



SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Linn County

BRM-1187(681)--8N-57

Effective Date
December 15, 2009

THE IOWA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS, SERIES OF 2009, ARE AMENDED BY THE FOLLOWING ADDITIONS, OR MODIFICATIONS. THESE ARE SPECIAL PROVISIONS AND SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS

TRAFFIC SIGNALIZATION SPECIAL PROVISIONS

6TH STREET SW

Project number: BRM-1187(681)--8N-57

TABLE OF CONTENTS

I GENERAL REQUIREMENTS

- 1.1 RELATED SPECIFICATIONS AND STANDARDS
- 1.2 LOCAL REQUIREMENTS
- 1.3 CONTRACTOR'S RESPONSIBILITY
- 1.4 TRAFFIC CONTROL
- 1.5 ORDER OF WORK
- 1.6 SALVAGE
- 1.7 UTILITIES
- 1.8 EQUIPMENT AND MATERIALS
- 1.9 MEASUREMENT AND PAYMENT

II MATERIAL REQUIREMENTS

- 2.1 ELECTRICAL
- 2.2 CONDUIT
- 2.3 GROUND RODS AND GROUND WIRE
- 2.4 CONCRETE BASES FOR POLES AND CONTROLLERS

III INSTALLATION REQUIREMENTS

- 3.1 GENERAL
- 3.2 CONCRETE BASES FOR POLES AND CONTROLLERS
- 3.3 HANDHOLES
- 3.4 CONDUIT
- 3.5 ELECTRICAL
- 3.6 POLE ERECTION
- 3.7 SIGNALS
- 3.8 CONTROLLER CABINET
- 3.9 EQUIPMENT TESTING

IV EQUIPMENT REQUIREMENTS

- 4.1 TRAFFIC ACTUATED TRAFFIC SIGNAL CONTROLLERS
- 4.2 MULTI-PHASE TRAFFIC ACTUATED CONTROLLERS
- 4.3 MAST ARM ASSEMBLIES
- 4.4 SIGNAL HEADS
- 4.5 TRAFFIC SIGNAL LAMPS
- 4.6 BACKPLATES
- 4.7 PEDESTRIAN PUSH BUTTON DETECTORS
- 4.8 VIDEO DETECTION CABLE
- 4.9 WIRELESS VEHICLE DETECTION SYSTEM

V TRAFFIC SIGNAL QUANTITIES

- 5.1 SCHEDULE OF UNIT PRICES
- 5.2 EQUIPMENT AND MATERIALS LIST

PART I GENERAL REQUIREMENTS

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

1.1 RELATED SPECIFICATIONS AND STANDARDS

Unless otherwise specified in the project plans and special provisions the traffic signal installed under this specification shall comply with:

- A. Latest series of the Standard Specifications of the Iowa Department of Transportation.
- B. Specifications of the Underwriters Laboratories Inc.
- C. National Electrical Code.
- D. Manual on Uniform Traffic Control Devices (MUTCD).

1.2 LOCAL REQUIREMENTS

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

1.3 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor will be responsible for incidental sidewalk removal and replacement necessary to complete the signal construction. All waste material and debris shall be disposed of at a sanitary landfill at no expense to the Contracting Authority.
- B. The Contractor shall perform all work required and furnish all labor, materials, equipment, tools, transportation and supplies necessary to complete the work in accordance with the project contract documents. The Contracting Authority or their representative shall have full freedom to observe all phases of the work performed by the Contractor and to discuss all matters dealing with the quality and progress of the work. Should any misunderstanding arise as to the intent or meaning of the plans or specifications, or should any discrepancy appear, the decision of the Contracting Authority or their representative shall be final and conclusive.
- C. The Contractor agrees to indemnify and hold harmless the City of Cedar Rapids, for all liability arising out of the negligent acts, errors or omissions of the Contractor, their employees, or agents as respects the project.
- D. All work included under this contract shall be done in accordance with the Occupational Safety and Health Act of 1970 (Williams-Steiger Act) as amended and enforced by the governmental authority responsible for the enforcement of the Act. Enforcement and responsibility for fulfilling this provision of the specifications shall rest solely with the Contractor, their superintendents, and their foremen and in no way shall rest with the Contracting Authority or the Engineer. The presence of the Engineer, the Contracting Authority, or their representatives shall not obligate the Engineer, Contracting Authority, or their representatives to the Contractor's responsibilities. The Contractor shall inform their subcontractors to this also.

1.4 TRAFFIC CONTROL

- A. Existing traffic signal installations shall be kept in effective operation, if required, except for shutdown to allow for alterations. The Contractor shall notify the local traffic enforcement agencies prior to any operational shutdown of a traffic signal installation. Any and all operational shutdowns will be coordinated with the Traffic Engineering Division. The Contractor shall be responsible for appropriate traffic control, which may include flaggers, off duty police officers, or other traffic control as specified by the Traffic Engineering Division.
- B. All traffic control shall be in accordance with the Manual on Uniform Traffic Control Devices

(MUTCD).

1.5 ORDER OF WORK

- A. The order of work shall be determined by the Contractor, subject to the approval of the Engineer.
- B. Upon completion of the work the Contractor shall thoroughly clean the site and restore it to a condition at least equal to that existing prior to construction.

1.6 SALVAGE

- A. The Contractor shall deliver all salvaged materials at to the Cedar Rapids Traffic Engineering Division, 1201 6th Street S.W.

1.7 UTILITIES

- A. The location of all utilities indicated on the plans is approximate only. The Contractor must determine the exact location and elevation of all public utilities. It shall be the duty of the Contractor to ascertain whether any additional facilities other than those shown on the plans may be present.
- B. The Contractor shall replace or repair any existing utilities damaged by their operations at their own expense.

1.8 EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be of new stock unless the plans provide for the use of existing equipment, or equipment furnished by others. New equipment and materials shall be the product of reputable manufacturers of electrical equipment and shall meet the approval of the Engineer.
- B. Before beginning work on the project, the Contractor shall submit six copies of catalog cuts for all equipment and materials supplied by the Contractor.
- C. Prior to ordering any materials the Contractor shall provide certification from the manufacturers of all electrical equipment, conduit, and cable stating said material complies with the specifications.
- D. All miscellaneous electrical equipment shall be UL approved.

1.9 MEASUREMENT AND PAYMENT

- A. Traffic Signalization as indicated on the plans, complete-in-place and accepted, will be measured as a unit lump sum quantity for all work necessary.
- B. Traffic Signalization, measured as provided above, will be paid for at the contract lump sum price bid, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete traffic control signal installation and for all equipment, tools, labor, and incidentals necessary to complete the work.

PART II MATERIAL REQUIREMENTS

2.1 ELECTRICAL

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

shall be black for the positive cable and white for the negative cables.

B. Signal cable shall be stranded and conform to the requirements of IMSA 19-1 or 20-1, or latest revision thereof. The number and size of conductors shall be as specified on the plans.

C. Connectors shall be either insulated spring steel connectors or insulated setscrew connectors. The spring steel connectors shall be 3M, Hyflex #212 or approved equal. The spring shall have sharp edges; round edges will not be approved.

The setscrew connectors shall be Ideal, Series 30- 200; Holub, Catalog No. 10-307, Model SS-2 or approved equal.

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

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

2.2 CONDUIT

A. Polyvinyl Chloride (PVC) conduit will be allowed for loop lead-in conduit. PVC conduit shall be Schedule 80. The number and size of the conduits shall be as called for on the plans.

B. 2 inch High density polyethylene (HDPE) conduit, where called for on the plans, shall meet or exceed the requirements of ASTM F 2160 "Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)". The HDPE conduit shall also meet Schedule 40 and SDR 13.5 requirements. Joints shall meet or exceed ASTM F 2176 "Standard Specification for Mechanical Joints Used on Polyethylene Conduit, Duct and Innerduct". Couplings shall be Moon Link and constructed from Polyurethane Elastomeric Plastic. Orange conduit will be required for underground fiber optic cable installation. Manufacturer's certification may be required for HDPE conduit.

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

2.3 GROUND RODS AND GROUND WIRE

A. Ground rods shall be high strength steel rods with chemically bonded copper coverings to provide high- conductivity and to prevent electrolytic action. Rods shall be full length as shown on the plans and shall have a nominal diameter of five-eighths inch unless otherwise specified. Ground rods shall conform to the requirements of IMSA specification No. 62-1956. Ground wires shall be connected to ground rods with one-piece nonferrous clamps which employ setscrews as tightening devices. Connections to ground rods need not be taped.

