install. The cable entry section shall support a minimum of four ports of the size cable being installed, greater than one-half inch. Unused ports shall be sealed. Enclosures shall be stainless steel or ultraviolet stabilized black glass filled high density thermoplastic shell material. The enclosure shall be provided with built in

shell stabilizers and air valve. The enclosure shall be provided with a heat shield to protect against extreme environment temperatures. The enclosure shall be provided with an adjustable aerial bracket mount and, where mounted inline, shall be provided with a vertical mount bracket. All aerial mount enclosures shall be provided with strength member brackets. The fibers shall be routed from the end plate to the splices trays using transition (transport) tubes.

3.12 BATTERY BACK-UP AND POWER SERVICE

The Contractor shall supply and install a combination battery back-up electrical service with meter and lighting controller. Features must include transfer switch for generator power, lockable in use, metered disconnect for traffic signal, and unmetered 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 quazite handhole (for traffic signal cabinet). The service pedestal shall be part of the continuously grounded system discussed in this specification.

The power meter pedestal shall satisfy the requirements of the utility provider for the identified service classification. The battery back-up system and electrical service equipment shall be protected within a vandal-resistant and weather-proof cabinet.

PART IV EQUIPMENT REQUIREMENTS

4.1 TRAFFIC ACTUATED TRAFFIC SIGNAL CONTROLLERS

A. GENERAL REQUIREMENTS

A.1. 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 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.

A.2. ELECTRICAL REQUIREMENT

A.2.1. POWER

A.2.1.1. NOMINAL VOLTAGE AND CURRENT. The controller shall be designed to operate from a nominal 120 volt alternating current, 60 hertz power source.

A.2.1.2. VOLTAGE AND CURRENT RANGES. The controller shall operate satisfactorily within a

voltage range of 95 to 135 volts alternating current and a frequency range of 57 to 63 hertz.

A.2.2. CONTROLLER CONNECTIONS. NEMA Connection Requirement. The controller shall contain a circular twist lock type connector meeting the requirements of Part 3, Section TS 13.05 "Pin Connections", paragraph A. NEMA Traffic Control Systems Standard TSI1983.

A.2.3. OVERCURRENT PROTECTION. The controller shall contain a front panel mounted AC power input fuse of suitable size to provide over current protection.

A.2.4. AUTOMATIC REORIENTATION. 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.

A.3. CONSTANCY OF INTERVALS. Minimum Requirements. The length of any interval or timing setting shall not change by more than +100 milliseconds from its set value, so long as the voltage and frequency of the power supply and the ambient temperature inside the controller cabinet remain within the tolerances specified in these specifications.

A.4. INTERVAL SEQUENCE

A.4.1. GENERAL. The controller shall provide the proper intervals and interval sequence as required in the following section of these specifications.

A.4.2. REQUIRED INTERVAL SEQUENCE. The phase and interval sequence shall be programmable to provide from two through eight phase dual ring operation with 4 overlaps as described in the latest revision of the NEMA Standards for traffic control systems.

A.4.3. SKIPPING OF ACTUATED PHASES. If, prior to the end of the green interval of the terminating phase, neither vehicle nor pedestrian memory indicates a need for the next traffic phase, the intervals, which comprise that phase, shall be omitted from the interval sequence. However, once the green interval has been terminated, the phase causing the termination may not be omitted.

This does not, however, preclude the use of recall switches, which when in the "on" position, shall cause the phase to be displayed even though no detector actuations have been received.

A.5. INTERVAL SETTING AND FUNCTIONS

A.5.1. PROVISION FOR SETTING. The controller shall provide for the setting of each interval, portion of interval, or function by means of a positive setting on a thumbwheel switch or keyboard.

A.5.1.1. THUMBWHEEL switches shall be calibrated in seconds and fractions thereof when applicable, and shall give a clear visual indication of the value of each interval or function. Setting of timing and function values shall be accomplished without the use of special tools or wiring changes.

A.5.1.2. KEYBOARD entry shall have a user friendly interface such that in every case the meaning of a number being displayed shall be clearly evident without reference to the sequence of keystrokes preceding the display and without reference to a manual or instruction sheet. The method of finding current data and of changing data shall be intuitive to the extent that little or no training is required and keystroke sequences do not need to be memorized except for security access codes.

A.5.2. LOCATION OF CONTROLS. The interval and function controls shall be located on the front of the controller and shall be properly designated as to the function each control performs.

A.5.3. REQUIRED INTERVALS/FUNCTIONS AND RANGES. The required intervals, portions of intervals, and functions for each phase of operation are listed in Table 1.

TABLE 1

Functions and Timing to be Provided On Each Phase of Operation

	Minimum Range (Sec.)	Increment (Sec.)
Minimum Initial	1 – 99	1.0
Maximum Initial *	0 – 99	1.0
Added initial Per Actuation	0 – 9	0.1
Passage Time	0 – 9	0.1
Minimum Gap	0 – 9	0.1
Time To Reduce to Minimum Gap	0 – 9	0.1
Time Before Reduction	0 – 99	1.0
Time Before Reduction	0 – 99	1.0
Maximum 1	1 – 99	1.0
Maximum 2	1 – 99	1.0
Yellow Change	0 – 9	0.1
Red Clearance	0 – 9	0.1
Walk	0 – 99	1.0
Pedestrian Clearance	0 – 99	1.0
Red Revert (One Per Controller)	3 – 9	1.0

* Maximum Initial may have fixed value of 30 Sec.

A.5.4. INTERVAL AND FUNCTION INDICATION

A.5.4.1. INDICATION. Long life light emitting diode indications or approved equal shall be provided and appropriately labeled on the controller to facilitate the determination of operation and termination of the intervals and functions contained therein. Indication shall include but not necessarily be limited to the following:

.Phase(s) next
.Phase(s) in service
.Initial interval
.Vehicle interval
.Yellow change interval
.Maximum termination
.Gap termination
.Dwell
.Walk
.Ped clear
.Force off
.Hold
.Red clearance

A.5.4.2. CALL INDICATION. Indication shall be provided on the controller to display presence of vehicle calls including memory and detector actuations and presence of pedestrian calls when pedestrian timing functions are included.

A.5.5. VEHICLE RECALL SWITCH(s). A recall switch shall be provided for each actuated vehicle phase which, when asserted, shall cause the automatic return of the right-of-way to that phase in accordance with the specified interval sequence.

A.5.6. MAXIMUM RECALL SWITCH(s). The recall switch(s) shall provide a maximum recall position which when asserted for a phase, shall cause the automatic return of the right-of-way to that phase for the duration of the maximum green interval in accordance with the specified interval sequence.

A.5.7. VEHICLE DETECTOR NONLOCK MEMORY SWITCH(s). A switch shall be provided for each actuated vehicle phase which, when placed in the non lock position, shall cause the vehicle detector memory circuit for that phase to be disabled.

A.5.8. PEDESTRIAN RECALL SWITCH(s). A recall switch shall be provided for each actuated phase that includes pedestrian interval timing function, which when asserted, shall cause the automatic return of the controller to that phase and related pedestrian interval(s).

A.5.9. FLASHING OF PEDESTRIAN CLEARANCE Interval Functions. Means shall be provided to control the flashing of pedestrian signals during the pedestrian clearance interval(s).

A.6. SIGNAL CIRCUITS

A.6.1. GENERAL. The controller shall be provided with suitable load switches, external to the controller, for closing and opening signal light circuits. Such shall be sufficient in quantity to provide the interval sequence as described in Subsection A.4.2 of this specification. Solid state load switches will be required for solid state controllers.

