SP- 120126
(New)

Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Polk County
IM-035-2(330)67--13-77

Effective Date
March 18, 2014

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

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1. GENERAL

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

The Standard Specifications for Highway and Bridge Construction, Series 2012, Iowa DOT, as modified by these specifications or other appropriate special provisions shall apply to this project. The installation of the traffic control signals and appurtenances shall be in conformance with the MUTCD.

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

At the completion of the project, provide the city with as-built drawings of the signal installation. At the completion of the project, mark the location of all conduits with paint and flags. The West Des Moines Public Works Department will then utilize their GPS equipment to map the conduit, footing, and handhole locations.

Measure the distance from the bottom of mast arm mounted signal heads and signs to the roadway surface beneath the signal or sign. Provide these measurements to the Engineer.

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

2. EQUIPMENT AND MATERIALS

Fabrication or assembly process materials shall comply with the applicable parts of Section 2523 of the Standard Specifications with the additions as stated herein.

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

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

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

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), and all material and work shall conform to the requirements of the National

Electrical Code (NEC), the Standards of the American Society for Testing Materials (ASTM), the American Standards Association (ASA), and local ordinances. Miscellaneous electrical equipment and materials shall be UL approved.

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

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

3. SCHEDULE OF UNIT PRICES

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

4. TESTING AND MAINTENANCE OF SIGNAL EQUIPMENT

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

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

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

5. GUARANTEE

In addition to warranties or guarantees on specific traffic signal equipment listed elsewhere in these specifications, the Contractor shall fully guarantee the traffic control signal installation

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

Transfer all required equipment warranties on the date of final acceptance to the City of West Des Moines.

6. HANDHOLES

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

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

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

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

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

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

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

An Omni Marker ball, Model 163 101.4 kHz telephone marker, manufactured by Industry Technology shall be installed in each Type 2 Handhole.

7. CONDUIT SYSTEM

The number, type, and size of conduit shall be as shown on the plans. Conduit shall meet the requirements of Articles 2523.03, N, and 4185.10 of the Standard Specifications.

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

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

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

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

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

Conduit buried in open trenches shall be placed a minimum of 24 inches deep unless otherwise directed in the contract documents. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Conduit in pavement areas shall be placed to a minimum depth of 24 inches below the finished pavement surface unless otherwise directed in the contract documents.

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

Whenever excavation is made across parkways, driveways or sodded areas, the sod, topsoil, crushed stone or gravel shall be replaced or restored as nearly as possible to its original condition and the whole area involved shall be left in a neat and presentable condition. Concrete

sidewalks, pavements, base courses, and bituminous surfaces shall be replaced with new materials. Surface restoration will not be paid for separately.

"Pushed" conduit shall be placed by jacking, pushing, boring, or any other means necessary to place the conduit without cutting, removing, or disturbing existing pavement. The size of a bored hole shall not exceed the outside diameter of the conduit that is to be placed. Tunneling under the pavement or water jetting will not be permitted. Pits for boring shall not be closer than 2 feet to the back of curb unless otherwise directed by the Engineer.

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

8. WIRING

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

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

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

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

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

9. ELECTRICAL CABLE

General

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

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

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

Home runs for cables shall be labeled as follows:

NW corner is red	SE corner is blue
NE corner is green	SW corner is orange

Power Lead-In Cable

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

Signal Cable

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

Tracer Wire

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

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

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

Emergency Vehicle Preemption Optical Detector Cable

The cable shall meet the requirements of IPCEA-S-61-402/NEMA WC 5, Section 7.4 600-volt control cable 75°C, Type B.

The cable shall contain 3 conductors, each of which shall be No. 20 AWG stranded, tinned copper with a 25 mil minimum average thickness low-density polyethylene insulation. Insulation shall be color coded 1-yellow, 1- blue, 1-orange.

The shield shall be aluminized polyester film with a nominal 20% overlap. A No. 20 AWG stranded, tinned, bare drain wire shall be placed between the insulated conductors and the shielded in contact with the conductive surface of the shield.

The jacket shall be black PVC with a minimum rating of 600 volts and 80°C and a minimum thickness of 45 mil. The jacket shall be marked as required by IPECA/NEMA.

Traffic Monitor Unit Cable

The cable shall be Cat5 outdoor use rated cable.

Adaptive Traffic Control System Camera Cables

The cables shall meet the requirements indicated in the ADAPTIVE TRAFFIC CONTROL SYSTEM section of these specifications.

10. CONCRETE BASES

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

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

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

Prior to setting poles, the anchor bolts shall be covered in such a manner as to protect them against damage and to protect the public from possible injury. The foundations must be given a minimum of 7 days to cure before poles are erected.

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

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

11. BONDING AND GROUNDING

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

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

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

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

12. SIGNAL APPURTENANCES

Signal Faces

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

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

Controller and Hub Cabinets

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

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

Pole Erection

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

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

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

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

13. ACTUATED CONTROLLER

General

The local intersection controller shall be an EPAC3168 M52 Series controller unit manufactured by Siemens Traffic Control Systems. The controller will be loaded with both ECOM and NTCIP software. The software and firmware shall be the latest revision that is fully compatible with the Siemens ACTRA ATMS system. The controller shall be fully compatible and interchangeable with the existing local controllers in the City of West Des Moines System operating as an ACTRA ATMS System. Two controllers shall be supplied with each cabinet. One controller will operate the intersection signals and the other will be delivered to the City of West Des Moines Public Works Facility

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

The controller shall provide fully prompted, menu driven programmability.

The controller shall provide the following internal functions:

Software compatible to the control and data protocol of the central office computer.

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

Provision for local coordination control.

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

Provide data uploading and down loading capability.

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

Provide local control of remotely selected NEMA and special functions.

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

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

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

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

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

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

Components

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

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

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

Chassis

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

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

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

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

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

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

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

Interval Programming

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

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

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

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

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

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

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

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

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

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

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

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

Operational Requirements

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

14. CONTROLLER CABINET AND AUXILIARY EQUIPMENT

General

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

Cabinet

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

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

full operation. A signal on-off switch shall also be provided to interrupt power to the signal heads only and continue controller operation.

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

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

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

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

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

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

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

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

Electrical Design

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

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

The AC+ field service shall be connected directly to a circuit breaker. This circuit breaker shall be a single pole, nonadjustable, magnetic breaker rated for 117 VAC operations. It shall be equipped with a solder less connector suitable for terminating the power lead-in wire. The circuit breaker shall be capable of manual operation and shall be clearly marked to indicate the "ON" and "OFF" positions.

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

The controller cabinet shall be furnished with a lightning arrestor on the AC service. The surge suppressor shall be an SHA-1210 manufactured by EDCO Inc., or approved equal that meets or exceeds the following requirements:

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

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

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

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

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

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

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

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

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

Controller Power Switch
Detector Test Switches
Stop Time Switch

Signal Flash Switch

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

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

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

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

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

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

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

The minimum terminals are as follows:

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

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

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

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

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

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

Terminals for all required auxiliary equipment.

Terminals for interconnect.

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

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

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

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

A Solid State conflict monitor shall be provided and located within the cabinet external to and electrically independent of the controller unit and enclosed in a finished metal case.

The monitor shall detect the occurrence of conflicting Green, Yellow, or Walk indications and shall cause the signals to go into predetermined flashing operation with stop timing applied simultaneously should conflicts be sensed. The conflict monitor shall conform to the specifications of NEMA TS1-1983 and shall be compatible with the controller. The monitor shall be provided with an Ethernet Port for remote monitoring from the Traffic Operations Center. The Communications Coordinator shall assign an appropriate IP address and place the monitor on-line at the Traffic Operations Center.

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

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

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

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

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

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

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

disconnection of the 24 pin connectors shall revert cabinet operation to a standard NEMA TS-1 operation or a NEMA TS-2 Type 2 operation. The detector counting termination harness and detector assignment shall be as indicated in the following table.