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

2.4 CONCRETE BASES FOR POLES AND CONTROLLERS

A. Concrete for bases shall be Class "C" structural concrete, C-4 mix.

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

PART III INSTALLATION REQUIREMENTS

3.1 GENERAL

- A. The Contractor shall be prepared to furnish, upon request from the Engineer, a sample for evaluation, of any item or material, which they propose to furnish for this project.
- B. The installation of all traffic signal equipment will be as shown in the plans. Any modifications of the installation are subject to the approval of the Engineer.
- C. Unless otherwise specified in these contract documents, the installation of all signal equipment shall be in accordance with the Traffic Signal Manual of the International Municipal Signal Association (IMSA).
- D. The painted surface of any equipment damaged in shipping or installation shall be retouched or repainted in a manner satisfactory to the Engineer.

3.2 CONCRETE BASES FOR POLES AND CONTROLLER

- A. Concrete bases for poles and controllers shall conform to the details shown on the plans.
- B. Excavations for these bases shall be made in a neat and workmanlike manner. Whenever the excavation is irregular, forms shall be used to provide the proper dimensions of the foundations below grade.
- C. The material for the forms shall be of sufficient thickness to prevent warping or other deflections from the specified pattern. The forms shall be set level and means shall be provided for holding them rigidly in place while the concrete is being deposited. When located in a continuous sidewalk area, the top of the pole bases shall be set flush with the sidewalk or pavement surface.
- D. All reinforcing bars, conduits, ground rods, and anchor bolts shall be installed rigidly in place before concrete is deposited in the forms.
- E. Anchor bolts for the signal poles or the controller shall be set in place by means of a template constructed to space the anchor rods in accordance with the manufacturer's requirements. The top of the bolts shall not vary more than 1/4 inch. Bolt projections shall be provided per manufacturer's recommendations. The center of the template and the center of the concrete base shall coincide unless the Engineer shall direct otherwise.
- F. The top of the base shall be finished level and the top edges shall be rounded with an edger having a radius of 1/2 inch. The exposed surface of the base shall have a wood floated surface finish. Exposed concrete surfaces shall be cured using white-pigmented curing compound or plastic film meeting the requirements of Article 2403.11 of the Standard Specifications.
- G. The bottom of the foundations and bases shall rest securely on firm undisturbed ground. Where the foundation or base cannot be constructed as shown on the plans because of an obstruction, the Contractor shall use other effective methods of supporting the pole as may be designated by the Engineer.
- H. Concrete shall be vibrated with a high-frequency vibrator after it is placed in the form to eliminate all voids.
- I. After the foundation or base has been poured, absolutely no modification of any sort may be made. If the anchor bolts, conduit, or any part of the foundation or base is installed in an incorrect manner as determined by the Engineer, the entire foundation or base shall be removed and a new foundation or base installed. The Contractor shall bear all costs of replacing work deemed unsatisfactory by the Engineer.

- J. Anchor bolts for poles where arms are to be perpendicular to the centerline of the street shall be installed so that a line through the center of one anchor bolt farthest from the curb and extended through the center of the adjacent anchor bolt closest to the curb will be perpendicular to the centerline of the street to within two degrees of arc unless otherwise specified.
- K. Prior to setting poles, the anchor bolts shall be covered in such a manner as to protect them against damage and to protect the public from possible injury.
- L. The Engineer prior to construction shall approve each base location. Base dimensions shown on the plans are minimum dimensions and based on stable soil conditions. Should extremely loose or sandy soil be encountered, the Contractor shall contact the Engineer for necessary base alterations.
- M. Where shown on the plans, the contractor shall remove the top of existing mast arm footings, anchor bolts, and conduits to 36 inches below the existing top of curb or edge of pavement elevation. Waste materials shall be removed from the site and disposed in accordance with local regulations. Backfilling for the removal shall be performed with mechanical compaction equipment meeting the requirements for backfilling conduit. The upper 6 inches of the removal area, if outside the proposed pavement, shall be backfilled with black dirt.

3.3 HANDHOLES

- A. Handholes shall be either built in place in an excavation made in a neat workmanlike manner or shall be a precast unit conforming to the requirements of the plans.
- B. When the use of forms is required, they shall be set level and of sufficient thickness to prevent warping or other deflections from the specified pattern. A means shall be provided for holding them rigidly in place while the concrete is being placed.
- C. The ends of all conduits leading into the handhole shall fit approximately 2 inches beyond the inside wall. A drain conforming to the dimensions shown on the plans shall be constructed in the bottom of the handhole unless otherwise specified.
- D. Frames and covers for handholes shall be made of cast iron conforming to the requirement of plans, and to the dimensions shown on the plans. Minimum weight of cover shall be 165 lbs. Lid shall have checkered top, with "TRAFFIC SIGNAL" legend and manufacturer's name on top.
- E. When installed in sidewalk or pavement, top of handhole cover shall be set flush with the sidewalk or pavement surface. When installed in an earth shoulder away from the pavement edge, the top surface of the handhole shall be approximately one inch above the surface of ground. When constructed in unpaved driveways, the top surface of the handhole shall be approximately level with the surface of the driveway.
- F. All conduit openings in the handholes shall be sealed with an approved sealing compound after the cables are in place. This compound shall be a readily workable soft plastic. It shall be workable at temperatures as low as 30 degrees F, and shall not melt or run at temperatures as high as 300 degrees F.
- G. Precast polymer concrete handholes shall be stackable, have bolted covers, and be sized 24" X 36" X 30" depth, unless otherwise specified in the Plans. Enclosures, boxes and covers are required to conform to all test provisions of ANSI/SCTE 77 "Specification for Underground Enclosure Integrity" for Tier 15 applications and must be UL labeled. In no assembly can the cover design load exceed the design load of the box. The lid shall be imprinted with the legend "TRAFFIC SIGNAL" and satisfy loading requirements of ANSI Tier 8.

3.4 CONDUIT

A. INSTALLATION

1. Conduit shall be placed as shown on the plans.
2. Conduit shall be installed without change in direction directly from one structure to another, unless approved by the Engineer. Change in direction may be allowed for physical restriction such as right-of-way restrictions, utilities, location of roadway slopes, retrofitting existing conduit stubs, and certain short sections of conduits.
3. Change in direction of rigid steel conduit, when approved, shall be accomplished by bending the conduit uniformly to a radius, which will fit the location (minimum radius 6 times the internal diameter of the conduit), or by the use of standard bends or elbows. Sharp kinks in the conduit will not be permitted.
4. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Where it is necessary to cut and thread steel conduit, exposed threads will be field galvanized.
5. All conduit and fittings shall be free from burrs and rough places. Standard manufactured elbows, nipples, tees, reducers, bends, couplings, union, etc. of the same materials and treatment as the straight conduit pipe shall be tightly connected to the conduit.
6. All conduit ends shall be provided with a bushing to protect the cable from abrasion, except for open ends of conduit being placed for future use. Bushings shall have grounding fittings, which shall be connected to the grounding system by a #6 ground wire as contained in these specifications.
7. All conduits placed for future use shall be plugged with a push penny cap and secured by electrical tape before backfill.
8. All conduits shall drain, except for specific locations approved by the Engineer. Contractor will not be allowed to bend conduits upward to accomplish the conduit clearances shown on the handhole details.

B. TRENCHING AND BACKFILLING

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

incidental to the work.

C. PUSHED CONDUIT

1. It is intended that all conduits be placed without disturbing the existing pavement, and the term "pushed" is used. "Pushed" conduit shall be placed by jacking, pushing, boring or any other means necessary to place the conduit without cutting or removing pavement.
2. Removal of pavement will require prior approval of the Traffic Engineering Division. Replacement of removed pavement will be done according to plan details and no additional payment will be made.
3. Plan quantities for pushed conduit include at least two feet of pushed conduit behind each curb.
4. The maximum conduit depth at handholes for all conduits, including pushed conduit, is as shown on the plans. Contractor must push their mole (without conduit) at least four (4) times before consideration will be given to allowing an upward bend in the conduit.

3.5 ELECTRICAL

A. All conductor cable combinations shall be shown on the plans. No substitutions will be permitted. Each signal head shall be wired separately from the handhole compartment in the pole base to the signal head.