A.6.2. CLOSING AND OPENING OF CIRCUITS/MINIMUM CAPACITY. 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.6.3. NEMA TRIPLE SIGNAL LOAD SWITCH(s). External jack mounted load switches shall be provided in accordance with Part 5, "Solid State Load Switches", Sec. TS 1 5.01, NEMA Traffic Control Systems Standards, TS1 1983.

A.7. CONFLICT MONITOR MINIMUM REQUIREMENTS. For actuated controllers of solid state design and construction or actuated controllers utilizing solid state load switches, a separate external signal monitoring device shall be provided to monitor the occurrence of conflicting Green or Walk indications and shall cause the signals to go into flashing operation should such conflicts be sensed. This shall conform to Part 6, NEMA TS11983.

A.8. FLASHING OF SIGNALS

A.8.1. MINIMUM REQUIREMENTS. Means external to the controller shall be provided to permit the substitution of flashing signal indications for the normal specified interval sequence. The indications to be flashed shall be as specified here or in the included interval sequence chart on the plans.

A.8.1.1. FLASHING RATE. Flashing shall be at the rate of neither 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.

A.8.1.2. CAPACITY. The operation of the flashing circuit shall be accomplished in such a manner as to avoid undue pitting or burning or other damage to load switches at 10 amperes of tungsten lamp load at 120 volts, 60 hertz AC for 50 million times.

A.8.2. CONTROL OF FLASHER MODE

A.8.2.1. POLICE PANEL SWITCH. Operation of flash mode from police panel shall put operation of controller into Stop Time Mode.

A.8.2.2. INSIDE SWITCH. An "auto off flash" mode switch shall be provided inside cabinet.

A.8.3. FLASHING OF VEHICULAR SIGNALS. 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 two flashers provide the flashing, they shall be wired to assure that the flashing of all lenses on the same approach is simultaneous.

A.8.4. FLASHING OF PEDESTRIAN SIGNALS (Pedestrian Clearance). When pedestrian interval timing functions are included, means shall be provided to permit flashing of the DON'T WALK pedestrian signals during the pedestrian clearance interval.

A.8.5. SOLID STATE FLASHER. A solid state flasher with no contact points or moving parts shall be provided. The solid state flasher shall utilize zero point switching. This shall conform to Part 8, NEMA Traffic Control Systems Standards, TS1 1983.

A.9. MANUAL CONTROL

A.9.1. MANUAL CONTROL ENABLE. When specified, manual commands shall place vehicle calls and pedestrian calls (when pedestrian timing is included in the controller's sequence of operation) on all phases, stop controller timing in all intervals except vehicle clearances, and inhibit the operation of the external advance input during vehicle clearance.

A.9.1.1. OPERATION WITHOUT PEDESTRIAN TIMING. When concurrent pedestrian timing is not provided, one actuation of the interval advance input shall advance the controller to Green rest, from which it will immediately select a phase next and advance to the Yellow Vehicle Clearance, subject to the constraints of concurrent timing.

A.9.1.2. OPERATION WITH PEDESTRIAN TIMING. When concurrent pedestrian service is provided, two sequential activations of the interval advance input shall be required to advance through a Green interval, the first actuation shall terminate the WALK interval, and the second shall terminate the GREEN interval including the Pedestrian Clearance Interval.

A.9.1.3. AUTOMATIC TIMING OF VEHICLE CHANGE/CLEARANCE Intervals. All Vehicle Change/Clearance Intervals shall be timed internally by the controller. Actuations of the interval advance input during Vehicle Change/Clearance intervals shall have no effect on the controller.

A.10. STOP TIMING. Suitable input from auxiliary equipment or other external sources shall cause cessation of controller timing during assertion of such input. Upon removal of such input assertion, the interrupted interval, which was timing, shall resume normal timing.

Provisions shall be made to insure that there is no conflict between the various inputs to this function, which would result in a stop time signal for one ring affecting the condition of the other ring.

A.11. COORDINATION

A.11.1. MINIMUM REQUIREMENTS. Means shall be provided within the controller to permit its interconnection into a coordinated traffic signal system when coordinating devices are added. As a minimum, this should include the provision of Yield circuit or Hold circuit, accessible to interruption by commands external to the controller.

A.11.2. HOLD FEATURE. The controller shall contain a Hold Feature which when asserted for a particular phase shall hold that phase in a rest condition. Upon release from the Hold, the phase shall immediately advance into the appropriate clearance interval or other unexpired portion of the green, provided there is an actuation on an opposing phase.

A.11.3. FORCEOFF FEATURE. The controller shall contain a Forceoff Feature which, when asserted shall cause termination of the current phase provided that phase is in the extension portion. In no case shall assertion of forceoff cause termination in a clearance interval or during a minimum green for vehicles or pedestrians.

A.11.4. NEMA COORDINATION REQUIREMENTS. In addition to the minimum coordination requirements specified above, the controller shall contain the coordination features for the applicable configuration included in NEMA Traffic Control Systems Standard TS11983.

A.12. ENVIRONMENTAL AND TESTING

A.12.1. MINIMUM REQUIREMENTS

A.12.1.1. GENERAL. The controller shall maintain all of its programmed functions and timing intervals when the ambient temperature and humidity are within the specified limits of this specification.

A.12.1.2. AMBIENT TEMPERATURE. The operating ambient temperature range shall be from 30 degrees to +165 degrees F.

A.12.1.3. COOLING/HEATING DEVICES. No heating or cooling devices other than standard vent fan(s) shall be required for proper operation of the controller.

A.12.1.4. HUMIDITY. The controller shall be designed to

operate properly within a relative humidity range of 0 to 95% up to 110 degrees F.

A.12.2. NEMA REQUIREMENTS

A.12.2.1. ENVIRONMENTAL AND OPERATING. The controller shall fulfill the environmental and operating requirements as described in Part 2, Section 1, "Environmental and Operating Standards", NEMA Standards TS11983.

A.12.2.2. TESTING. The controller shall fulfill the testing requirements as described in Part 2, Section 3, "Test Procedures", NEMA Traffic Control Systems Standard TS1 1983.

A.13. CABINET

A.13.1. BASIC CONSTRUCTION. The controller and all associated equipment shall be provided in weatherproof metal cabinet of cleancut design and appearance.

A.13.1.1. CONSTRUCTION MATERIAL. The cabinet shall be constructed of sheet or cast aluminum.

A.13.1.2. 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.

A.13.1.3. 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.

A.13.1.4. 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.

A.13.1.5. 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.

A.13.1.6. MOUNTING SCREWS. Screws used for mounting shelves or other mounting purposes shall not protrude beyond the outside wall of the cabinet.

A.13.1.7. 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 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.

A.13.2. SIZE, TYPE AND MOUNTING

A.13.2.1. 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.

A.13.2.2. 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.

A.13.3. 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.

A.13.4. CONNECTING CABLES, WIRING AND PANELS

A.13.4.1. 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).

A.13.4.2. 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.13.4.2.1. 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.

A.13.4.2.2. 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.

A.13.4.2.3. 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.

A.13.4.2.4. 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.

A.13.5. FUSING AND SURGE PROTECTION

A.13.5.1. INCOMING AC LINE. Suitable over current protection, utilizing one of the methods

described in Subsection A.13.4.2.1, shall be provided.

A.13.5.2. 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

A.13.5.3. 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.

A.13.5.4. 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.

A.13.6. 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.

A.13.7. 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.

A.14. 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.