Detector Counting Termination Harness
& Detector Assignment

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

Card Rack Assignments

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

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

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

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

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

Each cabinet shall be equipped with a splice/termination enclosure. This enclosure shall be mounted under the controller unit shelf and above the back panel on the left side, opposite from the power source input. The enclosure shall be provided with two each 12 position splice trays and 24 each termination ST connectors, ceramic ferrule, in front panel mounted ST Couplers arranged in two rows. Each row of ST Couplers shall have two sets of six each couplers. The top row shall be for fiber incoming and the bottom row shall be fiber departing, or as shown on the Plans as terminated fibers. All fibers used in any single tube shall be terminated or spliced. Unused tubes of fiber shall be coiled and be a minimum length of 10 feet. All fibers terminated shall be secured in a fan out kit prior to the splice or the junction to the pigtail. All connections in the cabinet to external devices shall be by two fiber Patch Cords of a length to easily reach the devices but not so long as to be pinched or cut by other devices, door openings, etc. Space in the cabinet shall be provided to allow one additional splice/termination enclosure and one wall mount 24 position termination only enclosure. Enclosures shall be SEICOR Model MIC-024 Series or preapproved equal. All splices shall be a fusion, or where specified on the Plans, mechanical UNICAM splices. Fusion splices to pigtails shall utilize a 900 micron coated pigtail. All fusion splices shall use heat shrink with a metal strip for support. The pigtail splice connection shall be provided with a second heat shrink that covers the entire section of the splice area that includes a portion of the fan out kit on one side to the 900 micron coated area of the other side.

Documentation

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

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

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

The controllers shall be provided with the most current software and documentation. The software and firmware shall be the latest revision that is fully compatible with the

Siemens ACTRA ATMS system. Future software and documentation revisions to the local system controller shall be provided without charge.

Cabinet wiring diagrams shall include two sheets. One sheet shall indicate the manufacturer point to point wiring of the terminal facility complete with all harnesses for the controller unit and the conflict monitor. This drawing shall be an unaltered generic drawing. The second drawing shall indicate the electrical connections of all equipment and terminal connections for the traffic control cabinet for each cabinet provided. The drawings shall include pictorial representations of the intersection geometrics and phasing. Detectors shall be positioned for each approach and lane, being tagged with its harness (rack/slot) assignment. The controller cabinet shall be positioned and shown as a rectangle with the two crossing diagonal lanes. In addition to the three sets of wiring diagrams specified above, one PDF file copy shall be provided to the Engineer at the time of turn on at the intersection.

The Signal Equipment Supplier shall provide a customized intersection graphic (CPU) depicting the local intersection for each intersection provided. The customized intersection shall include the following: correct number of lanes by function for each approach; graphically correct orientation of the intersection layout; proper phase assignment by lane; proper pedestrian phase assignments; street names on the lanes; key landmark indicators shown in the graphics. The Engineer will provide an 8 1/2 by 11 pictorial of the intersection geometrics and the key landmark indicators to be shown in the graphic. System detectors shall be shown on the graphic and labeled in accordance with the card rack/slot plus system detector assignment numbers. Orientation for all intersection displays shall be north as top of screen.

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

Managed Switches

The signal cabinet shall be provided with two each Comtrol RocketLinx ES8510-XT Series Managed Switches. Each switch will be fully capable of layer two operation. Each switch will come with three each Gigabit RJ45/SFP (10/100/1000 mbps) combo ports and seven each copper 10/100Base-XT RJ45 ports. The switches will be manufactured by Comtrol Corporation. Each switch will come with three (3) each Gigabit Single Mode SFP transceivers rated for 10 kilometers. The SFP Transceivers will have a temperature rating of -40C to +85C. The switches will be manufactured by Comtrol Corporation.

Each signal cabinet will come with one each Comtrol RocketLinx ES9528-XT Series Managed Switches. Each switch will be fully capable of layer two operation. Each Switch will come with four each Gigabit RJ45/SFP (10/100/1000 mbps) combo ports and 24 10/100Base-XT RJ45 ports. Each switch will come with four each Gigabit Single Mode SFP transceivers rated for 10 kilometers. The SFP Transceivers will have a temperature rating of -40°C to +85°C. The switches will be manufactured by Comtrol Corporation. The switch will come supplied with an external power supply recommended by the switch manufacturer and rated for the switch.

The exact port configuration for each switch shall be as specified above unless modified in the wiring diagrams. All Switches will be delivered to the City of West Des Moines Public Works Facility for programming and installed as specified by the Engineer.

The exact port configuration for each switch shall be as specified above unless modified in the wiring diagrams. All Switches will be delivered to the City of West Des Moines Public Works Facility for programming and installed as specified by the Engineer.

Guarantee

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

The entire controller unit shall be warranted to be free from defects in workmanship and materials for a minimum of 1 year from date of acceptance. Any parts found to be defective shall, be replaced free of charge.

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

15. VEHICLE TRAFFIC SIGNAL HEADS

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

LED Modules

The low power LED vehicle signals shall be installed in traffic signal housings rated as a 12 inch signal housing commercially manufactured with a durable polycarbonate material

and be compatible with traffic signal mounting brackets utilizing serrated locking between signal sections. The LED signal section shall be a self-enclosed, sealed unit, with electrical connections to be terminated on the standard terminal block, spade termination, mounted in the traffic signal section. The signals shall be 120 VAC rated and shall be compatible with either public utility or backup power sources of a 60-hertz, +/- 5-hertz with a voltage variance between 80 and 135.

All electronics in the signal shall meet NEMA temperature rating of –40 to +74ºC. The enclosure shall conform to NEMA Moisture Resistance Standard 250-1991 for Type 4 enclosures (ITE 6.4.6.2 Moisture Resistance). The signal electronics shall meet FCC Title 47, Subpart B, and Section 15 Regulations for Electrical Noise dissemination. The electronics shall be provided with an operating power factor correction of a minimum of 0.9 and shall be provided with fuse and transient suppression incorporated for line and load protection.

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

Red Signal Display (Dialight 433-1210-003XL)	
Luminous Intensity # (cd)	339
Dominant Wavelength (nm)	622
Lens Tint	Tinted
Typical Wattage at 25ºC	6
Meet or exceed current ITE specification.	

Yellow Signal Display (Dialight 433-3230-901XL)	
Luminous Intensity # (cd)	678
Dominant Wavelength (nm)	590
Lens Tint	Tinted
Typical Wattage at 25ºC	12
Approved by Caltrans	

Green Signal Display (Dialight 433-2270-001XL)	
Luminous Intensity # (cd)	678
Dominant Wavelength (nm)	500
Lens Tint	Clear
Typical Wattage at 25ºC	7
Meet or exceed current ITE specification	

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

Green Arrow Display (Dialight 432-2374-001XOD)	
Dominant Wavelength (nm)	500
Lens Tint	Tinted
Typical Wattage at 25ºC	6

Yellow Arrow Display (Dialight 431-3334-901)	
Dominant Wavelength (nm)	590
Lens Tint	Tinted
Typical Wattage at 25ºC	6

Arrow signals shall have power factor correction and temperature compensation.

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

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

Signal Head Assembly

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

The visors for each signal section shall be durable polycarbonate not less than 0.10 inches in thickness. It shall be designed to fit tightly against the door, and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be of the tunnel-type at least 8 inches long for all 12 inch rectangular pedestrian signals, at least 9 1/2 inches long for 12 inch diameter signals, shall angle slightly downward, and shall be of the type specified on the plans.

Specialized Options

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

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

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

Mast arm signal head assemblies shall be rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes. The contractor shall use a PELCO AB-116 ASTRO-BRAC ®, for mast arm mounting.

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

Miscellaneous Requirements

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

Certification

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

16. PEDESTRIAN TRAFFIC SIGNAL HEADS WITH COUNTDOWN DISPLAY

General Requirements

This section of the specifications describes minimum acceptable design and operating requirements for two-section, pedestrian traffic signal heads with LED "MAN" and "HAND" symbol messages in the top section and an LED digital countdown display in the lower section including all fittings and brackets, as specified on the plans. The pedestrian signal head shall comply with the latest version of the Institute of Transportation Engineers Standards on Pedestrian Traffic Signal Heads.

Signal Head Assembly

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

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

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

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

Pedestrian Signal LED Module

The upper section of the housing shall be equipped a HAND/MAN combination LED module. The LED Pedestrian module designed as retrofit for existing signal lamps shall not require special tools for installation. The LED modules shall fit into existing 12 inch traffic signal housings built to VTCSM standards without modification to the housing. The module shall be Dialight 430-6772-001X.