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

Pedestrian Signals

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

5 Section Traffic Signals

Green Ball - Green
 Yellow Ball - Orange
 Red Ball - Red
 Green Arrow - Black
 Yellow Arrow - W/BK

3 Section Traffic Signals

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

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

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

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

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

Identification ties shall be marked as follows:

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

- G. Cable slack shall be as follows:

- Four (4) feet in handholes
- Two (2) feet in signal bases
- Two (2) feet in the terminal compartment of the controller base

- H. Connectors shall be of the proper size for the number and size of the wires being connected.
- I. Wire ends must be thoroughly cleaned after the insulation is stripped off to insure complete contact with another wire, or the connector. If strands are damaged when the insulation is removed, the section of the cable must be discarded. Nicked or damaged conductor strands will not be permitted inside of connectors. Loose wire ends shall not be used as "shims" to make a connection.
- J. Electrical tape shall not be applied to the finished connections. Signal cable insulation shall extend beneath the insulated portion of the connector. The contractor shall redo any connection with exposed bare wire.
- K. Covered connections must be arranged so that they will not be in contact with the metal poles. Connections in the poles shall be pointed up to prevent accumulation of moisture in the connection.
- L. Cable connections in signal heads and controller cabinets shall be made at the terminal blocks provided for this purpose. All stranded wires inserted under a binder head screw shall be equipped with a solderless pressure type spade connector with a pre-insulated shank. All solid wire shall have an eye and shall not have a terminal connector.
- M. Service cable shall be continuous from the disconnect switch located on the service pole to the terminal compartment of the controller cabinet.
- N. A tracer wire shall be installed in all conduits with signal cables, detector lead-in cables, or communication cables. The tracer wire shall be identified in the controller cabinet, handholes, and poles by means of identification tags. The tracer wire shall be spliced in the handholes to form a continuous network.

3.6 POLE ERECTION

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

- B. Leveling shall be accomplished by the use of nuts on each anchor bolt. One nut shall be turned on each anchor bolt and the pole placed in position on these nuts. The top nuts shall then be placed loosely and the pole adjusted to the vertical position by adjusting both the upper and lower nuts.
- C. After the pole is securely fastened, install the metal mesh strips in the area between the pole and the base. The metal mesh strips will be supplied by the Traffic Engineering Division and the method of attachment shall be approved by the Traffic Engineering Division.
- D. Each pole shall be grounded from the pole to the foundation ground rod by a No. 6 AWG bare copper ground wire.
- E. Poles shall be placed so that modifications and/or attachments are correctly oriented, as indicated on the plans.
- F. The foundations must be given seven days to cure before poles are erected. The center of the poles are to be set back from the curb, a distance shown on the plans. Poles shall be erected so that they are plumb with traffic signals installed, in line, and all the same relative height above the centerline of the street and with the mast arms correctly oriented as shown on the plans.
- G. Poles must be erected so that they are plumb with traffic signal heads. The manufacturer recommendation for raking should be observed when setting the pole to assure that it is plumb when the load is applied.

3.7 SIGNALS

- A. All signal faces and indicators shall be installed as shown on the plans. Pole mounted signal heads and pedestrian push buttons are shown on the plans and schematic drawings in schematic form only. Pole mounted signal heads are generally intended to be mounted on the face of pole with respect to oncoming traffic. Modifications to this are required when the view of the pole mounted signal indication is blocked. (See Paragraph 3.8 E). Pedestrian push buttons shall be installed on the face of the pole in 90° increments with respect to the mast arm. The push button shall be located on the pole face so the arrow on the R10-4 sign directs pedestrians to the appropriate crosswalk.
- B. All optically limited signal heads shall be properly masked to limit their field of view as directed by the Engineer.
- C. Backplates shall be installed and properly secured for the traffic signal heads.
- D. All signal heads shall be kept securely covered until such time as the signals are put into operation.
- E. The Engineer shall approve the location of signal heads in which the view of the indications is blocked or partially blocked by utility poles, trees or other physical obstructions. Standard heights and locations shown on the plans are typical for unobstructed locations. Signal heads installed without approval of the Engineer, which in the opinion of the Engineer are obstructed, shall be relocated at the Contractor's expense. Holes in the poles due to this signal relocation shall be plugged in a manner acceptable to the Engineer.

3.8 CONTROLLER CABINET

- A. The controller cabinet shall be mounted with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller.
- B. All field wiring must be directly attached to the wiring lugs. Attachment of wiring shall be in a neat and workmanlike manner.

- C. All conduit openings in the controller cabinet shall be sealed with an approved sealing compound. This compound shall be a readily workable at temperatures as low as 30 degrees F and shall not melt or run at temperatures as high as 300 degrees F.
- D. All wiring diagrams, service manuals, instructions for installing and maintaining the equipment and advice as to timing and operation shall be returned to the Traffic Engineering Division in good condition.
- E. The Engineer or their representative shall inspect the installation before activation and shall be present at the time the controller is activated to assure that the controller is installed in accordance with the manufacturer's recommendations.

3.9 EQUIPMENT TESTING

- A. When the Contractor's work is complete and the project is open to normal traffic, the Contractor shall notify the Engineer in writing the date the signal will be ready for testing.
- B. Initial traffic signal timings and timing adjustments will be performed by the Traffic Engineering Division.
- C. Upon concurrence of the Engineer, the Contractor shall place any signal in operation for a consecutive 30-day test period. Any failure or malfunction of the equipment supplied or installation performed by the Contractor shall be corrected at the Contractor's expense and the signal tested for an additional 30 consecutive day period. This procedure shall be repeated until the signal equipment has operated satisfactorily for 30 consecutive days.
- D. If the signal is to operate independently of other signals or signal systems, it shall be tested as a single installation.
- E. If the signal is part of a system, the test period shall not be started until all signals in the system are ready to be tested. The system shall be tested as a unit.
- F. The Contractor shall initiate correction of any failure malfunction of the signal installation within 24 hours of notification by the Traffic Engineering Division. The Traffic Engineering Division will correct any failure or malfunction of the signal installation not investigated by the Contractor within the above time period, and will deduct its expenses from the Contractor's final payment.

PART IV EQUIPMENT REQUIREMENTS

4.1 TRAFFIC ACTUATED TRAFFIC SIGNAL CONTROLLERS

A. GENERAL REQUIREMENTS

A.1. PURPOSE. It is the purpose of Section A of these specifications to set forth minimum design and functional requirements for all actuated controllers included in this specification. Controllers shall be Eagle M50 by Siemens, so as to be fully compatible and interchangeable with controllers on the City's existing ACTRA signal system and to support all features of the system including communication over Ethernet and twisted pair.

A.2. ELECTRICAL REQUIREMENT

A.2.1. POWER

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

- A.2.1.2. **VOLTAGE AND CURRENT RANGES.** The controller shall operate satisfactorily within a voltage range of 95 to 135 volts alternating current and a frequency range of 57 to 63 hertz.
- A.2.2. **CONTROLLER CONNECTIONS. NEMA Connection Requirement.** The controller shall contain a circular twist lock type connector meeting the requirements of Part 3, Section TS 1-3.05 "Pin Connections", paragraph A. NEMA Traffic Control Systems Standard TSI-1983.
- A.2.3. **OVERCURRENT PROTECTION.** The controller shall contain a front panel mounted AC power input fuse of suitable size to provide over-current protection.
- A.2.4. **AUTOMATIC REORIENTATION.** In the event of a power interruption, the controller shall be capable of automatic reorientation upon power resumption and shall require no manual initiation or switching.
- A.3. **CONSTANCY OF INTERVALS. Minimum Requirements.** The length of any interval or timing setting shall not change by more than ± 100 milliseconds from its set value, so long as the voltage and frequency of the power supply and the ambient temperature inside the controller cabinet remain within the tolerances specified in these specifications.

A.4. INTERVAL SEQUENCE

- A.4.1. **GENERAL.** The controller shall provide the proper intervals and interval sequence as required in the following section of these specifications.
- A.4.2. **REQUIRED INTERVAL SEQUENCE.** The phase and interval sequence shall be programmable to provide from two through eight phase dual ring operation with 4 overlaps as described in the latest revision of the NEMA Standards for traffic control systems.
- A.4.3. **SKIPPING OF ACTUATED PHASES.** If, prior to the end of the green interval of the terminating phase, neither vehicle nor pedestrian memory indicates a need for the next traffic phase, the intervals, which comprise that phase, shall be omitted from the interval sequence. However, once the green interval has been terminated, the phase causing the termination may not be omitted.