A.15. 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 MULTIPHASE TRAFFIC ACTUATED CONTROLLERS

A.1. PURPOSE. It is the purpose of this section of the Special Provision to set forth minimum design and operating requirements for multiphase (two through eight phase) traffic actuated traffic signal controllers. Controllers shall be Eagle M50, or M52 as identified by the plans, 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 communications over Ethernet and fiber optic cable.

A.2. GENERAL DESIGN REQUIREMENTS. The General Design Requirements in Section A of this Special Provision shall apply in addition to certain design, operational and functional requirements hereinafter described.

A.2.1. NEMA DESIGN REQUIREMENTS. The controller shall be designed in accordance with the applicable requirements, included in NEMA Traffic Control System Standard TS1-1983.

A.2.2. CONTROLLER INTERCHANGEABILITY. Interchangeability of controllers furnished under this Special Provision shall be achieved by connector plug interchangeability as designated in Part 3, NEMA Traffic Control Systems Standard TS11983.

A.2.3. MAXIMUM CONTROLLER DIMENSIONS. The controller shall be no more than 19 inches wide, 13 inches high and 11 inches deep.

A.3. OPERATIONAL REQUIREMENTS.

A.3.1. MODE OF OPERATION. The controller shall provide the multiphase operation described in Subsections 1 and 2 of this section of the Special Provision and shall be fully actuated with means of receiving actuations on all phases.

The controller shall also permit a nonactuated mode of operation on any of its phases by assertion of the vehicle

recall function (or pedestrian recall function when such function is present) on the desired phase.

A.3.2. CALL TO NONACTUATED MODE. The controller shall feature an input which, when asserted, shall permit the selection of nonactuated mode of operation on any of its phases.

A.3.3. OPERATION WITH AUXILIARY FUNCTIONS/DEVICES. The controller shall be capable of having its basic operation expanded or augmented by the addition of auxiliary functions or devices.

A.3.4. MINIMUM GREEN

A.3.4.1. ACTUATED PHASE. The minimum green shall consist of an initial portion only, or a separately set Minimum Green function.
If pedestrian functions are provided and a pedestrian actuation is received, the Minimum Green shall consist of a WALK interval plus a Pedestrian Clearance interval.

A.3.4.2. NONACTUATED PHASE. In the nonactuated mode of operation, the Minimum Green on the nonactuated phase shall be equal to the values described for Actuated Phases in the preceding paragraphs or shall be equal to a separately set Minimum Green function.

A.3.5. UNIT EXTENSION. 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 by that traffic phase for one Unit Extension portion from the end of the actuation but subject to the Maximum (extension limit).

A.3.6. MAXIMUM (Extension Limit). The Maximum or extension limit shall determine the maximum duration of time the right-of-way can be extended for a phase having successive detector actuations spaced less than a Unit Extension portion apart.

A.3.7. INITIATION OF MAXIMUM (Extension Limit). The timing of the Maximum or extension limit shall commence (1) with the first actuation or other demand for right-of-way on a traffic phase not having the right-of-way or (2) at the beginning of the Green interval if an actuation or other demand for right-of-way has been previously registered on a traffic phase not having the right-of-way or, alternatively, the Maximum may commence at the end of the initial portion of the Green interval if an actuation or other demand has been previously registered on a traffic phase

not having the right-of-way.

A.3.8. TRANSFER OF RIGHTOFWAY. 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 provided that there has been an expiration of a Unit Extension portion with no continuing actuation or an expiration of the Maximum (extension limit) timing on the preceding phase having the right-of-way.

A.3.9. CHANGE CLEARANCE INTERVAL(s) Prior to Transfer. The transfer of right-of-way to any conflicting phase shall occur only after the display of the appropriate change clearance interval(s).

A.3.10. REST IN ABSENCE OF ACTUATION

A.3.10.1. MINIMUM REST. In the absence of detector actuation or assertion of recall switch(s), the right-of-way indication shall remain (rest) on the traffic phase on which the last actuation occurred.

A.3.10.2. REST IN ALLRED. In the absence of detector actuation or assertion of recall switch(s), the controller, after display of the appropriate clearance interval(s) on the last phase having the right-of-way, shall rest in Red (and associated Pedestrian DON'T WALK indications) on all phases until detector actuations are received.

A.3.11. MEMORY FEATURE. Unless precluded by the operation of nonmemory feature, the following memory retention shall be provided in the controller.

A.3.11.1. MEMORY CHANGE DURING CLEARANCE INTERVAL(s). 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.

A.3.11.2. MEMORY IF PHASE TERMINATED BY MAXIMUM (Extension Limit). 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.

A.3.12. PEDESTRIAN TIMING OPERATION. When pedestrian

timing functions are specified in the General Design Requirements, Section A of this specification, the following pedestrian function operation shall be provided.

A.3.12.1. PEDESTRIAN TIMING WITH NONACTUATED PHASE. In the non-actuated mode of operation, a WALK interval shall be provided simultaneously with the associated Minimum Green interval of the non-actuated phase. A flashing DON'T WALK Pedestrian Clearance Interval shall follow the WALK interval, during which the Green traffic phase continues to be displayed.

A.3.12.2. PEDESTRIAN TIMING WITH ACTUATED PHASE. 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.3.12.2.1. CONDITION IN ABSENCE OF PEDESTRIAN CALL. In absence of pedestrian actuation or assertion of pedestrian recall function, pedestrian signals shall remain in a DON'T WALK condition.

A.3.12.2.2. RECYCLE OF PEDESTRIAN FUNCTIONS. In the absence of opposing phase demand, it shall be possible to recycle the pedestrian interval functions to succeeding pedestrian actuations without change in vehicle indications.

A.3.12.2.3. PEDESTRIAN ACTUATION MEMORY. 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.

A.3.12.2.4. NONEXTENSION OF PEDESTRIAN INTERVALS. Successive pedestrian actuations shall not cause

extension of the pedestrian intervals.

A.3.13. ADVANCED OPERATIONAL FEATURES. When certain advanced operational features are specified in the General Design Requirements, Section A of this specification, the controller shall provide the following operation.

A.3.13.1. VOLUME DENSITY OPERATION

A.3.13.1.1. VARIABLE INITIAL. Utilizing the specified mode selected to provide this function, the controller shall enable an increase in timing of the Initial portion of the Green interval of a phase based upon the number of traffic actuations stored on that phase during its YELLOW and RED interval.

A.3.13.1.2. TIME WAITING GAP REDUCTION. Utilizing the functions specified, the controller shall enable a reduction in the Extension portion of the Green interval of the phase having the right-of-way in proportion to the time elapsed from the registration of an actuation on an opposing phase or from the beginning of the Green interval, whichever occurs later.

A.3.13.2. DUAL MAXIMUM (Extension Limit) Operation. Assertion by external command for the operation of a Maximum II function for a phase shall cause the controller to provide the timing value for that function in lieu of the normal maximum value.

A.3.14. NEMA OPERATIONAL REQUIREMENTS. In addition to the basic operational requirements specified above, the controller shall provide the operational features for the applicable configuration included in the NEMA Traffic Control Systems Standard TS11983.

A.4. FUNCTIONAL REQUIREMENTS

A.4.1. BASIC FUNCTIONAL REQUIREMENTS. Functional requirements for the multiphase traffic actuated controller shall be as specified in the General Design Requirements

in Section A of these specifications.

A.4.2. NEMA FUNCTIONAL REQUIREMENTS. In addition to the basic functional requirements specified above, the controller shall provide the functional features for the applicable configuration, included in the NEMA Traffic Control Systems Standard TS11983.