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

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

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

The LED signal module shall consist of a double message overlay combining the symbols of a filled hand and outline walking man. The LED’s shall be arranged in a manner to form an outline of the symbols. The shape of the outline shall conform to the standard symbols for pedestrian signals. The size HAND/MAN symbols shall comply with the Institute of Transportation Engineers Standards on Pedestrian Traffic Signal Heads. The LED’s shall be distributed evenly along the message outline. The distance between each LED shall not vary more than 10%. The individual light sources shall be interconnected so that a catastrophic failure of a single LED will result in a total loss of

not more than three LED's or 5% of the total light output. There shall be no electronic components visible on the front panel of the display face. The display face shall consist solely of LED's mounted on a mat black PCB.

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

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

Pedestrian Countdown Display LED Module

The lower section of the housing shall be equipped a Pedestrian Countdown Display LED module. The LED countdown module designed as retrofit for existing signal lamps shall not require special tools for installation. The LED modules shall fit into existing 12-inch traffic signal housings built to VTCSM standards without modification to the housing. The countdown module shall be Dialight Model 430-7773-001X.

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

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

The LED signal module shall consist of two seven-segment digits. The LED's shall be distributed evenly along the message outline. The distance between each LED shall not vary more than 10%. The countdown digits shall be at least 8 inches high and shall be made of at least 88 LED's. There shall be no electronic components visible on the front panel of the display face. The display face shall consist solely of LED's mounted on a mat black PCB.

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

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

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

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

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

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

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

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

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

Certification

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

Warranty

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

17. PEDESTRIAN PUSH BUTTONS

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

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

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

Push button signs shall be furnished and shall conform to the requirements of the MUTCD. Signs shall be R10-3.

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

18. TRAFFIC SIGNAL POLES

General

This section of the Special Provisions described minimum acceptable design, material, and fabrication requirements for traffic signal poles. Poles shall be manufactured in accordance with the requirements of the latest Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals as approved by the American Association of State Highway and Transportation Officials. The poles shall be manufactured by Valmont Industries, Inc. or Millerbernd Manufacturing Co., in accordance with city of West Des Moines standard shop drawings.

The traffic signal mast arm and pole assemblies shall be designed to support the number of signal heads (use weight and projected areas of die cast aluminum signal heads) and signs as shown on the plans. The mast arm and pole assemblies shall be designed to support a minimum of two signal heads and a traffic control sign at the outboard end of the arm.

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

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

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

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

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

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

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

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

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

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

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

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

Mast Arm

The mast arms shall be designed to support traffic signals and/or signs as shown on the plans and indicated in these Specifications. They shall be certified by the fabricator that the mast arms are capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure. The mast arms shall be of the length as shown on the plans. The mast arms shall be galvanized inside and out in accordance with ASTM A123, latest revision.

Poles

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

Combination Pole

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

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

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

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

The luminaire arm shall be arched.

Hardware

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

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

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

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

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

Shop Drawings

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

Certifications

The fabricator shall certify that the mast arms are capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure; that only certified welding operators in accordance with AWS D1.1-80 or latest revisions were used; and that only electrodes as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel for Highway Bridges were used.

19. TRAFFIC SIGNAL PEDESTALS

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

Materials

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

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

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

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

Anchor Bolts

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

Certification

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

20. TRAFFIC SIGNS

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

Traffic signs shall be mounted on the mast arms utilizing a universally adjustable mast arm mounted sign bracket.

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

The sheeting material for all signs shall be 3M Diamond Grade VIP Reflective Sheeting Series 3990.

21. TRAFFIC MONITOR SYSTEM

The Traffic Monitor System-TM utilized on the Project shall be the Axis Q6044-E PTZ Dome Network Camera or approved equal and be fully compatible with the City of West Des Moines' traffic monitor system network.

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

The image sensor shall be a 1/4 inch Ex View HAD progressive scan CCD. The minimum illumination for color shall be 0.5 lux at 30 IRE F1.4 and for black/white 0.008 lux at 30 IRE F1.4

The dome electronics shall provide E-flip and 100 preset positions. Camera pan shall be 360 degree endless, 0.05 degrees – 450 degrees/s. Camera tilt shall be 220 degrees, 0.05 degrees – 450 degrees/s. Camera zoom shall be 35x optical zoom and 12x digital zoom, total 420x zoom.

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

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

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

The camera will be supplied with all necessary licenses needed to be fully functional and compatible with the City’s current Milestone Enterprise Video Management System.

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

22. EMERGENCY VEHICLE PREEMPTION SYSTEM

The preemption detector shall be a Strobecom II Model 2091-SD as manufactured by TOMAR. The optical signal processor card shall be a Strobecom II Model 4140 as manufactured by TOMAR. A cable shall be utilized to provide data from the optical signal processor card to the Managed Switch hereinbefore specified controller unit. The processor card will have four-channel detection.

The system will employ optical communication to identify the presence of designated priority vehicles and cause the traffic signal controller to advance to and/or hold a desired traffic signal display selected from set phases normally available. The system provided shall properly receive

and decode the strobe pulse, and provide a NEMA defined ground true input to the traffic signal controller. This communication is a line-of sight path of up to 2500 feet. The system requires no attention of the vehicle operator other than an "Emitter On" switch located in the vehicle that is to remain "On" until the end of the emergency run. The system shall operate on a first come first serve basis. The system shall interface with existing traffic signal controllers, without compromising normal operation or existing safety provisions. The Optical Control System shall consist of Optical emitter Assemblies, Optical Detectors and Controller Interface Assemblies, and Optical Detector Cables.

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

The installation shall include all connectors, power supplies, or additional equipment necessary for a complete and functional interconnected installation providing communications from the Traffic Operations Center to this controller site.

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

System Operation

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

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

System Component Specifications

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

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

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

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

System Equipment

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

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

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

Reliability

All equipment supplied as part of these specifications shall operate under the following environmental condition: Temperature Range: -40°C to +75°C.

The manufacturer and/or manufacturer's representative shall provide quality service before, during, and after installation of the priority control system. The manufacturer and/or manufacturer's representative must provide certified, trained technicians, traffic systems industry experience, and operational knowledge of priority control systems. The manufacturer and/ or manufacturer's representative, working with the City recommended Communications Coordinator, shall on-line the preemption location on the central computer system after installation and verify a valid communications link and programmability of the intersection.

The manufacturer shall warrant that, provided the control system has been properly installed, operated, and maintained, component parts that prove to be defective in workmanship and/or material for a minimum of 1 year from the date of operation for the manufacturer shall be covered in a documented system protection plan. The warranty period normally offered by the manufacturer shall apply if the offered warranty period is greater than 1 year.

23. COMMUNICATIONS AND NETWORK INTERFACE

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

The contractor shall contact the city's Communications Coordinator (gba Systems Integrators, 309-428-3027) to obtain services to facilitate the communications interface of field equipment with the Traffic Operations Center. The Communications Coordinator shall provide all IP addressing for all devices being installed compliant with the IP addressing scheme developed for the City of

West Des Moines. All switches, managed and unmanaged shall be programmed by the Communications Coordinator and tested for Ring and/or Mesh topology redundancy functionality. IP addressing is required for the traffic controller unit, video monitoring device, preemption device, UPS battery backup device and all managed switches.

24. FIBER OPTIC CABLE

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

General Requirements

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

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

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

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

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

Fiber Characteristics

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

Single-Mode Fiber

Typical core diameter: 8.3um
Cladding diameter: 125 +1.0um by fiber end measurement
Core-to-cladding offset: <1.0um
Coating diameter: 250 +15um
Attenuation uniformity: No point discontinuity shall be greater than 0.1 dB, except terminations or patch cords, at either 1310nm or 1550nm. The coating shall be a layered UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically removable without damaging the fiber.

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

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

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

Fiber Specification Parameters

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

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

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

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

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

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

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

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

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

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

All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. Cable jacketing shall utilize the newer designs to provide maximum flexibility without loss or appreciable dB attenuation. Cable diameter shall not exceed 0.50 inch.