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

A.5. INTERVAL SETTING AND FUNCTIONS

- A.5.1. **PROVISION FOR SETTING.** The controller shall provide for the setting of each interval, portion of interval, or function by means of a positive setting on a thumbwheel switch or keyboard.
- A.5.1.1. **THUMBWHEEL switches** shall be calibrated in seconds and fractions thereof when applicable, and shall give a clear visual indication of the value of each interval or function. Setting of timing and function values shall be accomplished without the use of special tools or wiring changes.
- A.5.1.2. **KEYBOARD entry** shall have a user-friendly interface such that in every case the meaning of a number being displayed shall be clearly evident without reference to the sequence of keystrokes preceding the display and without reference to a manual or instruction sheet. The method of finding current data and of changing data shall be intuitive to the extent that little or no training is required and keystroke sequences do not need to be memorized except for security access codes.
- A.5.2. **LOCATION OF CONTROLS.** The interval and function controls shall be located on the front of the controller and shall be properly designated as to the function each control performs.
- A.5.3. **REQUIRED INTERVALS/FUNCTIONS AND RANGES.** The required intervals, portions of intervals, and

functions for each phase of operation are listed in Table 1.

TABLE 1
Functions and Timing to be Provided on Each Phase of Operation

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

*Maximum Initial may have fixed value of 30 Sec.

A.5.4. INTERVAL AND FUNCTION INDICATION

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

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

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

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

A.5.6. MAXIMUM RECALL SWITCH(S). The recall switch(s) shall provide a maximum recall position which when asserted for a phase, shall cause the automatic return of the right-of-way to that phase for

the duration of the maximum green interval in accordance with the specified interval sequence.

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

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

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

A.6. SIGNAL CIRCUITS.

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

A.6.2. CLOSING AND OPENING OF CIRCUITS/MINIMUM CAPACITY. The closing or opening of signal circuits shall be positive without objectionable dark intervals, flickering of lights, or conflicting signal indications. Each switch shall have a capacity of not less than 10 amperes of incandescent lamp load at 120 volts AC.

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

A.7. CONFLICT MONITOR MINIMUM REQUIREMENTS. For actuated controllers of solid state design and construction or actuated controllers utilizing solid state load switches, a separate external signal monitoring device shall be provided to monitor the occurrence of conflicting Green or Walk indications and shall cause the signals to go into flashing operation should such conflicts be sensed. This shall conform to Part 6, NEMA TS1-1983.

A.8. FLASHING OF SIGNALS

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

A.8.1.1. FLASHING RATE. Flashing shall be at the rate of neither less than 50 nor more than 60 flashes per minute with approximately 50% on and 50% off periods. Flashing rate shall not vary so long as the power source remains within the specified limits.

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

A.8.2. CONTROL OF FLASHER MODE.

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

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

A.8.3. FLASHING OF VEHICULAR SIGNALS. Flashing of vehicular signal indications shall be obtained from

one or more flashers, each of which is a self-contained device designed to plug into a panel in the controller cabinet. If two flashers provide the flashing, they shall be wired to assure that the flashing of all lenses on the same approach is simultaneous.

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

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

A.9. MANUAL CONTROL.

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

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

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

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

A.10. STOP TIMING.

Suitable input from auxiliary equipment or other external sources shall cause cessation of controller timing during assertion of such input. Upon removal of such input assertion, the interrupted interval, which was timing, shall resume normal timing. Provisions shall be made to insure that there is no conflict between the various inputs to this function, which would result in a stop time signal for one ring affecting the condition of the other ring.

A.11. COORDINATION

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

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

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

A.11.4. NEMA COORDINATION REQUIREMENTS. In addition to the minimum coordination requirements specified above, the controller shall contain the coordination features for the applicable configuration included in NEMA Traffic Control Systems Standard TS1-1983.

A.12. ENVIRONMENTAL AND TESTING.

A.12.1. MINIMUM REQUIREMENTS.

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

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

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

A.12.1.4. HUMIDITY. The controller shall be designed to operate properly within a relative humidity range of 0 to 95% up to 110 degrees F.

A.12.2. NEMA REQUIREMENTS.

A.12.2.1. ENVIRONMENTAL AND OPERATING. The controller shall fulfill the environmental and operating requirements as described in Part 2, Section 1, "Environmental and Operating Standards", NEMA Standards TS1-1983.

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

A.13. CABINET.

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

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

A.13.1.2. DOOR. A hinged door shall be provided permitting complete access to the interior of cabinet. When closed, the door shall fit closely to gasketing material, making the cabinet weather and dust resistant. The door shall be provided with a strong lock and key.

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

A.13.1.3. AUXILIARY DOOR. A small hinged and gasketed "door-in-door" shall be included on the outside of the main controller door. The auxiliary door shall not allow access to the controller, its associated equipment, or exposed electrical terminals but shall allow access to a small switch panel and compartment containing a signal shutdown switch, a flash control switch, and other specified functions.

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

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

A.13.1.4. DOOR STOP. The controller cabinet door shall be provided with a stop and catch

arrangement to hold the door open at angles of both 90 degrees and 180 degrees, \pm 10 degrees.

A.13.1.5. MOUNTING SHELVES. The cabinet shall contain strong mounting table(s) or sliding way(s) to accommodate the mounting of the controller and all included auxiliary equipment. The mounting facilities shall permit the controller and/or auxiliary equipment to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connections or interrupting operation of the controller.

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

A.13.1.7. OUTLET AND LAMP. An electrical outlet shall be furnished and located in an accessible place near the front of the cabinet. Each cabinet shall be provided with a light mounted in the cabinet in a manner, which will provide adequate light to service all parts of the cabinet interior during nighttime hours. The light shall be controlled by a toggle switch mounted on the inside control panel.

A.13.2. SIZE, TYPE AND MOUNTING.

A.13.2.1. SIZE. The cabinet shall be of such size to adequately house the controller, all associated electrical devices and hardware, and other auxiliary equipment herein specified.

A.13.2.2. MOUNTING. The cabinet shall be arranged and equipped for concrete base mounting on an aluminum riser. The riser shall provide 15 inch depth and shall be constructed of the same material and finish as the cabinet. Sufficient galvanized anchor bolts, clamps, nuts, hardware, etc., as required for the specified mounting type shall be furnished with each cabinet.

A.13.3. VENTILATION. A thermostatically controlled duct fan unit with a minimum rating of 100 CFM in free air shall be installed in the cabinet to provide forced air ventilation through the cabinet. The fan unit shall be mounted to the inside top of the cabinet and shall be easily removed and replaced without having to dismantle any part of the cabinet or exhaust duct system. The thermostat controlling the fan shall be manually adjustable to turn on between 90 degrees F and 150 degrees F with a differential of not more than 10 degrees F between automatic turn-on and turn-off. The fan shall intake air through filtered vents located near the bottom of the cabinet or cabinet door and exhaust it through a weatherproof, screened duct located near the top of the cabinet. Fiberglass type dry filters shall be used to cover the air intakes into the cabinet. These filters shall be easily removed and replaced and be of standard dimensions commercially available. The filters shall be provided with positive retainment on all sides to prevent warping and entry of foreign matter around the edges.

A.13.4. CONNECTING CABLES, WIRING AND PANELS.

A.13.4.1. CONNECTING CABLES. Electrical connections from the controller (and auxiliary devices when included) to outgoing and incoming circuits shall be made in such a manner that the controller (or auxiliary device) can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires leading there from. This can be accomplished by means of a multiple plug, a spring-connected mounting or approved equivalent arrangement. Correlation shall be made with connecting cable plug and controller jack as described in Subsection 2.2., Section A of this specification.

In addition to the above, a mating plug/cable assembly shall be provided for all connectors on the controller (or auxiliary device).

A.13.4.2. PANELS AND WIRING. Each cabinet shall be furnished with suitable, easily accessible wiring panel(s). All panel wiring shall be neatly arranged and firm.

A.13.4.2.1. WIRING TERMINALS. Terminals shall be provided, as a minimum, for the following:

Terminal with N.E.C. cartridge fuse receptacle, fuse, power line switch or magnetic circuit breaker, with integral power line switch, for the incoming power line.

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

Terminals and bases for signal load switches, and outgoing signal field circuits.

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

Terminals for detector cables.

Terminals for all required auxiliary equipment.

Terminals for all conflict monitor inputs and outputs.

Terminals for all NEMA defined inputs and outputs

Terminals for all inputs and outputs defined by the controller manufacturer which may be in addition to the NEMA defined inputs and outputs.

A.13.4.2.2. CLEARANCE BETWEEN TERMINALS. Adequate electrical clearance shall be provided between terminals. The controller, auxiliary equipment, panel(s), terminals and other accessories shall be so arranged within the cabinet that they will facilitate the entrance and connection of incoming conductors.

A.13.4.2.3. SIGNAL CIRCUIT POLARITY. The outgoing signal circuits shall be of the same polarity as the line side of the power service; the common return of the same polarity as the grounded side of the power service.