A.4.3. OVERLAPS. When required by the interval sequence chart in the General Design Requirements section of these specifications, overlap(s) shall be provided by the controller and may be implemented via internal or external logic.

A.5. ENHANCED OPERATION

A.5.1. PREEMPTION. A minimum of two preemption inputs shall be provided. These shall be designed for railroad or emergency vehicle preemption and shall provide the ability to set the delay before start of preempt sequence and the duration of the preempt sequence. It shall also be possible to define the status of each phase as red, green, flashing yellow, or flashing red during the preemption period and to provide an orderly transition into and out of the preemption period.

A.5.2. COORDINATION. The controller shall be capable of emulating a 3 dial/3 split/3 offset pre-timed controller coordinated with a 9 wire interconnect system.

A.5.3. TIME BASE FUNCTIONS. The controller shall have the capability to provide internal time based coordination. In addition it must provide a minimum of two auxiliary outputs controlled by the time base coordination, which can be fully programmed on a time basis to control external devices on a cycle-by-cycle, time of day, day of week, and/or holiday schedule on an annual basis.

A.6. REMOTE FLASH. A remote flash input is required which will provide for the remote implementation of flashing operation consistent with the requirements of the MUTCD. This shall include a means of programming a "Flash Entry Phase" and a "Flash Exit Phase."

4.3 INDUCTIVE LOOP VEHICLE DETECTOR

A. DESIGN REQUIREMENTS

A.1. OPERATION

A.1.1. GENERAL The detectors shall be designed to operate with

loop and lead-in wire combinations having a wide variation in electrical characteristics. The electrical characteristics are a function of the length and width of the loop, the length and type of lead-in wires, and other factors. The detector shall operate with the usual configurations of loops and lead-in wires, standard with the Division, which have a 40 to 700 micro Henry total inductance.

The detector shall provide reliable detection and maintain an output indication for a period of not less than three (3) minutes for a vehicle that causes a 0.02% change in the total inductance of the loop and lead-in system as measured at the detector loop input terminals. The detector shall provide operation as above with a loop system having any or all of the following characteristics:

- A shunting resistance of 10,000 ohms or greater to a common or circuit ground bus.
- A loop system quality factor (Q) of not less than 5.0, when connected to the detector being tested. Q is defined as the ratio of the resonant operating frequency over the half power bandwidth.
- A total or equivalent inductance within the range of 40 to 700 micro henries at the detector loop input terminals.

A sensitivity adjustment or selector shall be provided to allow selection of a high, medium or low sensitivity adjustment.

A.1.2. LOOP ENERGIZING AND DETECTOR SENSING CIRCUITS. The detector shall provide reliable detection of licensed motor vehicles. The detector shall provide an input (switch closure) only when vehicles are passing or stopped over the loop and shall detect all vehicles passing over the loop at speeds up to 80 miles per hour.

A.1.2.1. TURN ON. When first turned on, while tuning or being tuned, the detector shall provide a continuous output pulse (switch closure), plus a visual indication, in both the presence and pulse modes of operation. On power failure, or loop failure that would cause the inductance to exceed the tuning range, the detector must place a continuous call.

A.1.2.2. FREQUENCY. To prevent mutual interference "crosstalk", the detectors shall be provided with a three position frequency mode switch on the front panel.

A.1.2.3. AUTOMATIC TUNING. The detector shall be

designed to be initially tuned to the loop and provide for automatic drift compensation.

A.1.2.4. WEATHER. The operation of the detector shall not be affected by changes in the inductance of the loop caused by environmental changes, such as rain, hail, snow, temperature humidity, nor shall the sensitivity be markedly affected.

A.1.3. ACCURACY. The detector shall be able to detect all licensed vehicles, including motorcycles, accurately.

A.2. DETECTOR OUTPUT. The detector output (switch closure) to the associated traffic control equipment shall be provided by means of a relay. The relay shall have a mechanical life of at least 1,000,000 operations. The contacts shall have a rating of at least 1.0 ampere at 120 volts AC or DC.

A.3. POWER SUPPLY. The detector shall be designed to operate on a 110 commercial 60hertz power line over a voltage range of 100-125 volts. The primary of the power supply transformer shall be fused with a 1/4 inch diameter, 1 1/4 inches long, 250 volt fuse of suitable current rating. An extractor post fuse holder shall be provided. The fuse rating shall be marked by the fuse holder.

A.4. VISUAL INDICATOR. A long life light emitting diode shall be used to provide a visual indication of each vehicle detection. Lamps shall be easily replaceable without the use of tools. The indication must be readily visible in the indirect sunlight.

All indicator lights shall have a minimum design life of 20,000 hours at rated voltage unless an ONOFF switch is provided to control the lights. If an ONOFF switch is provided, the design of the lights need be only 1,000 hours at rated voltage.

A.5. DIELECTRIC STRENGTH. The detector shall withstand a dielectric strength test of 1,250 volts, 60 hertz per second, AC applied between the 120 vac line supply circuit and the terminals for the external loop for a period of one minute

A.6. INTERCHANGEABILITY AND DESIGN LIFE. All modules and components of the same type shall be interchangeable. The design life of all components, under conditions of normal operation, shall not be less than five years.

A.7. DELAY CALL. The detector, when specified on the bid form, to have a "Delayed Call" feature, shall be capable of ignoring a vehicle actuation unless it persists for more than a predetermined period of time. The predetermined time shall be adjustable from 0 to 25 second minimum on the front panel. The "Delayed Call" feature shall be inoperative during the green interval for the phase

related to the amplifier.

B. ENCLOSURE

B.1. GENERAL. A dustproof, metal enclosure shall be provided to enclose all electrical parts of the detector. The enclosure shall be designed for placement on a shelf in a weatherproof field cabinet. The detector shall not be position sensitive.

B.2. DETECTOR UNITS. Detector units shall be designed for use with loop combinations (two to four loops) in series or parallel or series-parallel). The detector model shall have a visual indication of a call and will not require external equipment for tuning or adjustment.

B.3. SIZE. A small size enclosure and the ability to stack the enclosures, one on top of another, is desirable. Single detector units shall not be larger than 6 inches by 3 inches by 8 inches deep.

B.4. MARKING. Each detector shall be marked with the manufacturer's name, model, catalog, or type number, and serial number. The electrical input rating (voltage, frequency, and wattage) shall be included in the marking.

C. INPUT/OUTPUT RECEPTACLE

C.1. FUNCTION ASSIGNMENT. Input and output connections for the detector shall be made to a type MS3102A181P box receptacle with 10 male contacts. A plastic cover shall be provided on the receptacle. The pin positions of the input/output connector shall be assigned as follows:

Pin No. Function

A. 120 vac ()
B. Output Relay Common
C. 120 VAC (+)
D. Input from Loop
E. Input from Loop
F. Output Relay N.O.
G. Output Relay N.C.
H. Chassis Ground
I. Spare
J. Spare

C.2. PLUG AND CABLE. A plug, type MS3108B with type 181S insert, with 10 female contacts shall be furnished, wired, leads of leads of #18 AWG stranded, color coded wire with 300 volt insulation. A type MS305710 cable clamp and boot shall be provided for strain

relief. The leads shall be 5 feet 0 inches in length, the first 16 inches of leads, from the plug, shall be enclosed in cotton braiding. No terminals are required on the leads.

D. COMPONENTS

D.1. INDUCTORS AND TRANSFORMERS. All inductors and transformers shall have their windings insulated and shall be impregnated to exclude moisture. All wire leads shall be color coded.