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

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

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

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

#10, 10th tube or fiber	violet
#11, 11th tube or fiber	rose
#12, 12th tube or fiber	aqua

Quality Assurance Provisions

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

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

Cable Installed in Ducts and Conduits

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

Hub cabinet – 30 feet
Type 1Handhole – 20 feet
Type 2 Handhole – 100 feet

Storage of minimum slack cable in controller cabinets and additional slack at pull boxes shall be coiled. The slack coils shall be bound at a minimum of three points around the

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

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

Minimum Bend Radius

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

After the Fiber Optic Cable Installation

Each section of the cable shall be tested for continuity and attenuation as a minimum. If the attenuation is found not to be within the acceptable nominal values, the Contractor shall use an optical time domain reflectometer (OTDR) to locate points of localized loss caused by bends or kinks. If this is not successful the Contractor shall replace the damaged section of cable with no additional payment. Splices will not be allowed to repair the damaged section. After all fiber cable is installed between traffic controller cabinets and fiber links between fiber distribution points (FDP) complete links, all fibers, whether terminated or non-terminated, shall be tested with an OTDR. All fibers terminated shall be tested with a power meter. The Contractor may jumper termination points at controller cabinets to minimize the number of tests and run a single OTDR test between several controller cabinets, subject to the range of the OTDR. Links between FDP’s shall be tested separately. Each OTDR trace, for documented test result submittal, shall be displayed individually and not be combined with other fiber traces as overlays. Single mode fiber shall be tested at 1310 nM. The results of the OTDR test shall be provided on an electronic media (disk) and paper printout. The OTDR wave,

pictorial diagram of dB loss over the length of fiber tested, shall be provided along with the measured data values. The printout shall contain the manufacturer's fiber optic Index of Refraction to the third decimal point for the fiber provided. The Contractor shall provide the Engineer with a written report showing all the values measured compared to the calculated values for length and coupler/connector losses at the completion of these tests. Outdoor patch cords between FDP and controller units less than 151 feet do not need be OTDR tested.

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

Patch cords/Pigtails	.15 SM dB each
Unicam Terminations	1.0 dB set of 2 [In and Out]
Splices	0.08 each

1 KM = 0.3077 KF where KF is 1000 feet

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

Cable Termination

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

connectors. All termination ST couplers shall be rated for dual fiber application, MM and SM.

Breakout Kits

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

Connectors

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

Splices

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

between enclosures by the use of buffer tubing or approved equal support material or shall be pigtail patch cords. Termination / splice enclosures shall be separated by less than 12 inches unless a conduit is installed between enclosures. All splices shall be performed by an automated splicer device that verifies the final splice termination quality. All splices shall be nominally .03 to .05 dB loss but shall be less than a 0.08 dB loss.

Light Source

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

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

Power Meter

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

Launch Reference Attenuator

The launch attenuator, two each for single and multimode fiber testing, shall be utilized for all OTDR tests such that one launch cable shall be at the beginning of the fiber being tested and the second launch cable shall be on the end of the fiber being tested past the final connector. Only one launch cable shall be required when testing non-terminated fiber. The launch attenuator(s) shall be of the same fiber core size and type as the fiber under test. The attenuator shall emulate 300 foot fiber length, minimum, for multimode and 900 feet length, minimum, for single mode fiber or as specified by the OTDR manufacturer for stabilization of the pulse generation. Launch cables shall be of identical

length for incoming and outgoing light during tests. ST connectors shall be utilized with each attenuator to connect the device to the test device, OTDR. One launce cable shall be installed on the start of the fiber being tested and one launch cable shall be installed on the end of each terminated to view the dB loss of the final connector.

The OTDR shall have the Threshold Loss set at a value to show each splice or termination junction of a single fiber in each tube 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 re-testing of all fibers in a section to insure proper quality assurance both during and after installation and testing. Deviations from Engineer testing and report documentation shall be reviewed and the Contractor shall be able to retest any or all challenged measurements to verify a valid test. Inconsistent test results, in the sole opinion of the Engineer, shall be cause for the Contractor to retest the entire fiber installation.

Testing

General

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

Attenuation

The end-to-end attenuation shall be measured for each fiber for each link after installation and termination. A patch cord jumper cable shall be connected to both the light source and the receive cable to the power meter by the use of a connector (barrel). The two reference cables shall then be connected via a termination coupler and the power meter “zeroed” to eliminate the line loss. This process results in a reading of the actual line loss (dB) of the input connector, fiber cable, exiting connector and any other splices or jumpers installed in the measured test link. The calculated “loss” shall not include the input or departing cables in the loss calculation. The calculated fiber loss measured shall

list the number of terminations, including the input and departing connectors, the number of splices and the number of patch cords used to jumper the link(s) into the measured final link. The measured values for each terminated fiber in each tube shall include the Tube number, fiber number, number of feet in the link, the number of splices, the number of patch cords, and the number of connectors, if any. The length of optical cable shall be as measured by the OTDR rather than the fiber cable jacket as the fiber is a reverse oscillation process resulting in a greater optical distance than the fiber cable jacket. The value for both the OTDR length and the cable jacket shall be provided in the recorded documentation for each link distance. All distances shall be recorded in feet rather than meters for both recorded lengths.

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

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

Each tube of a cable shall be in the same file divider where the tube cover OTDR page shows the overview of all splices, patch cords, terminations from start to end. The second section shall include all Power Meter readings and the mandated documentation to show the calculated line loss (losses). The third section shall contain all OTDR traces, one trace per screen. The fourth section shall include the spool sheet for the fiber installed on the test section. An “explanation” sheet may be included where required to clarify an unusual reading that is valid but difficult to be explained through traditional data presentation, such as a video feed fiber that is attached to a jumper to provide continuous feed from the start to end of the tube length where other fibers in the same tube are simply spliced. The above format shall be repeated for each tube of a cable. Traffic multimode fiber measured in sections marked by traffic controller cabinets between Hub Sites may be sub-sectioned in an easy to understand format or may be jumpered using patch cords as a single OTDR Link with each section separated for power meter readings.

Continuity

Continuity tests shall be used to determine whether a test or system jumper does or does not pass light. A continuity test shall also be used to assure the fibers have not been

crossed over in the jumper and that the transmit fiber goes to the receiver fiber. The visible light tester shall be utilized to illuminate faulty terminations or fibers with excessive bends failing to pass light.

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

Optical Time Domain Reflectometer Testing

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

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

Documentation

The results of all testing shall be recorded along with date of test, name of person performing test, brand name, model number, serial number of equipment used during test, and any other pertinent information and data. The Contractor shall be responsible to provide input to the Engineer reviewing the recorded data documentation to resolve all questions or data discrepancies. A copy of the evaluation calculation equations to be used may be obtained by the Contractor by request and by supplying a floppy disk. (The evaluation FO Calculator is an EXCEL program worksheet that calculates design dB Loss

based on required inputs.) Documentation shall be considered incidental to bid items and no additional compensation shall be provided.

25. BATTERY BACKUP SYSTEM

General

All traffic signal battery backup units for this project shall be a Model 22 BBS, TSBBUS manufactured by Tesco in accordance with the City of West Des Moines specifications.

Enclosure

Anodized aluminum weatherproof enclosure shall house BBS and batteries. Enclosure shall be TIG welded construction with welding materials specifically designed for the material to be welded. Enclosure shall have fully framed side hinged outer doors with swaged close tolerance sides for flush fit with drip lip and closed cell neoprene flange compressed gaskets. Front door shall include a #2 keyed lock and incorporate a full-length piano hinge, pad-lockable draw latch (center area on door-latch side), and a pad lockable welded-in place vandal-proof tabs rated at 2000 pounds. There shall be no exposed nut, bolts, screws, rivets or other fasteners on the exterior of the enclosure. Maximum cabinet dimensions 46 inches H by 20 inches W by 10.25 inches D. Weight 250 pounds with batteries. BBS shall be mounted in an interior tilt out housing with 800 lb rated stops. Battery connectors shall be Anderson Connectors with silver plated contacts. Batteries shall be installed in fixed position framed trays for seismic safety and be readily accessible for maintenance. Batteries shall be mounted allowing airflow front and back. Enclosure will include two transfer bypass switches, one for BBS bypass and the second for auxiliary generator. All switches must be panel mounted on interior dead front panel board. A generator receptacle shall be included in the side of the enclosure. UV resistant plastic laminated nameplates shall identify all controls and major components. A plastic covered wiring diagram will be attached to the inside of the front door. All components shall be factory wired and conform to required NEMA, NEC, and UL standards. A chassis ground point shall be provided. Panel shall be UL 508 Industrial Control Panel rated.