A.13.4.2.4. GROUNDING CONDUCTOR BUS. An equipment grounding conductor bus shall be provided in each cabinet. The bus shall be grounded to the cabinet in an approved manner.

A.13.5. FUSING AND SURGE PROTECTION.

A.13.5.1. INCOMING AC LINE. Suitable overcurrent protection, utilizing one of the methods described in Subsection A.13.4.2.1, shall be provided.

A.13.5.2. BRANCH AC CIRCUITS. Suitable overcurrent protection devices shall be provided for each of the following AC power line input circuits:

- Controller mechanism
- Cabinet fan
- Conflict monitor
- Detector amplifiers
- Flash transfer

A.13.5.3. LIGHT & OUTLET FUSE. A 15 ampere fuse and indicating type of fuse holder, wired in advance of the main circuit breaker for protection of the AC power input circuits to the cabinet light and the convenience duplex receptacle shall be provided.

A.13.5.4. SURGE PROTECTION. High-energy transient surge protection shall be provided on the incoming AC power lines in order to minimize potential controller damage. This shall be a gas discharge lightning arrester - 200-400 volts. A second such device shall be provided on

the AC power line to the controller unit.

- A.13.6. PAINTING. The cabinet shall be natural, unfinished aluminum. All mounting attachments shall be natural, unfinished aluminum or finished with two coats of high-grade aluminum colored paint.
- A.13.7. PLASTIC ENVELOPE. A heavy-duty clear plastic envelope shall be securely attached to the inside wall of the cabinet door. Minimum dimensions shall be 9 inches wide x 11 inches deep.
- A.14. GUARANTEE.
The equipment furnished shall be new, of the latest model fabricated in a first-class workmanlike manner from good quality material. The manufacturer shall replace free of charge to the purchaser any part that fails in any manner by reason of defective material or workmanship within a period of 18 months from date of shipment from the supplier's factory, but not to exceed one year from the date that the equipment was placed in operation after installation.
- A.15. WIRING DIAGRAMS AND DOCUMENTATION. One documentation package shall be supplied in each controller cabinet and three additional copies will be supplied for office use. Each package will consist of the following list of items for the cabinet and load facility and for each model of controller, conflict monitor, load switch, and flasher.
- a) Complete schematic diagram, accurate and current for unit supplied.
 - b) Complete physical description of unit.
 - c) Complete installation procedure for unit.
 - d) Specifications and assembly procedure for any attached or associated equipment required for operation.
 - e) Complete maintenance and troubleshooting procedures.
 - f) Warranty and guarantee on unit, if any.
 - g) Complete performance specifications (both electrical and mechanical) on unit.
 - h) Complete parts list - listing full names of vendors and parts not identified by universal part numbers such as JEDEC, RETMA, or EIA.
 - i) Pictorial of components layout on chassis or circuit boards.
 - j) Complete stage-by-stage explanation of circuit theory and operation.

4.2 MULTI-PHASE TRAFFIC ACTUATED CONTROLLERS

- A.1. PURPOSE. It is the purpose of this section of the Special Provision to set forth minimum design and operating requirements for multi-phase (two through eight phase) traffic actuated traffic signal controllers. Controllers shall be Eagle M50, or M52 as identified by the plans, by Siemens, so as to be fully compatible and interchangeable with controllers on the City's existing ACTRA signal system and to support all features of the system including communications over Ethernet and fiber optic cable.
- A.2. GENERAL DESIGN REQUIREMENTS. The General Design Requirements in Section A of this Special Provision shall apply in addition to certain design, operational and functional requirements hereinafter described.
- A.2.1. NEMA DESIGN REQUIREMENTS. The controller shall be designed in accordance with the applicable requirements, included in NEMA Traffic Control System Standard TS1-1983.
- A.2.2. CONTROLLER INTERCHANGEABILITY. Interchangeability of controllers furnished under this Special

Provision shall be achieved by connector plug interchangeability as designated in Part 3, NEMA Traffic Control Systems Standard TS1-1983.

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

A.3. OPERATIONAL REQUIREMENTS.

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

The controller shall also permit a non-actuated mode of operation on any of its phases by assertion of the vehicle recall function (or pedestrian recall function when such function is present) on the desired phase.

A.3.2. CALL TO NON-ACTUATED MODE. The controller shall feature an input which, when asserted, shall permit the selection of non-actuated mode of operation on any of its phases.

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

A.3.4. MINIMUM GREEN

A.3.4.1. ACTUATED PHASE. The minimum green shall consist of an initial portion only, or a separately set Minimum Green function.

If pedestrian functions are provided and a pedestrian actuation is received, the Minimum Green shall consist of a WALK interval plus a Pedestrian Clearance interval.

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

A.3.5. UNIT EXTENSION. The actuation of a vehicle detector during the extendible portion of an actuated traffic phase having the right-of-way shall cause the retention of right-of-way by that traffic phase for one Unit Extension portion from the end of the actuation but subject to the Maximum (extension limit).

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

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

A.3.8. TRANSFER OF RIGHT-OF-WAY. The actuation of any detector on a traffic phase not having the right-of-way shall cause the transfer of the right-of-way to that traffic phase at the next opportunity in the normal phase sequence provided that there has been an expiration of a Unit Extension portion with no continuing actuation or an expiration of the Maximum (extension limit) timing on the preceding phase having the right-of-way.

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

A.3.10. REST IN ABSENCE OF ACTUATION.

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

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

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

A.3.11.1. MEMORY CHANGE DURING CLEARANCE INTERVAL(S). An actuation received during a change clearance interval for a traffic phase shall cause the right-of-way to return to that phase at the next opportunity in the normal phase sequence.

A.3.11.2. MEMORY IF PHASE TERMINATED BY MAXIMUM (Extension Limit). If the right-of-way is transferred by the operation of the Maximum or extension limit, the traffic phase losing the right-of-way shall again receive it without further actuation at the next opportunity in the normal phase sequence.

A.3.12. PEDESTRIAN TIMING OPERATION. When pedestrian timing functions are specified in the General Design Requirements, Section A of this specification, the following pedestrian function operation shall be provided.

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

A.3.12.2. PEDESTRIAN TIMING WITH ACTUATED PHASE. When pedestrian actuation is received, a WALK interval shall be provided concurrently with the associated Green traffic phase interval. A flashing DON'T WALK Pedestrian Clearance interval shall follow the WALK interval during which the Green traffic phase continues to be displayed.

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

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

A.3.12.2.3. PEDESTRIAN ACTUATION MEMORY. Pedestrian actuations received by a phase during steady or flashing DON'T WALK indications of that phase shall be remembered and shall cause the controller to provide pedestrian timing functions for that phase at the next opportunity in the normal phase sequence.

A.3.12.2.4. NON-EXTENSION OF PEDESTRIAN INTERVALS. Successive pedestrian actuations shall not cause extension of the pedestrian intervals.

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

A.3.13.1. VOLUME DENSITY OPERATION.

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

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

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

A.3.14. NEMA OPERATIONAL REQUIREMENTS. In addition to the basic operational requirements specified above, the controller shall provide the operational features for the applicable configuration included in the NEMA Traffic Control Systems Standard TS1- 1983.

A.4. FUNCTIONAL REQUIREMENTS.

A.4.1. BASIC FUNCTIONAL REQUIREMENTS. Functional requirements for the multi-phase traffic actuated controller shall be as specified in the General Design Requirements in Section A of these specifications.

A.4.2. NEMA FUNCTIONAL REQUIREMENTS. In addition to the basic functional requirements specified above, the controller shall provide the functional features for the applicable configuration, included in the NEMA Traffic Control Systems Standard TS1-1983.

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

A.5. ENHANCED OPERATION.