D.2. RESISTORS AND CAPACITORS. All resistors and capacitors shall be insulated and shall be marked with their resistance or capacitance value. Resistance and capacitance values may be indicated by the Radio Electronics Television Manufacturer's Association (RETMA) color codes. All electrolytic capacitors shall be marked to indicate polarity and voltage.

D.3. PRINTEDCIRCUIT BOARDS. All printed circuit boards shall be at least 1/16 inch thick and shall be made of glass cloth silicone. National Electric Manufacturer's Association (NEMA) type G10 glass epoxy or equivalent. The conductor material shall be copper, 0.0027 inch thick, having a weight of 2.0 ounces per square foot, with a protective solder coating. All printed circuit board connectors (male and female) shall be gold plated over the copper base. The printed circuit boards shall be securely mounted in such a way as to prevent flexing or bending of the boards, and shall be easily removable for servicing or replacement.

D.4. WIRING. All interconnecting wire shall be insulated #22 AWG or larger, suitable for 180 degrees F operation.

D.5. SOLID STATE CIRCUITRY

D.5.1. COMPONENTS. Transistors, integrated circuits, or semi-conductor diodes shall be used for all amplifying, detecting, rectifying, counting logic, and regulator circuits. No vacuum or gas tubes shall be used except for pilot lights. Transistors, integrated circuits, and diodes shall be marked with their type number and shall be types listed by the Radio Electronics Television Manufacturer's Association (RETMA). No electromechanical timers, synchronous motors, or relays shall be employed, except as specified in Section 1B.

D.5.2. PROPRIETARY PARTS. All electronic and electrical components must be of standard manufacture and available from a source other than the manufacturer of the loop detector unit.

D.6. TEMPERATURE. The temperature of components shall not cause

any appreciable reduction in component life when the detector is operated in an ambient temperature from 20 degrees to 180 degrees F.

E. WORKMANSHIP The enclosure and all modules shall be fabricated, assembled, and wired in a workmanlike manner.

F. DOCUMENTATION

1. CONTENTS. A documentation package shall be supplied in each controller cabinet for the inductive loop vehicle detectors which shall consist of the following:

a. Complete schematic diagram, accurate and current for unit supplied.
b. Complete physical description of unit.
c. Complete installation procedure for unit.
d. Loop specifications and loop assembly procedure.
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.

2. NUMBER OF COPIES. At least three full documentation packages for each detector sensing unit model shall be supplied to the Cedar Rapids Traffic Engineering Division.

4.4 MAST ARM ASSEMBLIES

A. The mast arms, support poles, and luminaire arms shall be continuous tapered, round or octagon steel poles of the anchor base type. The poles and mast arms shall be a minimum of 7 gauge fabricated from one length of steel sheet with one continuous arc welded vertical seam, unless otherwise approved by the Engineer. The poles and mast arms shall be fabricated from corrosion resistant steel meeting requirements of ASTM A572 or A1011 GRADE 50 and the base and flange plates shall be fabricated from A36 structural steel. After manufacture, poles and mast arms shall have minimum yield strength of 48,000 p.s.i. The base plate shall be attached to the lower end of the shaft by a continuous arc weld on both the inside and outside of the shaft.

B. It may be permissible to fabricate poles and mast arms by welding two sections together. Welding, fabrication, and inspection shall conform to the Iowa Department of Transportation (Iowa DOT) Standard

Specifications Section 2525.06, a separate Specification. Pole manufacturers shall certify that only certified welding operators in accordance with Iowa DOT Standard Specifications were used. The welding consumables used shall be in accordance with the approved list furnished by the Iowa DOT.

C. Personnel performing nondestructive testing shall be qualified in accordance with the American Society for Nondestructive Testing Recommended Practice No. SNTTC1A 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 supplier and will be considered incidental.

D. The mast arms shall be designed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals and designed to support greater traffic signals and/or signs load as listed in these documents. Fabricator shall certify that the mast arms are capable of withstanding winds up to 100 miles per hour without failure. The length of the mast arms shall be as specified on the Plan Documents.

E. When loaded with the signals and signs the mast arms shall have a slight rise. Unloaded the maximum angle between the mast arm and horizontal shall be 2 degrees to 5 degrees depending on the length of the mast arm, unless approved by the Engineer.

F. The pole shall be designed to support the mast arm so when it is equipped with the traffic signals and/or signs it will provide a minimum of 15.0 feet and a maximum of 19.0 feet clearance from the street surface to the bottom of the signal heads or signs.

G. The pole shall be equipped with two reinforced handholes with covers (4” x 6½” minimum). One handhole shall be located 18 inches above the base and 180 degrees with respect to the mast arm. The second handhole shall be located directly opposite the traffic signal mast arm. Securing the cover to the pole shall be done with the use of simple tools.

H. Provide a lug in the pole base near the handhole to permit connection of a #6 AWG grounding wire.

I. Provide a J-hook wire support (a curved 3/8” diameter steel bar) 6” to 12” above and 90 degrees with respect to the opening for each mast arm and luminaire arm.

J. Signal Pole and Mast Arm Loading: Traffic signal poles and mast arms shall be fabricated to the greater of the loading listed in the Plan

Documents (Pole Data Table) and the following signal head and signing loads:

1. Maximum Loading for Arms 36 to 47 Feet Long: 5section head on end, 24”x30” sign centered 2 ft. inboard, 3section head 12 ft. inboard, 3section head 24 ft. inboard, 21”x120” metro sign centered 28 ft. inboard, 2 3section pole mounted heads, 2 2-section pole mounted pedestrian heads, luminaire, 6” backplates on all signal heads.

2. Maximum Loading for Arms greater than 47 Feet Long: 5section head on end, 24”x30” sign centered 2 ft. inboard, 3section head 12 ft. inboard, 24”x30” sign centered 14 ft. inboard, 3section head 24 ft. inboard, 3section head 36 ft. inboard, 21”x120” metro sign centered 28 ft. inboard, 2 3section pole mounted heads, 2 2-section pole mounted pedestrian heads, luminaire, 6” backplates on all signal heads.

K. Unless otherwise specified on the Plan Documents, poles and mast arms shall be galvanized steel per the following:

1. Surface Preparation

   a. Steel plates shall be blast cleaned as necessary to remove rolled in mill scale, impurities, and nonmetallic foreign materials. After assembly, all weld flux shall be removed.
   b. The iron or steel shall be degreased by immersion in caustic solution, pickled by immersion in sulfuric acid, and rinsed clean from any residual effects of the caustic or acid solutions by immersion in a fresh water bath.
   c. Final preparation shall be done by immersion in a concentrated zinc ammonium chloride flux solution with an acidity maintained between 4.55.0 pH.
   d. The assembly shall then be air dried to remove any moisture remaining in the flux coat and/or trapped within the product.

2. The assemblies shall be hot dipped galvanized to the requirements of ASTM A123 for fabricated products or ASTM A153 for hardware items.

L. Packaging: All parts shall be packaged, wrapped, or cradled in a manner which will insure arrival at the destination without damage to the surface.

M. 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.

N. The anchor bolts shall meet the requirements of F1554 Grade 105 or

approved equal.

O. Bolts attaching the arms to the pole shall meet the requirements of ASTM A325 or approved equal.

P. 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 8 inches at one end and have a 4 inch long 90 degree bend at the other end. The Fabricator shall submit drawings for the anchor bolts and base plate design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A153, Class D, or shall have an electrodeposited coating of the same coating thickness, and so designed for this purpose.