BBS Panel Minimum Features

System shall provide 700 watts of full control run time for 2 hours. In addition the system shall provide 6 to 8 hours of flash.

BBS bypass and BBS isolation switch.

Deadfront safety panel board with all switches, indicating fuses, plugs, and isolation fuses for each battery pre-wired with phenolic nameplates.

All nameplates shall be screwed on phenolic engraved type.

All wire terminating lugs shall be full wrap around type.

All batteries shall be captive spaced from external captive sides in earthquake proof buckets.

Cabinet ventilation shall be by two 4 inch by 1/4 inch louvers top and bottom with encapsulated bug screens, cleanable filters and a 100 cfm fan to completely exchange air 25 times minimum per minute.

All DC terminals and connections shall incorporate safety covers such that the safety covers are in place for every normal maintenance mode.

Event Counters & Total Run Time Counter.

BBS Unit Minimum Specifications

BBS unit shall provide a true sine-wave output with minimum 2000 Volt-Amp continuous capacity. BBS must provide for utility service isolation when in operation. The minimum rating for wattage output will be 950 watts. The BBS shall be capable of running an intersection with LED lights. The unit shall operate off-line, with transfer time of 2 ms or less, with battery condition indicator, with automatic test provisions, and with hot-swappable batteries (all batteries in system). BBS will automatically recharge batteries from full discharge to 95% capacity within 6 hours. BBS will provide on-line operation for a minimum input of 92 to 145 VAC, provide full load output of 120VAC – 10% / +4% at 60 Hz +/- 0.05% over a temperature range of -37°C to +74°C and be a UL Approved Design. For Safety and maintenance the BBS shall not exceed 28 pounds. The BBS unit will be delivered with maintenance manuals and schematic diagrams.

BBS Unit Minimum Features

2000VA 950 Watts, with quick make/break connectors and plugs. (Systems requiring hard wiring termination to/from the inverter are unacceptable).

Surge energy withstand 480 Joules, 6.5kA

Common mode clamping 0 ns < 5ns typical UL 1449

Conditioned power – Computer quality

Transient lighting protection – 160 Joules

Transfer to battery time – 2 ms

Retransfer to utility – 2 ms

Each battery shall be 24 volts @ 18 AH with heavy duty Anderson plugs and isolated fused (deadfront panel mounted 30 amp) connections to the BBS for greater system reliability and ease of maintenance. Series wiring is unacceptable.

Fan cooling shall be fused for locked rotor current.

Cooling air shall be ducted to cool the front and back of each battery with air space on all four sides and top of battery.

BBS covers shall be 60% open on both sides to diminish the environmental effects of extreme temperatures.

Includes USB & RS232, DB9 Computer Interface Ports.

Low voltage safety design at 24v DC. (Higher voltage DC systems are unacceptable).

BBS Communications Module

All inverter connections shall be made without the use of tools. This includes: A/C-Input, A/C-Output, Normally-Open, and Normally-Closed programmable contacts.
Smart Slot Relay I/O Module;
Input #1 Turn the BBS on.
Input #2 Turn the BBS off.

Input #3	Start the BBS self-test.
Input #4	Shut down the BBS (when on battery).
Output #1	The BBS is on-battery (during a power failure, self-test or run time calibration).
Output #2	BBS has a low battery – Programmable.
Output #3	The protected load is not receiving power from the BBS.
Output #4	Replace the BBS batteries.
Output #5	The BBS is overloaded.
Output #6	Any BBS fault or self-test failure.

Batteries

Batteries shall be maintenance-free, type AGM/VRLA (Absorbed Glass Mat / Valve Regulated Lead Acid), such as APC Smart-UPS RMXL or approved equal. Batteries shall be independently pre-wired and individually fused. Batteries shall be furnished with heavy-duty 50 amp rated silver-plated Anderson Connectors. 100 Amp internal fuse by Battery supplier. Batteries shall be lightweight for personnel safety and protection plus ease of installation and maintenance. Batteries with a weight of over 26 pounds are not acceptable.

Enclosure Temperature Compensation

Operating temperature shall be a minimum -37°C to +74°C.

Power System Analyzer and Conflict Resolution Module

Incorporate an integrated Power System Analyzer and Conflict Resolution Module. The Analyzer will evaluate and make limited adjustments to the incoming utility power and will automatically transfer load to the battery back-up power if utility power is lost. When utility power becomes available, the BBS will analyze the power to verify stability and return to normal operation. The system provides automatic BBS failure detection and automatically isolates the failed BBS and locks the unit on to utility power. Once the failure has been corrected, the system will return to the normal operation.

Triple Bypass System for Offline BBS

1. SPACT – Smart Power Analyzer with Conflict Monitor Isolation and Transfer Module.
2. PCM – Power Conflict Monitor
3. The PCM shall provide a totally redundant failsafe system. The PCM shall monitor load bus power available continuously. If load bus power fails for 5ms the PCM will transfer and isolate the BBS and guarantee that commercial power will be locked on.
4. Watchdog Timer – Redundant 5 ms delay and hard transfer to utility power.
5. The outboard Smart Transfer Switch shall not interrupt the normal controller function. Transfer time shall be 2 ms.
6. Onboard Smart I/O module will execute lockout of battery back up system upon Smart detection of any inverter BBS fault. If BBS resets itself, it will automatically be available for backup.
7. ON Inverter to timed relay for Full Time control of Output, 0 to 10 hours.

Smart Battery Charger

The battery charger shall charge from shut off discharge to 95% fully charged in less than 6 hours. Batteries shall be ambient enclosure compensated to less than 120°F. The battery charger shall utilize Smart Cell Technology to extend battery life.

Intelligent Battery Management

The BBS system shall utilize Cell Guard to provide longer battery life – Improved reliability results from a precision battery charging system, and automatic true-load battery tests.

Redundant overcharge protection contributes to longer battery life. Smart Boost and SmartTrim shall regulate under and over voltages without switching to battery.

The BBS System shall utilize Battery Replacement Warning to prevent downtime. The BBS system shall automatically perform a self-test every two weeks. This is to provide alerts to degrading batteries before they wear out. Through software, or the push of a button, self-tests may be performed at any time. The BBS battery charging systems shall be microprocessor controlled to precisely charge batteries in less time than legacy BBS systems. This makes the system available more quickly for subsequent power disturbance.

Hot-Swappable Battery Replacement

A 60 second, user friendly, hot-swappable battery replacement system shall be used to save the time and expense of returning the BBS to the factory for battery service, and allows safe and easy replacement of batteries while your system is up and running. Replacement battery packs shall be shipped in a reusable box for convenient return of exhausted batteries to a recycling center.

Ethernet Communications

The BBS system shall be provided with Web SNNP/Ethernet (IP addressable communication) capability that will enable communication between the BBS system at an intersection and the City's Traffic Control Center.

Warranty

Manufacturers shall provide a 2 year factory-replacement parts warranty on the BBS. Batteries shall be warranted for full replacement for 2 years.

26. RADAR PRESENCE VEHICLE DETECTION

General

The above-ground radar presence detector (RPD) vehicle detection shall be the Wavetronix SmartSensor Matrix.

Sensor Outputs. The RPD shall present real-time presence data in 10 lanes.

The RPD shall support a maximum of eight zones.

The RPD shall support four channels and have user-selectable channel assignments.

The RPD shall use OR logic to combine multiple zones to a channel output, and shall have channel output extend and delay functionality.

The RPD algorithms shall mitigate detections from wrong way or cross traffic.

The RPD system shall have fail-safe mode capabilities for contact closure outputs if communication is lost.

Detectable Area

Detection Range. The RPD shall be able to detect and report presence in lanes with boundaries as close as 6 ft. from the base of the pole on which the RPD is mounted.

The RPD shall be able to detect and report presence in lanes located within the 140 foot arc from the base of the pole on which the RPD is mounted.