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

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

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

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

4.3 MAST ARM ASSEMBLIES

- A. The mast arms, support poles, and luminaire arms shall be continuous tapered, round or octagon steel poles of the anchor base type. The poles and mast arms shall be a minimum of 7 gauge fabricated from one length of steel sheet with one continuous arc welded vertical seam, unless otherwise approved by the Engineer. The poles and mast arms shall be fabricated from corrosion resistant steel meeting requirements of ASTM A572 or A1011 GRADE 50 and the base and flange plates shall be fabricated from A36 structural steel. After manufacture, poles and mast arms shall have minimum yield strength of 48,000 p.s.i. The base plate shall be attached to the lower end of the shaft by a continuous arc weld on both the inside and outside of the shaft.
- B. It may be permissible to fabricate poles and mast arms by welding two sections together. Welding, fabrication, and inspection shall conform to the Iowa Department of Transportation (Iowa DOT) Standard Specifications Section 2525.06, a separate Specification. Pole manufacturers shall certify that only certified welding operators in accordance with Iowa DOT Standard Specifications were used. The welding consumables used shall be in accordance with the approved list furnished by the Iowa DOT.
- C. Personnel performing nondestructive testing shall be qualified in accordance with the American Society for Nondestructive Testing Recommended Practice No. 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 supplier and will be considered incidental.
- D. The mast arms shall be designed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals and designed to support greater traffic signals and/or signs load as listed in these documents. Fabricator shall certify that the mast arms are capable of withstanding winds up to 100 miles per hour without failure. The length of the mast arms shall be as specified on the Plan Documents.
- E. When loaded with the signals and signs the mast arms shall have a slight rise. Unloaded the maximum angle between the mast arm and horizontal shall be 2 degrees to 5 degrees depending on the length of the mast arm, unless approved by the Engineer.
- F. The pole shall be designed to support the mast arm so when it is equipped with the traffic signals and/or signs it will provide a minimum of 15.0 feet and a maximum of 19.0 feet clearance from the street surface to the bottom of the signal heads or signs.
- G. The pole shall be equipped with two reinforced handholes with covers (4" x 6½" minimum). One handhole shall be located 18 inches above the base and 180 degrees with respect to the mast arm. The second handhole shall be located directly opposite the traffic signal mast arm. Securing the cover to the pole shall be done with the use of simple tools.
- H. Provide a lug in the pole base near the handhole to permit connection of a #6 AWG grounding wire.
- I. Provide a J-hook wire support (a curved 3/8" diameter steel bar) 6" to 12" above and 90 degrees with respect to the opening for each mast arm and luminaire arm.

- J. Signal Pole and Mast Arm Loading: Traffic signal poles and mast arms shall be fabricated to the greater of the loading listed in the Plan Documents (Pole Data Table) and the following signal head and signing loads:
- a. Maximum Loading for Arms 36 to 47 Feet Long: 5-section head on end, 24"x30" sign centered 2 ft. inboard, 3-section head 12 ft. inboard, 3-section head 24 ft. inboard, 21"x120" metro sign centered 28 ft. inboard, 2 3-section pole-mounted heads, 2 2-section pole-mounted pedestrian heads, luminaire, 6" backplates on all signal heads.
 - b. Maximum Loading for Arms greater than 47 Feet Long: 5-section head on end, 24"x30" sign centered 2 ft. inboard, 3-section head 12 ft. inboard, 24"x30" sign centered 14 ft. inboard, 3-section head 24 ft. inboard, 3-section head 36 ft. inboard, 21"x120" metro sign centered 28 ft. inboard, 2 3-section pole-mounted heads, 2 2-section pole-mounted pedestrian heads, luminaire, 6" backplates on all signal heads.
- K. Unless otherwise specified on the Plan Documents, poles and mast arms shall be galvanized steel per the following:
- a. Surface Preparation
 - i. Steel plates shall be blast-cleaned as necessary to remove rolled-in mill scale, impurities, and non-metallic foreign materials. After assembly, all weld flux shall be removed.
 - ii. The iron or steel shall be degreased by immersion in caustic solution, pickled by immersion in sulfuric acid, and rinsed clean from any residual effects of the caustic or acid solutions by immersion in a fresh water bath.
 - iii. Final preparation shall be done by immersion in a concentrated zinc ammonium chloride flux solution with an acidity maintained between 4.5-5.0 pH.
 - iv. The assembly shall then be air dried to remove any moisture remaining in the flux coat and/or trapped within the product.
 - b. The assemblies shall be hot-dipped galvanized to the requirements of ASTM A123 for fabricated products or ASTM A153 for hardware items.
- L. Packaging: All parts shall be packaged, wrapped, or cradled in a manner which will insure arrival at the destination without damage to the surface.
- M. The mast arms and poles shall be equipped with all necessary hardware, shims and anchor bolts to provide for a complete installation without additional parts.
- N. The anchor bolts shall meet the requirements of F1554 Grade 105 or approved equal.
- O. Bolts attaching the arms to the pole shall meet the requirements of ASTM A325 or approved equal.
- P. The anchor bolts shall be hot dip galvanized for a minimum of 12 inches on the threaded end. The anchor bolts shall be threaded a minimum of 8 inches at one end and have a 4 inch long 90 degree bend at the other end. The Fabricator shall submit drawings for the anchor bolts and base plate design. All hardware shall be steel, hot dipped galvanized meeting the requirements of ASTM A153, Class D, or shall have an electrodeposited coating of the same coating thickness, and so designed for this purpose.

- Q. Anchor bolt covers, pole top covers, and mast arm end covers shall be gray cast iron castings conforming to ASTM Designation: A48 Class 30 or fabricated from ASTM A36 Steel.
- R. Traffic signal pole assemblies which require luminaire extensions are indicated on the Plan Documents. The pole for the luminaire extension shall provide a continuous shaft as required for the mast arm.
- S. The pole for the luminaire extension shall be vertical and shall provide a 35-ft. luminaire mounting height, unless approved by the Engineer. Luminaire arm shall be a single curved arm, unless otherwise noted on the Plan Documents.
- T. The length of the luminaire arm shall be 15 feet, and the orientation of the luminaire arm shall be 10 degrees counterclockwise from the mast arm, unless otherwise noted on the Plan Documents.
- U. A one-and-one-eighth inch (1-1/8") min. diameter hole shall be drilled in the pole directly opposite the luminaire arm attachment point and in line with the hole leading into the luminaire arm.
- V. The traffic signal assemblies without luminaire extensions shall be designed to support a future luminaire extension.
- W. The pole shall have a 1" thick steel plate welded in the top of the pole to receive the future luminaire extension. The steel plate shall be tapped unless otherwise specified on the Plan Documents.
- X. The future luminaire will be installed 35 feet above the pavement surface and the luminaire arm will extend 15 feet from the pole, unless otherwise specified on the Plan Documents.

4.4 SIGNAL HEADS

A. GENERAL

1. The signal heads shall be complete with all fittings and brackets for a complete installation. Each signal shall consist of a main body assembly, optical units, necessary screws, wing nuts, eyebolts, etc., and shall be delivered completely assembled. All hardware including hinge pins, wing nuts, eye bolts or latch bolts shall be made of a solid non-corrosive metallic material to prevent seizure or corrosion by the elements. Each signal shall be smooth both inside and outside and shall contain no sharp fins or projections of any kind. The doors and visors shall be flat black. All metal parts shall be painted with one coat of primer and two coats of a high grade Federal Black enamel. All parts of the vehicle signals shall be in compliance with the latest ITE Report on Adjustable Face Vehicle Traffic Control Signal Heads.
2. The electrical and optical system of the signal head shall be designed to operate on 115 volt, single phase, 60 Hertz alternating current.
3. All exterior surfaces shall be black.
4. Main Body Assembly of the signal unit shall consist of one or more polycarbonate sections with integral cast serrations such that when assembled with the proper brackets they may be adjusted in increments and locked securely to prevent moving. The sections shall be designed so that when assembled they interlock with one another. All joints between sections shall be waterproof. The sections shall be held firmly together by locknuts or other means approved by the Engineer. Any open end on an assembled signal face housing shall be plugged with an ornamental cap and gasket.
5. Doors and Optical Units

- a) The doors shall be made of polycarbonate. Each door shall be of the hinged type and shall be held closed by a wing nut or other approved means. The hinge pins shall be designed so that the doors may be easily removed and reinstalled without the use of special tools. Each door shall have a polycarbonate visor designed to shield each lens. The inside of each visor shall be flat black.
 - b) The optical system shall be so designed as to prevent any objectionable reflection of sun rays even at times of the day when the sun may shine directly into the lens. When the door of the optical unit is closed, all joints in the assembly between the interior and exterior of the reflector shall be closed against suitable gaskets in order that the units may be dust-tight. Between the door and the lens, there shall be a neoprene gasket securely fastened around the outer surface of the lens. Said gasket to be engaged by the rim of the reflector holder when the door is closed to render the union between the reflector holder and the door assembly dust-tight.
 - c) The reflector shall be parabolic in design and made of specular Alzak aluminum.
 - d) The reflector holder shall be of non-ferrous or rust-proofed metal and designed to separately support the reflector and socket in proper relation to the lens. The reflector holder shall be hinged to the left-hand side of the signal body when viewed from the front. On the right-hand side, the reflector holder shall be held in place by a spring catch or other quickly releasable means.
 - e) Both the hinge device and the spring catch or equivalent shall be of a flexible nature which will permit the reflector holder to be pushed inwardly for at least one-sixteenth of an inch and to align itself correctly with the lens when the door of the optical unit is closed and pressed against the rim of the reflector holder. By such means, the joint between the reflector holder and the lens shall be rendered dust-tight. It shall not be necessary to remove any screws or nuts in order to swing the reflector holder out of the body section to obtain access to the light socket.
 - f) The socket shall be arranged with a lamp grip so it will be impossible for the lamp to be loosened by vibration.
6. The wire entrance fitting shall be made of malleable iron or other approved material equipped with a standard 1 ½ inch pipe fitting for attachment to the signal head. It shall be provided with weatherproofing means so that when is attached to the top of the signal a weatherproof assembly results. Positive locking means shall be provided so that the signal cannot loosen from the fitting. The fitting shall be provided with an insulation bushing at the point where wires enter. The fitting shall be provided with self-locking features to prevent the signal head from turning out of directional adjustment in a strong wind. It shall be painted in color to match that of the signal.