Q. Anchor bolt covers, pole top covers, and mast arm end covers shall be gray cast iron castings conforming to ASTM Designation: A48 Class 30 or fabricated from ASTM A36 Steel.

R. Traffic signal pole assemblies which require luminaire extensions are indicated on the Plan Documents. The pole for the luminaire extension shall provide a continuous shaft as required for the mast arm.

S. The pole for the luminaire extension shall be vertical and shall provide a 35ft. luminaire mounting height, unless approved by the Engineer. Luminaire arm shall be a single curved arm, unless otherwise noted on the Plan Documents.

T. The length of the luminaire arm shall be 15 feet, and the orientation of the luminaire arm shall be 10 degrees counterclockwise from the mast arm, unless otherwise noted on the Plan Documents.

U. A one and one eighth inch (1-1/8”) min. diameter hole shall be drilled in the pole directly opposite the luminaire arm attachment point and in line with the hole leading into the luminaire arm.

V. The traffic signal assemblies without luminaire extensions shall be designed to support a future luminaire extension.

W. The pole shall have a 1” thick steel plate welded in the top of the pole to receive the future luminaire extension. The steel plate shall be tapped unless otherwise specified on the Plan Documents.

X. The future luminaire will be installed 35 feet above the pavement surface and the luminaire arm will extend 15 feet from the pole, unless otherwise specified on the Plan Documents.

4.5 SIGNAL HEADS

A. GENERAL

1. The signal heads shall be complete with all fittings and brackets for a complete installation. Each signal shall consist of a main body assembly, optical units, necessary screws, wing nuts, eyebolts, etc., and shall be delivered completely assembled. All hardware including hinge pins, wing nuts, eye bolts or latch bolts shall be made of a solid noncorrosive metallic material to prevent seizure or corrosion by the elements. Each signal shall be smooth both inside and outside and shall contain no sharp fins or projections of any kind. The doors and visors shall be flat black. All metal parts shall be painted with one coat of primer and two coats of a high grade Federal Black enamel. All parts of the vehicle signals shall be in compliance with the latest ITE Report on Adjustable Face Vehicle Traffic Control Signal Heads.

2. The electrical and optical system of the signal head shall be designed to operate on 115 volt, single phase, 60 Hertz alternating current.

3. All exterior surfaces shall be black.

4. Main Body Assembly of the signal unit shall consist of one or more polycarbonate sections with integral cast serrations such that when assembled with the proper brackets they may be adjusted in increments and locked securely to prevent moving. The sections shall be designed so that when assembled they interlock with one another. All joints between sections shall be waterproof. The sections shall be held firmly together by locknuts or other means approved by the Engineer. Any open end on an assembled signal face housing shall be plugged with an ornamental cap and gasket.

5. Doors and Optical Units

   a. The doors shall be made of polycarbonate. Each door shall be of the hinged type and shall be held closed by a wing nut or other approved means. The hinge pins shall be designed so that the doors may be easily removed and reinstalled without the use of special tools. Each door shall have a polycarbonate visor designed to shield each lens. The inside of each visor shall be flat black.

   b. The optical system shall be so designed as to prevent any objectionable reflection of sun rays even at times of the day when the sun may shine directly into the lens. When the door of the optical unit is closed, all joints in the assembly between the interior and exterior of the reflector shall be closed against suitable gaskets in order that the units may be dust tight. Between the door and the lens, there shall be a neoprene gasket securely fastened around the outer surface of the lens. Said gasket to be engaged

by the rim of the reflector holder when the door is closed to render the union between the reflector holder and the door assembly dust tight.

c. The reflector shall be parabolic in design and made of specular Alzak aluminum.

d. The reflector holder shall be of nonferrous or rust proofed metal and designed to separately support the reflector and socket in proper relation to the lens. The reflector holder shall be hinged to the left-hand side of the signal body when viewed from the front. On the right-hand side, the reflector holder shall be held in place by a spring catch or other quickly releasable means.

e. Both the hinge device and the spring catch or equivalent shall be of a flexible nature which will permit the reflector holder to be pushed inwardly for at least one sixteenth of an inch and to align itself correctly with the lens when the door of the optical unit is closed and pressed against the rim of the reflector holder. By such means, the joint between the reflector holder and the lens shall be rendered dust tight. It shall not be necessary to remove any screws or nuts in order to swing the reflector holder out of the body section to obtain access to the light socket.

f. The socket shall be arranged with a lamp grip so it will be impossible for the lamp to be loosened by vibration.

6. The wire entrance fitting shall be made of malleable iron or other approved material equipped with a standard 1 ½ inch pipe fitting for attachment to the signal head. It shall be provided with weatherproofing means so that when is attached to the top of the signal a weatherproof assembly results. Positive locking means shall be provided so that the signal cannot loosen from the fitting. The fitting shall be provided with an insulation bushing at the point where wires enter. The fitting shall be provided with self-locking features to prevent the signal head from turning out of directional adjustment in a strong wind. It shall be painted in color to match that of the signal.

B. VEHICLE SIGNALS

In addition to meeting the requirements of Section A., Vehicle Signals shall meet the requirements of the “Manual on Uniform Traffic Control Devices” and the following requirements:

1. All indications shall use Light Emitting Diode (LED) Vehicle Signal Modules.

2. All lenses shall be prismatic and long range. The lenses shall be 12 inches in diameter. All lenses shall be made of vandal resistant polycarbonate or acrylic plastic free from bubbles and flaws. The lenses shall meet the light transitivity and chromaticity standards established by the ITE Standard for Adjustable Face Vehicle Traffic Control Signal Heads.

3. The lamp sockets shall have a 3 inch light center length. Each socket shall be provided with one black lead from the socket and one white lead from the shell. Leads shall be of 18 gauge, stranded wire per MILW76A Specifications.

4. Visors shall be of the tunnel type not less than eight inches in length and shall be designed in a manner such that the visor may be easily installed or removed from the signal head.

5. A terminal block shall be mounted in the back of the second section of the signal head. The terminal blocks shall be secured at both ends.

6. Signals shall be shipped completely assembled with tunnel visors attached to the signal door.

C. PEDESTRIAN SIGNALS

In addition to meeting the requirements of Section 1.A., Pedestrian Signals shall meet the design requirements of the “Manual on Uniform Traffic Control Devices” and the following requirements:

1. Pedestrian signals shall consist of a single unit, nominal 16” x 18”, with housing and mounting attachments. The left half shall display a “HAND” symbol and a “WALKING PERSON” symbol. The right half shall display clearance interval countdown numerals. The signals shall operate with light emitting diode (LED) lamps that meet or exceed ITE PTCSI-2 LED Pedestrian Signal Specifications.

2. The lenses shall be made of vandal resistant polycarbonate or acrylic plastic. Unless otherwise specified on the Plan Documents, the symbols on these lenses shall be at least 9 inches high and shall be designed to produce a maximum legibility both day and night. The “HAND” symbol shall be Lunar White and the “WALKING PERSON” symbol and numerals shall be Portland Orange. The background or field around both messages shall be black.

D. MOUNTING ASSEMBLIES

1. Mounting assemblies shall consist of 1 ½ inch standard pipe and fittings. All members shall be so fabricated such that they provide plumb, symmetrical arrangement, and securely fabricated

assemblies. Construction shall be such that all conductors are concealed within assemblies. Cable guides shall be used to support and protect conductors entering assembly through poles. All threads shall be coated with rust preventive paint during assembly.