Field of View. The RPD shall be able to detect and report presence for vehicles within a 90 degree field of view.

Lane Configuration. The RPD shall be able to detect and report presence in up to 10 lanes.

The RPD shall be able to detect and report presence in curved lanes and areas with islands and medians.

Preassembled Panel. Each RPD shall have a traffic cabinet preassembled panel with the following:

- AC/DC power conversion
- Surge protection
- Terminal blocks for cable landing
- Communication connection points
- Four-sensor plate ability

The preassembled back plate for the RPD shall be a cabinet side mount or rack mount.

Maintenance. The RPD shall not require cleaning or adjustment to maintain performance.

The RPD shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement.

Once the RPD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes.

Physical Properties. The RPD shall not exceed 4.2 pounds in weight.

The RPD shall not exceed 13.2 inches by 10.6 inches by 3.3 inches in its physical dimensions.

Enclosure. The RPD shall be enclosed in a Lexan EXL polycarbonate.

The enclosure shall be classified “f1” outdoor weatherability in accordance with UL 746C.

The RPD shall be classified as watertight according to the NEMA 250 Standard.

The RPD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- External Icing (NEMA 250 clause 5.6)
- Hose-down (NEMA 250 clause 5.7)
- 4X Corrosion Protection (NEMA 250 clause 5.10)
- Gasket (NEMA 250 clause 5.14)

The RPD shall be able to withstand a drop of up to 5 feet without compromising its functional and structural integrity.

The RPD enclosure shall include a connector that meets MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

Power. The RPD shall consume less than 10 W. The RPD shall operate with a DC input between 9 VDC and 28 VDC.

Communication Ports. The RPD shall have two communication ports, and both ports shall communicate independently and simultaneously.

The RPD shall support the upload of new firmware into the RPD's non-volatile memory over either communication port.

The RPD shall support the user configuration of the following:
- Response delay
- Push port

The communication ports shall support a 9600 bps baud rate.

The RDP will be supplied with a remote IP communications connection

Radar Design. The RPD shall be designed with a matrix of radars

Frequency Stability. The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is reference to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any up conversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

The RPD shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

The bandwidth of the transmit signal of the RPD shall not vary by more than 1% under all specified operating conditions and over the expected life of the RPD.

Antenna Design. The RPD antennas shall be designed on printed circuit boards.

The vertical beam width of the RPD at the 6 dB points of the two-way pattern shall be 65 degrees or greater.

The antennas shall cover a 90 degree horizontal field of view.

The sidelobes in the RPD two-way antenna pattern shall be -40 dB or less.

Resolution. The RPD shall transmit a signal with a bandwidth of at least 245 MHz.

RF Channels. The RPD shall provide at least eight RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

Verification. The RPD shall have a self-test that is used to verify correct hardware functionality.

The RPD shall have a diagnostics mode to verify correct system functionality.

Configuration.

Auto-configuration. The RPD shall have a method for automatically defining traffic lanes, stop bars and zones without requiring user intervention. This auto-configuration process shall execute on a processor internal to the RPD and shall not require an external PC or other processor.

The auto-configuration process shall work under normal intersection operation and may require several cycles to complete.

Manual Configuration. The auto-configuration method shall not prohibit the ability of the user to manually adjust the RPD configuration.

The RPD shall support the configuring of lanes, stop bars and detection zones in 1 foot increments.

Windows Mobile®-based Software. The RPD shall include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic representation.

The graphical interface shall operate on Windows Mobile, Windows XP and Windows Vista in the .NET framework.

The software shall support the following functionality:

- Operate over a TCP/IP connection
- Give the operator the ability to save/back up the RPD configuration to a file or load/restore the RPD configuration form a file.
- Allow the backed-up sensor configurations to be viewed and edited.
- Provide zone and channel actuation display
- Provide a virtual connection option so that the software can be used without connecting to an actual sensor.
- Local or remote sensor firmware upgradability.

Operating Conditions.

RPD operation shall continue in snow or in rain up to 1 in. per hour.

The RPD shall be capable of continuous operation over an ambient temperature range of -40°F to 165.2°F.

The RPD shall be capable of continuous operation over a relative humidity range of 5% to 95% (noncondensing).

Mounting Assembly. The RPD shall be mounted directly onto a mounting assembly fastened to a mast arm, pole or other solid structure.

The RPD mounting assembly shall provide the necessary degrees of rotation to ensure proper installation.

The RPD mounting assembly shall be constructed of weather-resistant materials and shall be able to support a 20 pound load.

Mounting Location. The RPD shall be mounted at a height that is within 15 to 30 feet per manufacturer's recommended mounting heights.

The RPD shall be mounted at an offset from the first lane that is not less than 6 feet per the RPD's minimum offset.

The RPD shall be mounted so that at least 20 feet along the farthest lane to be monitored is within the field view of the RPD.

The RPD shall be mounted with its cable connector down and shall be tilted so that the RPD is aimed at the center of the lanes to be monitored. Typically, the RPD is titled off of vertical by 20

to 30 degrees.

The RPD shall be mounted on a vertical signal pole or on the horizontal mast arm.

The RPD shall be mounted so that its field of view is not occluded by poles, signs or other structures.

RPDs that are mounted within 20 feet of each other or that are monitoring the same intersection shall be configured to operate on different RF channels regardless of the pointing direction of the RPDs.

It is recommended that the manufacturer be consulted to verify final RPD placement if the RPD is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway.

Cabling. Ground wire No. 4 AWG shall be provided from the equipment location to the foundation ground. The cable shall be SmartSensor 6-conductor wire. The cable end connector shall meet the MIL-C-26482 specification and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector backshell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket, and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series, and recommended backshells are Glenair Series 37 cable sealing backshells.

The cable shall be the Orion Wire Combo-2204-2002-PVC-GY or an equivalent cable that conforms to the following specifications:

- The RS-485 conductors shall be a twisted pair.
- The RS-485 conductors shall have nominal capacitance conductor to conductor of less than 71pF/Ft at 1 Khz.
- The RS-485 conductors shall have nominal conductor DC resistance of less than 16.5 ohms/(304.8 m) at 68°F
- The power conductors shall be one twisted pair with nominal conductor DC resistance of less than 11.5 ohms/(304.8 m) at 68°F.
- Each wire bundle or the entire cable shall be shielded with an aluminum/mylar shield with a drain wire.

The cable shall be terminated only on the two farthest ends of the cable.

The cable length shall not exceed 2000 feet for the operational baud rate of RS-485 communications (9.6 Kbps).

If 12 VDC is being supplied for the RPD then the cable length shall not exceed 110 feet.

If 24 VDC is being supplied for the RPD then the cable length shall not exceed 600 feet.

Both communication and power conductors can be bundled together in the same cable as long as the above-mentioned conditions are met.

In Cabinet Interface Equipment. The RPD shall be installed using the SmartSensor Matrix Preassembled Traffic Cabinet Backplate or an equivalent that provides input power surge suppression, sensor cable surge suppression, AC to DC power conversion (if necessary), and terminal blocks. The surge protection devices shall meet or exceed the EN 6100-4-5 Class 4 specifications.

Power Supply. If needed, the RPD shall be installed using the Click! 202, Click! 204 or an equivalent AC to DC power converter that meets the following specifications:

The power converter shall be power rated at 48 W for temperatures less than 140°F) with a 5% power decrease for each degree increase up to 158°F.

The power converter shall operate in the temperature range of -29.2^{o}F to +165.2^{o}F.

The power converter shall operate in the humidity range of 5% to 95% at 77^{o}F non-condensing.

The power converter shall accept an input voltage of 85 VAC to 264 VAC or 120 VDC to 370 VDC.

The power converter shall operate at an input frequency of 47 Hz to 63 Hz.

The power converter shall produce an output voltage of 24 VDC ±4%.

The power converter shall withstand a voltage across its input and output of 2kV. The power converter shall withstand a voltage across its input and ground of 1.5 kV.

The power converter shall conform to safety standards UL 60950 and EN60950.

The power converter shall conform to EMC standards EN55022 Class B and EN61000-3-2, 3.

In brown-out conditions (i.e. <85VAC input), the output voltage of the power converter shall be less than 1 VDC.