B. VEHICLE SIGNALS

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

1. All indications shall use Light Emitting Diode (LED) Vehicle Signal Modules.
2. All lenses shall be prismatic and long range. The lenses shall be 12 inches in diameter. All lenses shall be made of vandal resistant polycarbonate or acrylic plastic free from bubbles and flaws. The lenses shall meet the light transitivity and chromaticity

standards established by the ITE Standard for Adjustable Face Vehicle Traffic Control Signal Heads.

3. The lamp sockets shall have a 3 inch light center length. Each socket shall be provided with one black lead from the socket and one white lead from the shell. Leads shall be of 18 gauge, stranded wire per MIL-W-76A Specifications.
4. Visors shall be of the tunnel type not less than eight inches in length and shall be designed in a manner such that the visor may be easily installed or removed from the signal head.
5. A terminal block shall be mounted in the back of the second section of the signal head. The terminal blocks shall be secured at both ends.
6. Signals shall be shipped completely assembled with tunnel visors attached to the signal door.

C. PEDESTRIAN SIGNALS

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

1. 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 combination HAND/MAN symbol LED module and a Numeric Countdown Display LED Module shall be installed in the 16" x 18" pedestrian signal head.

Signal mounting hardware shall consist of clamshell mounts. Signals shall be secured to pole by using a minimum 5/8-inch wide stainless steel banding material.

2. Pedestrian Signal LED Module

The LED Pedestrian module shall not require special tools for installation. The LED modules shall fit into 16 x 18-inch traffic signal housings.

The LED signal module shall be a single, self-containing device, not requiring on-site assembly for installation. 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 filled walking man. The symbols shall have a uniform

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

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

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

3. Pedestrian Countdown Display LED Module

The LED countdown module shall not require special tools for installation. The LED modules shall fit into 16x18-inch traffic signal housings.

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

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

The LED's shall be distributed evenly along the message outline and shall have a uniform appearance. The distance between each LED shall not vary more than 10%. The countdown digits shall be at least eight-inches high and shall be made of at least 88 LED's. There shall be no electronic components visible on the front panel of the

display face. The display face shall consist solely of LED's mounted on a mat black PCB.

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

The countdown module shall be compatible with all types of traffic controllers in existence. The countdown timer module shall have a micro-processor 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.

4. Certification

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

D. MOUNTING ASSEMBLIES

1. Mounting assemblies shall consist of 1 ½ inch standard pipe and fittings. All members shall be so fabricated such that they provide plumb, symmetrical arrangement, and securely fabricated assemblies. Construction shall be such that all conductors are concealed within assemblies. Cable guides shall be used to support and protect conductors entering assembly through poles. All threads shall be coated with rust preventive paint during assembly.
2. Support brackets, trunnions, and fittings shall be made of cast aluminum, steel, or cast iron. Bracket parts except for stainless steel parts shall be given one prime coat of metal primer and two coats of high quality Black exterior enamel.
3. Mounting assemblies shall be watertight and all open segments of the fittings shall be plugged with an ornamental plug and a gasket.
4. Mast arm mounting brackets shall be furnished with a completely adjustable stainless steel strap around arm, malleable clamp casting, vertical support tube, top and bottom signal head support with set screws, bolts, hole with rubber grommet in mast arm, and all incidentals necessary for complete installation.
5. Brackets for mounting the signal head on top of a pedestal shall provide support for both the top and bottom of the signal head.

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

4.5 TRAFFIC SIGNAL LAMPS

A. LED VEHICLE SIGNAL MODULES

1. LED Vehicle Traffic Signal Modules shall comply with the latest revision of the "Equipment and Material Standards of the Institute of Transportation Engineers: Chapter 2a: VTCSH Part 2: Light Emitting Diode (LED) Vehicle Signal Modules (Interim)"
 - Note the following:
 - "Section 5.5 Dimming (Optional)" is not required.
 - "Section 5.8 Failed State Impedance (Optional)" is required.
2. Compliance with all other sections of this standard is required.

4.6 BACKPLATES

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

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

4.7 PEDESTRIAN PUSH BUTTON DETECTORS

- A. The pushbutton shall provide a minimum 2 inch diameter aluminum ADA compliant plunger, pressure-activated so as to require no more than 3.5 lbs force to activate. LED light and audible tones shall confirm activation. The light and tones shall be momentary (not latched) and require no additional power source.
- B. The body material shall be aluminum, and powder-coated black. The entire assembly shall be weather tight and secure against electrical shock. A saddle shall be provided if necessary to secure a rigid installation and neat fit.
- C. The Contractor shall furnish and install signs with each pushbutton, identifying the associated street crossing. The signs shall be 9 inch x 12 inch, *MUTCD* Pedestrian Traffic Signal Signs, R10-4b. Combination pushbutton/ sign assemblies are not acceptable.
- D. The pushbutton shall be located on the pole so the arrow on the accompanying sign directs pedestrians to the appropriate crosswalk.

4.8 VIDEO DETECTION CABLE

- A. The Contractor shall install cable, as specified by the manufacturer, from the cabinet to each camera including 1) Belden 8281 coax or equivalent, and 2) Anixter 2A-1607 or equivalent, 7 conductor, 20 AWG cable for AC Power with ground and zoom/focus controls. The zoom/focus control wires shall be wired into the cabinet for each camera utilizing the appropriate connector to facilitate the zoom/focus process without the need for additional wiring. The connector shall mate with the connector on a zoom/focus (LAM, Lens Adjustment Module) module. The video detection cable run from the traffic signal controller to each video camera shall be continuous and unspliced.
- B. Video detection combination coaxial/power cable shall consist of a coaxial cable and a 3-conductor power cable combined within one jacket.
- C. The coaxial cable shall be #20 A.W.G. Solid BC meeting the requirements of a 75 ohm RG/U Audio/Video Coaxial Cable. The solid wire shall have a solid polyethylene covering with a nominal outside diameter of 0.196 inches. The outer polyethylene jacket shall be black in color with a minimal thickness of 0.035 inches. The outside diameter of the coaxial cable shall be 0.304 inches.
- D. The power cable shall be 3-conductor #16 A.W.G. HDPE insulation covering the conductors. The nominal thickness of the insulation shall be 0.015 inches. The color code for the conductors shall be black, white, and green. The outer PVC jacket shall be gray in color with a nominal thickness of 0.015 +/- 0.003 inches. The outside diameter of the power cable shall be 0.221 +/- 0.005 inches.

A polyethylene jacket, black in color, shall cover the coaxial cable and power cable with a nominal thickness of 0.30 +/- 0.005 inches. The outside diameter of the combination coaxial/power cable shall be a nominal 0.592 +/- 0.005 inches.

4.9 WIRELESS VEHICLE DETECTION SYSTEM

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

- B. The system shall be comprised of these principal items: in-pavement (flush to surface) wireless sensor unit at locations where detection is required, a base station at each traffic signal controller, any required amplifier units to ensure the strength of the wireless signal at the base station, along with any associated equipment required to set up the system. The equipment shall include any required mounting brackets and cable both internal and external to the traffic signal cabinet. The system shall also include any modifications to the traffic signal controller cabinet(s) necessary to provide the wireless vehicle detection.
- C. The in-pavement wireless sensor unit and the amplifier unit shall be battery powered.
- D. The Wireless Vehicle Detection System shall comply with FCC Part 15, UL, and Public Safety (Part 70).