2. Support brackets, trunnions, and fittings shall be made of cast aluminum, steel, or cast iron. Bracket parts except for stainless steel parts shall be given one prime coat of metal primer and two coats of high quality Black exterior enamel.

3. Mounting assemblies shall be watertight and all open segments of the fittings shall be plugged with an ornamental plug and a gasket.

4. Mast arm mounting brackets shall be furnished with a completely adjustable stainless steel strap around arm, malleable clamp casting, vertical support tube, top and bottom signal head support with set screws, bolts, hole with rubber grommet in mast arm, and all incidentals necessary for complete installation.

5. Brackets for mounting the signal head on top of a pedestal shall provide support for both the top and bottom of the signal head.

E. Each signal shall be packed or crated separate and complete by itself. The outside of each package or crate shall clearly show the manufacture, type, catalog number, City purchase order number and project. Mounting attachments may be shipped separate from the signals, but the boxes or crates shall be marked clearly with the same information as the signals. Mounting attachments of different types shall not be mixed in one box or crate.

4.6 TRAFFIC SIGNAL LAMPS

A. LED VEHICLE SIGNAL MODULES

1. LED Vehicle Traffic Signal Modules shall comply with the latest revision of the “Equipment and Material Standards of the Institute of Transportation Engineers: Chapter 2a: VTCSH Part 2: Light Emitting Diode (LED) Vehicle Signal Modules (Interim)”

   Note the following:

   • “Section 5.5 Dimming (Optional)” is not required.
   • “Section 5.8 Failed State Impedance (Optional)” is required.

2. Compliance with all other sections of this standard is required.

4.7 BACKPLATES

A. Backplates shall be 0.125 inch thick thermoplastic and provide a minimum of a 5 inch black field around the assembly. Corners of the backplates shall be rounded with a 2½ inch radius.

B. Backplates shall be supplied with attaching bolts or screws in sufficient quantity to securely hold the backplates to the signal heads.

4.8 ALUMINUM TRAFFIC SIGNAL PEDESTAL

A. The pedestal shaft shall be fabricated of aluminum tubing with a wall thickness of not less than 0.125 inches. Shaft shall have a brushed aluminum finish.

B. The shaft shall be attached to a square cast aluminum base with a handhole. The size of the handhole shall be at least 8½ inches by 8½ inches and equipped with a cover, which can be securely fastened to the base with the use of simple tools. A lug shall be provided near the handhole to permit connection of a #6 AWG grounding wire.

C. The length of the pedestal, from the bottom of the base to the top of the shaft, shall be as noted in the Plans. The top of the shaft shall have an outer diameter of 4½ inches.

D. Pedestals shall be equipped with all necessary hardware, shims and anchor bolts to provide for a complete installation without additional parts.

E. The pedestal base shall be designed to mount on four ¾inch anchor bolts spaced evenly around a 12¾inch diameter bolt circle.

4.9 PEDESTRIAN PUSH BUTTON DETECTORS

A. The pushbutton shall provide a minimum 2 inch diameter aluminum ADA compliant plunger, pressure activated so as to require no more than 3.5 lbs force to activate. LED light and audible tones shall confirm activation. The light and tones shall be momentary (not latched) and require no additional power source.

B. The body material shall be aluminum, and powder coated black. The entire assembly shall be weather tight and secure against electrical shock. A saddle shall be provided if necessary to secure a rigid installation and neat fit.

C. The Contractor shall furnish and install signs with each pushbutton, identifying the associated street crossing. The signs shall be 9 inch x 12 inch, MUTCD Pedestrian Traffic Signal Signs, R104b. Combination pushbutton/ sign assemblies are not acceptable.

D. The pushbutton shall be located on the pole so the arrow on the accompanying sign directs pedestrians to the appropriate crosswalk.

4.10 VIDEO DETECTION SYSTEM (If specified in the plans)

A. This specification sets forth the minimum requirements for a Video

Detection System that monitors vehicles on a roadway via processing of video images and provides detector outputs to a traffic controller or similar device. All work, equipment and materials to provide a properly functioning Video Detection System is included.

B. The system shall be composed of these principal items: the cameras, the field communications link between the camera(s) and the processor unit(s) along with any PC, video monitor or associated equipment required to set up the system. The equipment shall include camera mounting brackets and standard detector rack(s) with power supply.

C. The configuration will consist of the following primary components: mounted cameras, rack mounted detector cards, processor, field video monitor, software and all associated equipment required to set up and operate in a field environment. Mounting positions and heights are as identified in the Plans, unless otherwise directed by the Engineer.

D. Material provided by the Contractor shall include two (2) sets of operations manuals and one (1) service manual with schematics and parts list for out of–warranty repairs.

E. Detection

1. The system shall provide real-time vehicle detection comparable to properly operating inductive loops.
2. The system software shall be able to detect either approaching of departing vehicles in multiple traffic lanes.
3. A minimum of 24 detector outputs for a multiple camera processor and 6 detector outputs for a single camera processor shall be available.
4. A minimum of 16 detection zones per camera shall be available that are user defined through interactive graphics.
5. The system shall compensate for minor camera movement (up to 2 percent of the field of view at 400 feet) without falsely detecting vehicles. The camera movement shall be measured on the unprocessed video input to the processor units.

F. Detection Zones

1. The system shall provide flexible detection placement anywhere within the combined field of view of the image sensors.
2. Placement of detection zones shall be by means of a graphical interface using the video image of the roadway. The monitor shall show images of the detection zones superimposed on the video image of traffic.
3. Detection zones shall be capable of being sized, shaped and overlapped to provide optimal road coverage and detection.
4. Detection zones shall be provided that are sensitive to direction of travel. The direction to be detected by each zone shall be user programmable.

5. When a configuration has been created, the system shall provide a graphic display on the monitor. When a vehicle occupies a detection zone, the zone on the live video shall indicate the presence of a vehicle.
6. Detection zones shall have the capability of implementing logical functions (including AND and OR), counting, and delay and extension timing. These logical functions may be excluded in the provisions are made to bring each detector separately into the controller and the controller can provide these functions.
7. It shall be possible to save detector configurations on disk, to download configurations to the processor, and to retrieve the configuration that is currently running in the processor.
8. The user shall be able to redefine previously defined detection zones and configurations using a mouse or keyboard.
9. Equipment failure, either camera or processor, shall result in constant vehicle call on affected detection zones.

4.11 WIRELESS COMMUNICATION SYSTEM (If specified in the plans)

A. This specification sets forth the minimum requirements for a Wireless Communication System that provides the required connectivity between traffic signal controllers for traffic signal interconnection as indicated in the plans. All work, equipment and materials to provide a properly functioning Wireless Communication System is included.

B. The system shall be composed of these principal items: the base station, the remote unit(s) located at the remote intersection(s) and the outdoor antenna(s) along with any associated equipment required to set up the system. The equipment shall include any required mounting brackets and cable both internal and external to the traffic signal cabinet. The system shall also include any modifications to the traffic signal controller cabinet(s) necessary to provide the wireless data communication.

C. The Wireless Communication System shall provide data communication via broadband with a minimum rating of 4.9 GHz.

D. The Wireless Communication System shall comply with FCC Part 15, UL, and Public Safety (Part 70).

4.12 WIRELESS VEHICLE DETECTION SYSTEM (If specified in the plans)

A. This specification sets forth the minimum requirements for a Wireless Vehicle Detection System that provides the required advanced vehicle detection as indicated in the plans. All work, equipment and materials to provide a properly functioning Wireless Vehicle Detection System is included.