The terminal blocks shall be color-coded insulation displacement terminal blocks.

The terminal blocks shall be prewired to the other in-cabinet equipment so that no wiring other than cable terminations, connecting input power and connecting input file cards shall be required during installation.

The preassembled backplate shall be a preassembled traffic cabinet backplate that includes the following elements (where multiple models of the same device are listed, their use depends on whether the PB is meant to support one, two or four sensors): a DC power supply equivalent to the Click 201/202/204; one, three or five circuit breakers equivalent to the Click 210/210-02; an AC surge suppresion device equivalent to the Click 230; 1 or 2 system surge protection devices equivalent to the Click 222 or Click 223; T-bus connectors and end blocks; terminal blocks for sensor cable termination; terminal blocks for AC line input; end blocks for stabilization and spacing; a traffic cabinet backplate as a mounting platform; and necessary cables, including a power cord, ground cable, and patch cables.

27. ADAPTIVE TRAFFIC CONTROL SYSTEM

OVERVIEW

This work shall consist of furnishing, configuring and placing into operation an adaptive traffic signal control system that detects and collects vehicle data and automatically optimizes the changing of traffic signals to instantly adapt to real-time traffic demand. System shall include the components, adaptive operations, software, installation training, technical support and warranty described herein. System supplier must be able to provide ample evidence, both of a quantitative and qualitative nature, of the adaptive system's successful performance in multiple locations and public transportation agencies' positive experience with supplier. The system shall be the InSync adaptive traffic control system manufactured by Rhythm Engineering.

SYSTEM COMPONENTS

Material Adherence to Quality Standards

Equipment and material shall be of new stock unless the contract provides for relocation of existing units or use of units furnished by others. New equipment and material shall be the product of reputable manufacturers and conform to all relevant requirements including the requirements of Caltrans, ICEA, IMSA, ITE, MUTCD, NEMA, RETMA, NEX and regulations of the National Board of Fire Underwriters, as applicable, and meet the approval of the engineer.

System Compatibility

Installation of adaptive system shall not require the replacement of any traffic controllers or cabinets, or modification thereof. The adaptive traffic control system must be compatible with all major makes and models of digital traffic controllers and cabinets, including but not limited to those associated with NEMA, Caltrans, Econolite, Eagle, McCain, Peek, Naztec and other prominent controllers manufactured currently or in the last 15 years. For controllers, this includes compatibility with all prominent types including but not limited to 170, 2070 and NEMA TS-1 and TS-2 styles. For cabinets, this includes compatibility with all prominent types including but not limited to 332 and NEMA styles. System shall be able to coordinate a minimum of fifty signals regardless of controller types at those intersections to allow for future expansion as desired.

System Components

The adaptive traffic control system shall consist of Internet-protocol (IP) color video cameras enclosed in secure housings, a shelf- or rack-mounted processing unit, appropriate connection cables, software and licenses for system control via a web browser such as Microsoft Internet Explorer on any authorized computer, and a switch with the capability of independently networking a minimum of four video cameras and the processor.

Processing Unit (PU)

General

The adaptive traffic control system shall include a separate processor unit (PU) mounted in the traffic cabinet that connects to the controller which is running in free mode. The processor shall intercept detection calls, hold and analyze them and place calls passively to the traffic controller.

The PU may be rack or shelf mounted and shall be modular in design. It shall support on-site configuration using a USB keyboard and VGA monitor, or remote configuration over an IP Network. It shall support on-site backup to restore from a USB memory stick for rapid replacement. The PU shall contain at least 2 USB ports to allow simultaneous connection of peripherals and storage devices.

Communications

Communications from the PU to any computer shall be through RJ45 (8P8C) connector over a regular IP network connection at the installation location or over a network. The computer shall have the capability to download detection data as well as the real-time detection information needed to show detector actuations. The user shall also have the capability of connecting directly to the detection cameras over the IP network and display post-processed and pre-processed color video in the MPEG 4 and MJPEG format.

Compatibility with NEMA Standards

The PU shall be available with NEMA TS1/TS2 detector interface. Output levels shall be compatible with the NEMA TS1 and NEMA TS2 Type 2 standards.

Historical Green Time Information

The PU shall store historical information of the green time allotted to each phase and when the system goes into fog mode or emergency mode shall compute and deploy optimized signal green times based on historical information.

Free Mode Controller Operations

The PU shall input optimized detector calls into a controller that is running in free mode.

Suspension of Inputs When Needed

The PU shall suspend, for the necessary time, its inputs to a controller when calls of a higher priority are put in to the controller by preemption vehicles or the pre-determined parameters set by traffic officials.

Transmission of Information to Adjacent Intersections

The PU shall automatically send all necessary information to system processors at adjacent upstream and downstream intersections in order to facilitate the progression of traffic flow along the arterial. Furthermore, the system shall have a communications failure strategy implemented that maintains near-optimal performance in the event communications between cabinets fails.

Optimization of Traffic Flow

The adaptive traffic control system must be able to assess volume and delay in real time to optimize signalization. System shall adapt to traffic demand changes immediately, not in future cycles. The PU shall optimize the flow of traffic at both intersections and arterials based on the possible states unbound by traditional cycles. The system must be able to perform adaptive calculations without regularly relying on recalculating offsets to perform adaptive operations.

System shall be able to serve a non-coordinated phase multiple times or no times between serving the coordinated movement. The sequence of phase pairs must be dynamic allowing for serving one phase twice before first serving another phase once. The system must have the ability to adjust green time without a per cycle maximum permitted adjustment.

System shall not require creation or maintenance of time-of day plans. System shall not require the agency to develop new timing plans, modify existing timing plans or maintain timing plans for adaptive operation.

Pedestrian Calls

The PU shall incorporate the optional capability to include pedestrian calls in the optimization algorithms.

Time Clock Synchronization

The PU shall keep accurate time using a mechanism that synchronizes the clocks at least weekly.

Time of Day Operation

The PU shall be capable of functioning in a detector mode or adaptive mode selectable by time of day and day of week.

<u>Vehicle Detection</u>

General

The adaptive traffic control system must include in its base product standard Internet protocol (IP) cameras which allow for real-time images to be viewed remotely via the Internet using a standard browser, not proprietary software. The

video cameras shall be digital cameras and their video feeds shall be available over standard IP connection in Motion JPEG and MPEG 4 formats using the latest IP technology. All camera views shall be obtainable simultaneously without cable swaps. The system shall be capable of displaying post-processed video on a web browser such as Microsoft Internet Explorer. The engineer shall have the option to view one camera at a time, all cameras at an intersection, or some or all of the cameras along an arterial in a single browser window.

The video detection system shall be included and provide flexible detection zone and/or count sensor placement anywhere and at any orientation within the combined field of view of the image processors. Preferred presence detector zone configurations shall be a box or polygon across lanes of traffic placed parallel with lanes of traffic. A single detector zone shall be able to replace multiple conventional detector loops. Detection zones shall be capable of overlapping. Detection zones shall detect multiple vehicles within a single detection zone.

Detection Zones

The detection zones shall be created by using a pointing device and a graphical user interface (GUI) displayed on any computer connected directly to the PU or a GUI available to any authorized remote terminal over IP network connection. It shall be possible to add, edit or remove previously defined detector configurations to fine-tune detection zone placement.

Detection System Outputs

When a vehicle is detected by entering a detection zone, there shall be a visual change on the video display, such as a change in color or intensity, thereby verifying proper operation of the detection system. The system shall compute and display real-time queue information per lane. The system shall compute and store traffic volumes, stopped time delay, and Level of Service per phase and display such information on demand over an Internet Browser.

Detection System Performance Standards

Using camera, optics and in the absence of occlusion, the system shall be able to detect vehicle presence with 93% accuracy under normal (day and night) conditions and with only a slight deterioration in performance under adverse (fog, snow, rain) conditions. During extremely adverse conditions or camera failures the system shall default to emergency mode or fog mode. The processor shall store historical split information and shall compute and deploy optimized signal splits based on historical split information when the system goes into fog mode or emergency mode.

Camera Operation

The camera shall automatically function in a special mode at night and the processor shall utilize such images and conduct image processing after filtering out a high degree of reflected and ambient lighting. The PU shall change image parameters such as sharpness and contrast based on the lighting conditions.