PART IV TRAFFIC SIGNAL QUANTITIES

Schedule of Unit Prices

6TH STREET SW AND US 30 RAMPS / 50TH AVENUE COURT

No.	Item Description	Units	Estimated Unit Cost	Quantity	Extended Price
1	NEMA Traffic Signal Controller, Cabinet, Riser, Accessories	EA	\$	1	\$
2	Power Supply - Furnish and Install Meter Socket	EA	\$	1	\$
3	Concrete Cabinet Footing and Pad	EA	\$	1	\$
4	Wireless Access Points Inc. Hardware, Brackets, and Contact Closure Interface Cards	EA	\$	2	\$
5	Wireless In-Pavement Sensors - F Sensors	EA	\$	16	\$
6	Wireless In-Pavement Sensors - T Sensors	EA	\$	25	\$
7	Combination Signal Pole, 78' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base	EA	\$	1	\$
8	Combination Signal Pole, 70' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base	EA	\$	1	\$
9	Combination Signal Pole, 60' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base	EA	\$	1	\$
10	Combination Signal Pole, 48' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base	EA	\$	1	\$
11	3-Section Signal Head, 12" RYG, w/Backplate, Mast Arm Mounted (All LEDs)	EA	\$	9	\$
12	3-Section Signal Head, 12" RYG, w/Backplate, Side-of-Pole Mounted (All LEDs)	EA	\$	3	\$
13	5-Section Signal Head, 12" RYG Balls w/ YG Left Turn Arrows, w/ Backplate, Mast Arm Mounted (All LEDs)	EA	\$	2	\$
14	5-Section Signal Head, 12" RYG Balls w/ YG Right Turn Arrows, w/ Backplate, Mast Arm Mounted (All LEDs)	EA	\$	1	\$
15	5-Section Signal Head, 12" RYG Balls w/ YG Right Turn Arrows, w/ Backplate, Side-of-Pole Mounted (All LEDs)	EA	\$	1	\$
16	1-Section, 16" Countdown Hand / Man Pedestrian Head, All LEDs	EA	\$	4	\$
17	Pedestrian Pushbuttons	EA	\$	4	\$
18	2" Schedule 80 Rigid PVC Conduit, Trenched	LF	\$	415	\$
19	2" HDPE Conduit, Trenched	LF	\$	2063	\$
20	3" Schedule 80 Rigid PVC Conduit, Trenched	LF	\$	488	\$
21	4" Schedule 80 Rigid PVC Conduit, Trenched	LF	\$	32	\$
22	Pull Rope	LF	\$	3033	\$
23	Tracer Cable 1c#10	LF	\$	3033	\$
24	Bare Copper Ground #6	LF	\$	963	\$
25	1c#8 Power For Street Lighting	LF	\$	968	\$
26	1c#10 Street Lighting in Pole	LF	\$	494	\$
27	Outdoor Rated Cat5 Cable for Connecting Wireless Access Points to Cabinet	LF	\$	554	\$
28	Coax / Power / Focus Cable for Video Cameras	LF	\$	1123	\$
29	2c#14 Ped Button Detector Cable	LF	\$	505	\$
30	5c#14 Signal Cable	LF	\$	2058	\$
31	7c#14 Signal Cable	LF	\$	1592	\$
32	Concrete Base, 3.0' Diameter X 11.5' Deep Footing	EA	\$	1	\$
33	Concrete Base, 3.0' Diameter X 14.0' Deep Footing	EA	\$	1	\$
34	Concrete Base, 3.0' Diameter X 16.0' Deep Footing	EA	\$	1	\$
35	Concrete Base, 3.5' Diameter X 23.0' Deep Footing	EA	\$	1	\$
36	Handhole, Type 1, 24" Dia.	EA	\$	7	\$
37	Handhole, Type 2, 24"x36"	EA	\$	5	\$
38	RM-40 Connectors Type L1	EA	\$	2	\$
39	RM-40 Connectors Type L2	EA	\$	2	\$
40	RM-40 Connectors Type Y1	EA	\$	2	\$
41	RM-40 Connectors Type Y2	EA	\$	2	\$
42	RM-40 Connectors Type Y3	EA	\$	2	\$
43	Left Turn Yield On Green, 30"x36", R10-12, Mast Arm Mounted	EA	\$	4	\$
44	Right Turn Only, 30"x36", R3-5R, Mast Arm Mounted	EA	\$	2	\$
45	Left Turn Only, 30"x36", R3-5L, Mast Arm Mounted	EA	\$	3	\$
46	Thru Only, 30"x36", R3-5A, Mast Arm Mounted	EA	\$	1	\$
47	Pedestrian Pushbutton Signage, 9"x15", R10-4b	EA	\$	4	\$
48	Wood Utility Pole for Mounting Wireless Repeater at a Minimum Height of 30'	EA	\$	1	\$
49	Galvanized Steel Luminaire Pole with 15' Luminaire Arm for Mounting Wireless Repeater at 30'	EA	\$	1	\$
50	Remove Existing Traffic Signal Including Footings, Conduit, Poles, Cabinet, etc.	LS	\$	1	\$
51	Temporary Traffic Signal	LS	\$	1	\$

Total Project Costs = \$ _____

Approved: _____
Project Engineer Date

Equipment and Materials List

6TH STREET SW AND US 30 RAMPS / 50TH AVENUE COURT

Plan Quantity	Units	Item Description	Manufacturer	Catalog Number
1	EA	NEMA Traffic Signal Controller, Cabinet, Riser, Accessories		
1	EA	Power Supply - Furnish and Install Meter Socket		
2	EA	Wireless Access Points Inc. Hardware, Brackets, and Contact Closure Interface Cards		
16	EA	Wireless In-Pavement Sensors - F Sensors		
25	EA	Wireless In-Pavement Sensors - T Sensors		
1	EA	Combination Signal Pole, 78' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base		
1	EA	Combination Signal Pole, 70' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base		
1	EA	Combination Signal Pole, 60' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base		
1	EA	Combination Signal Pole, 48' Mast Arm, 15' Single Tapered Luminaire Arm, Anchor Base		
9	EA	3-Section Signal Head, 12" RYG, w/Backplate, Mast Arm Mounted (All LEDs)		
3	EA	3-Section Signal Head, 12" RYG, w/Backplate, Side-of-Pole Mounted (All LEDs)		
2	EA	5-Section Signal Head, 12" RYG Balls w/ YG Left Turn Arrows, w/ Backplate, Mast Arm Mounted (All LEDs)		
1	EA	5-Section Signal Head, 12" RYG Balls w/ YG Right Turn Arrows, w/ Backplate, Mast Arm Mounted (All LEDs)		
1	EA	5-Section Signal Head, 12" RYG Balls w/ YG Right Turn Arrows, w/ Backplate, Side-of-Pole Mounted (All LEDs)		
4	EA	1-Section, 16" Countdown Hand / Man Pedestrian Head, All LEDs		
4	EA	Pedestrian Pushbuttons		
415	LF	2" Schedule 80 Rigid PVC Conduit, Trenched		
2063	LF	2" HDPE Conduit, Trenched		
488	LF	3" Schedule 80 Rigid PVC Conduit, Trenched		
32	LF	4" Schedule 80 Rigid PVC Conduit, Trenched		
3033	LF	Pull Rope		
3033	LF	Tracer Cable 1c#10		
963	LF	Bare Copper Ground #6		
968	LF	1c#8 Power For Street Lighting		
494	LF	1c#10 Street Lighting in Pole		
554	LF	Outdoor Rated Cat5 Cable for Connecting Wireless Access Points to Cabinet		
1123	LF	Coax / Power / Focus Cable for Video Cameras		
505	LF	2c#14 Ped Button Detector Cable		
2058	LF	5c#14 Signal Cable		
1592	LF	7c#14 Signal Cable		
7	EA	Handhole, Type 1, 24" Dia.		
5	EA	Handhole, Type 2, 24"x36"		
2	EA	RM-40 Connectors Type L1		
2	EA	RM-40 Connectors Type L2		
2	EA	RM-40 Connectors Type Y1		
2	EA	RM-40 Connectors Type Y2		
2	EA	RM-40 Connectors Type Y3		
4	EA	Left Turn Yield On Green, 30"x36", R10-12, Mast Arm Mounted		
2	EA	Right Turn Only, 30"x36", R3-5R, Mast Arm Mounted		
3	EA	Left Turn Only, 30"x36", R3-5L, Mast Arm Mounted		
1	EA	Thru Only, 30"x36", R3-5A, Mast Arm Mounted		
4	EA	Pedestrian Pushbutton Signage, 9"x15", R10-4b		
1	EA	Galvanized Steel Luminaire Pole with 15' Luminaire Arm for Mounting Wireless Repeater at 30'		

Approved: _____
 Project Engineer Date