B. The system shall be comprised of these principal items: in pavement (flush to surface) wireless sensor unit at locations where detection is required, a base station at each traffic signal controller, any required

amplifier units to ensure the strength of the wireless signal at the base station, along with any associated equipment required to set up the system. The equipment shall include any required mounting brackets and cable both internal and external to the traffic signal cabinet. The system shall also include any modifications to the traffic signal controller cabinet(s) necessary to provide the wireless vehicle detection.

C. The in-pavement wireless sensor unit and the amplifier unit shall be battery powered.

D. The Wireless Vehicle Detection System shall comply with FCC Part 15, UL, and Public Safety (Part 70).

4.13 ETHERNET COMMUNICATIONS SYSTEM (If specified in the plans)

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 6KQ
- Serial to FSK Converter shall be GarrettCom Magnum 100 Mb Fiber Media Converter
- Device server shall be 4-port, premium rated GarrettCom Magnum for Outdoors 10/100.
- Ethernet Access Device (EAD) shall be Actelis ML620
- Edge switches shall be ES42 PD as manufactured by GarrettCom

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.

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.

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

The Contractor shall supply and install a 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 quazite 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. Battery back-up system will include:

- 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.
- No tools required for inverter I/O contact connections and simple slide-in installation.
- Full power bypass and isolation switches.
- Power Analyzer with triple redundant bypass. Condition power, Power Conflict Motor with isolation and transfer module. Watchdog timer with redundant 5 ms delay and hard transfer to utility power.
- RS 232 and USB ports for local or remote monitoring.
- 24V 18AH batteries AGM/VRLA (absorbed glass mat/valve regulated lead acide).

C. 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.

D. 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 118” 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.
- Smart 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.

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.

4.15 FIBER OPTIC DATA HUB CABINET (Caltrans 332 Style)

The cabinet shall include:

- Two door (66" H x 24" W x 30" D), heavy duty 0.125 thick aluminum cabinet.
- Meets all Caltrans TEES requirements.
- Base mounted with 4- 3/4" x 16" anchor bolts.
- Three point locking system with Pelco locks and #2 keying standard.
- Police panel with standard skeleton key.
- Anodized finish.
- Stainless steel door handles with padlocking capability.
- Two-position door stops on top and bottom of front and rear doors.
- Removable self-standing rack assembly.

- 100 CFM fan with thermostatic control.
- Fluorescent light.

4.16 PAN, TILT, ZOOM (PTZ) CAMERA

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

1. High sensitivity with Day/Night function: 0.5 lux (Color) at F1.4 (Wide), 0.04 lux (B/W) at F1.4 (Wide). IR cut filter switches on/off to enhance the sensitivity in B/W mode.
2. Adaptive Digital Noise Reduction: Integration of 2D-DNR and 3DDNR ensures noise reduction in various conditions.
3. Electronic sensitivity enhancement: Auto (Up to 32x) / OFF
4. 30x zoom lens: 3.8 ~ 114 mm (approx. 300x with digital zoom)
5. Pan/Tilt speed of max. 400°/s at preset mode and 0.065°/s super fine control at manual mode
6. Auto tracking: The camera automatically pans and tilts to follow a moving subject and keep it in the center of the image.
7. Various I/O terminals: ALARM IN 1 / BW IN, ALARM IN 2 /ALARM OUT, ALARM IN 3 / AUX OUT
8. Alarm sources include Terminal 1 ~ 3, VMD. Alarm actions include Preset positions 1 ~ 256, PATROL 1 ~ 4, SD memory recording, FTP image transfer, E-mail notification, Indication on browser, Terminal output, protocol output and Auto track.
9. Auto Image Stabilizer
10. Camera title display: 16 alphanumerics OSD and 20 alphanumerics on the browser
11. Digital Slip-ring Transmission: The high speed digital video signal travels through the compact slip-ring without any DA/AD conversion process preventing image quality loss.
12. MPEG-4/JPEG digital signal output at VGA image size with up to 30 ips
13. MPEG-4 and JPEG dual stream output for simultaneous real time monitoring and high resolution recording
14. Progressive output with motion adaptive interlace/progressive conversion allows every image to be clear even when the object is moving.
15. PTZ control can be made on the user-friendly GUI with 16 speeds an/tilt and new “Drag and Zoom” operation enabling finer control. 256 speeds available for system with WV-CU950 system controller.
16. 360° map shot: 8 thumbnail images at 45° intervals make it simple to direct the camera by clicking on a thumbnail.
17. Multiscreen: Image from 16 cameras can be displayed in 4 different Quad screens or 16-screen (JPEG only).
18. FTP client function enables periodic image data transfer or transfer upon alarm.
19. Alarm notification via e-mail
20. Full duplex 2-way audio allows interactive communication

between camera site and monitoring site.

21. Alarm log, Manual REC log, FTP error log saved in the SD memory card is displayed on the browser GUI and can be downloaded to the client PC. Playback or Image data download through the log is also available.
22. Internet mode: MPEG-4 images can be transmitted over HTTP protocol.
23. SD memory card slot for Manual recording, Alarm recording and Backup upon network failure
24. Scheduling function for Alarm / VMD / Access permission, Preset position call and Position refresh
25. IP66 rated water and dust resistant. Compatible with IEC60529 measurement standard.
26. Built-in fan/heater/sun shield for temperature changes of –40 °C ~ +50 °C (–40 °F ~ +122 °F)

B. Camera / operating system specifications:

- Lens Focal Length 3.8 mm ~ 114 mm, 30x zoom, 300x with 10x digital zoom
- Zoom Speed Manual: Approx. 6 sec. (Wide ~ Tele) Preset: Approx. 2 sec. (Wide ~ Tele)
- Angular Field of View H: 1.9° (Tele) ~ 52.0° (Wide), V: 1.4° (Tele) ~ 40.0° (Wide)
- Maximum Aperture Ratio 1 : 1.4 (Wide) ~ 3.7 (Tele)
- Focusing Range 1.5 m ~ ∞
- Aperture Range F1.4 ~ 22, Close
- Pan and Panning Range 360° endless
- Tilt Panning Speed Manual: Approx. 0.065°/s ~ 120°/s, Up to 256 steps (depending on the controller). Preset: up to approx. 400°/s
- Tilting Range –5° ~ 185° (upward-level-downward) Tilting angle limit: 0° / –1° / –2° / –3° / –4° / –5°
- Tilting Speed Manual: Approx.0.065°/s ~ 120°/s, Up to 256 steps (depending on the controller). Preset: up to approx. 400°/s
- Proportional Pan/Tilt Control
- Number of Preset Positions: 256
- Auto Mode OFF / preset sequence / auto pan / auto track / patrol
- Auto Track Standard Auto track
- Patrol 1 / 2 / 3 / 4
- Image Hold ON / OFF
- Digital Flip Yes
- PTZ Position Display ON / OFF
- Map Shot 360° map shot / preset map shot
- Browser Camera Control Pan/Tilt (16 steps), Zoom, Focus, Click centering, Drag zoom, GUI Iris, Preset position call and program, Auto mode Display Mode Image from 16 cameras can be displayed in 4 different Quad screens or 16-screen (JPEG only).
- Camera Title Up to 20 alphanumeric characters
- SD Memory Data Download Images recorded in the SD memory card

can be downloaded.

- Clock Display Time: 12H / 24H, Date: 5 formats on the browser, Summer time (Manual)
- Alarm Control Reset
- Includes IP Setup software, viewer software, network operating instruction and GUI / Setup Menu English
- System Log Alarm log, Manual REC log, FTP error log (SD memory required