Camera Notifications

The system shall be able to automatically generate notifications to one or more email addresses and other communication devices when a camera has failed or the view is obstructed (e.g. fog or ice).

<u>Video Camera and Housing</u>

General

The PU supplier shall furnish the video camera for traffic detection. The camera shall produce a usable color video image of vehicles under normal roadway lighting conditions regardless of time of day. Usable video in color shall be produced for scenes with a minimum luminance of 0.65 lux at aperture f-value 1.0.

Camera System Sensing and Video Streams

The camera system shall use a CMOS sensing element and be capable of delivering MJPEG and MPEG 4 video streams simultaneously.

Camera Lens and Control

The camera shall include an electronic shutter or auto iris control based upon average scene luminance and shall be equipped with an auto iris lens.

Camera Focal Length

The camera shall have a variable focal length. The maximum aperture of the lens shall not be smaller than f1.8 and the minimum aperture shall not be larger than f360.

Camera Environmental Parameters

The camera shall be able to operate under harsh environmental conditions, including temperatures -30°F to 165°F, heavy rain, and ice. The enclosure shall allow the camera to be adjusted in the field during installation.

Camera Enclosure

The enclosure shall be equipped with a sun shield that prevents sunlight from directly entering the lens. The sun shield shall include a provision for water diversion to prevent water from flowing in the camera field of view.

Camera System Access

The camera system shall be Ethernet-centric. The system shall be capable of delivering MPEG-4 and MJPEG video to the switch in the cabinet. The user shall be able to access the camera directly over the network and configure the camera parameters using a standard Internet Browser.

Cable

Ethernet Cable

Any Ethernet cable run outside of the traffic cabinet shall be environmentally hardened, shielded, and outdoor rated 350 MHz Category 5e cable. The cable shall be riser rated, No. 24 AWG solid copper, have Polyolefin insulation, UV and oil resistant PVC jacket. Pair 1 shall be Blue, White/Blue, Pair 2 shall be Orange, White/Orange, Pair 3 shall be Green, White/Green and Pair 4 shall be Brown, White/Brown. The operating temperature shall be from -40°C to +70°C. The cable shall conform to the following standards: ISO/IEC 11801 Category 5e, NEMA WC 63, and ANSI/TIA/EIA 568-B.2 Category 5e. The cable shall be without splicing or joints for any single run. The contractor shall obtain instructions from the manufacturer about alternate architecture when length of a single run of CAT 5e cable exceeds 320 feet.

RJ-45

The RJ-45 plug connectors shall be used at both the camera and cabinet ends. The supplier of the video detection systems shall approve the Category 5 cable, RJ-45 connector and crimping tool and the manufacturer’s instructions must be followed to insure proper connection.

Power Cable

Power cable shall be No. 14 AWG three-conductor cable. This cable shall comply with the requirements of IMSA Specification 19-1.

System Software

The system shall include software that detects vehicles in multiple lanes using the video image and an option for integrating existing detection, such as inductive loops. The software shall automatically account for changes in scene including but not limited to lighting conditions or adverse weather. The engineer would have the dual benefit of defining detection zones via a web interface accessible from any regular computer with an IP network connection or using a computer physically connected to the network (which may include a laptop computer). A minimum of 12 detection zones per camera shall be available. The detections zones must be capable of counting multiple vehicles within a single detection zone. The system software shall communicate to an existing signal controller passively, allowing the signal controller to still handle emergency pre-empts. The software shall determine and display real-time queue lengths along each approach.

The software/hardware shall have the capability to seamlessly intercept existing detection status. If the option is chosen, the detection logic used for integrating system video detection with existing detection shall work as follows:

1. If existing detection is positive and video detection is negative, the result shall be positive.
2. If existing detection is negative and video detection is positive, the result shall be negative.
3. If existing detection is negative and video detection is negative, the result shall be negative.

The adaptive traffic control system shall use a distributed intelligence architecture and not rely on a central server or central software for regular adaptive operations.

Access to Detection System Data

The video detection system shall be programmable via a web browser using the same IP network connection that delivers the video camera output and thus allow the engineer to have complete control of the system without being physically present at the intersection. It shall provide still image and real time detection displays in color video to a remote computer using a web browser such as Microsoft Internet Explorer. The system shall collect real-time traffic data such as vehicle counts, stop delay and level of service. Real-time and historical statistical information must be available to the engineer in graphical and/or tabular form as and when required.

Configuration user software

System shall include software that enables local traffic engineers and technicians to review, modify and deploy changes to the adaptive protocols and operational preferences. Software will use a user-friendly graphical interface. Software will not require licenses or fees but rather be available for use on as many computers as requested for as long as needed without per-user or time-based fees. All training and documentation necessary for proficiency in the software will be provided.

ADAPTIVE TRAFFIC CONTROL OPERATIONS

General

The adaptive traffic control module shall be contained within the PU. The PU shall communicate with neighboring PUs over an IP network. The PUs shall be capable of communicating information to other signals and the network of signals so as to account for changes in demand therefore the progression protocols and configurations.

Optimization of Green Time Allocation

The adaptive traffic control shall not use common cycle lengths but use algorithms and artificial intelligence to optimize traffic flow. The optimization shall be real time using the principles of a finite state changing machine and shall not involve switching between cycle lengths or timing plans. The system shall not be in transition at any time but shall respond to real-time inputs with changing of states. Guaranteed arterial progression shall be created using dynamic green bands. Non-arterial traffic at each intersection shall be served adequately without interfering with the green bands.

Configuration of Signal Control

The supplier's engineers shall configure the adaptive traffic signal control system for optimal operation of the arterial or arterial network. Traffic flow and anomalous traffic conditions shall be programmed into the adaptive traffic signal control system.

Configuration via IP Network

The parameters for the adaptive traffic signal control shall be capable of being configured remotely over the IP network. Parameters are adjustable via a web browser capable of running Java, such as Internet Explorer. The software shall also display traffic signal green status and up to 48 camera views. All configuration information shall be stored in easily backed-up and humanly readable XML files.

Monitoring of Arterial

The system shall allow monitoring via a web browser such as Microsoft Internet Explorer on any authorized computer. It shall be possible to view a single camera, multiple cameras from a single intersection, or multiple cameras from multiple intersections. This system must be capable of displaying these views even under limited network bandwidth. It must be possible to format these views to support different size viewing screens.

The system shall have remote monitoring and configuring capability using IEEE 802.3 standards. The equipment shall meet the NEMA environmental, power and surge ratings according to the latest NEMA Specifications.

Failure Mitigation Mechanisms

The system shall be able to automatically generate notifications to one or more email addresses when it detects disruption of the communications network, failure of PUs, intersections going into flash, or other such events that would impact the operation of the arterial.

System shall maintain near-optimal adaptive operation in the event of a communications failure, and rely on historical data specific to the time-of-day and day-of-week in the event of detector failure.

INSTALLATION

A factory-certified representative from the supplier shall be on-site at the beginning of installation. The adaptive traffic control system shall be installed as recommended by the manufacturer and as documented in the installation materials provided by the supplier.

EVIDENCE OF OPERATIONAL PERFORMANCE

The adaptive traffic control system selected shall be deployed and currently operating at a minimum of 20 independent, noncontiguous corridors in the United States.

System shall have independent engineering studies using industry-accepted methods demonstrating the system's field results in at least three non-contiguous corridors in which the adaptive system reduced travel times by at least 30% in at least one peak-period per corridor.

System shall have field evidence from a source not related to the vendor or manufacturer of the system's ability to reduce traffic accidents.

System supplier shall supply no fewer than five positive references from public agencies operating the system speaking directly to the quality of post-sale support.

WARRANTY AND SUPPORT

Warranty Period

The adaptive traffic control system hardware and software shall be warranted to be free of defects in material workmanship for a minimum of 2 years.

Technical Support

System supplier shall maintain a 24 hours per day support hotline, available on an unlimited basis during the warranty period. This support shall be available from factory certified personnel or factory certified installers.

28. BASIS OF PAYMENT

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

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

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

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

The Contractor shall provide a warranty covering workmanship and materials for 1 year after final acceptance of the project.