



Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION

Johnson County
STP-U-5557(615)--70-52

Effective Date

April 20, 2010

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 SIGNAL SPECIFICATIONS
Project Number: STP-U-5557(615)--70-52

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TRAFFIC SIGNALIZATION
STP-U-5557(615)--70-52

PART 1 GENERAL REQUIREMENTS

This part of the Special Provisions consists of the general requirements necessary when furnishing a traffic signal installation complete, in place and operative as described in the project plans and these Special Provisions.

1.01 SCOPE OF WORK

- A. The work shall consist of furnishing labor, materials and performing all work necessary to install traffic control signals for the following project in the North Liberty, Iowa: Highway 965 Improvements as shown on the plans and as specified in these Special Provisions and contract documents, as directed by the Engineer, and in those sections of the Iowa Standard Specifications for Highway and Bridge Construction, Series of 2009, that are either directly or by reference included herewith to result in a complete and finished job.
- B. Detailed Special Provisions, as included in these "Specifications and Contract Documents" or as may be embodied in the plans in the form of notes or details, modifying these Special Provisions in particular cases shall supersede and control these Special Provisions in those particulars.

1.02 EQUIPMENT AND MATERIALS

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

1. Equipment List

A list of equipment and materials to be installed will be furnished each bidder with these Special Provisions. The Contractor shall complete the list by writing in the name of the equipment manufacturer and catalog number of each item listed which they propose to install. Prior to the purchase and/or fabrication of any component equipment or material for this Project and not more than 60 days after the awarding of the Contract; the Contractor shall submit to the Engineer for review five copies of the Material and Equipment List.

Review by the Engineer of shop drawings and equipment and material lists shall not relieve the Contractor of any responsibility under the Contract or the successful completion of the work in conformity with the Plans and Special Provisions.

2. Shop Drawings and Catalog Cuts

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

- 3. Before acceptance of the work, the Contractor shall furnish the Engineer with three copies of the manufacturer's instructions for maintenance and operation of all signal equipment, wiring diagrams of the installation or system, and a parts list sufficient for the ordering of any parts.

1.03 UTILITIES

- A. Utility information on existing underground obstructions known to the Engineer are indicated on the Plans. The locations are from office records only and are generally correct, but are not guaranteed. (Service lines to individual structures or residences are not indicated, or are

indicated in approximate location only.) The Contractor shall notify owning utilities of their approach to any of the facilities and conform to the requirements. The Contractor shall perform exploratory operations as necessary to verify the location, elevation, and dimensions of all known or suspected underground obstructions ahead of any work affected thereby, and shall use care to avoid damage to them. The Contractor shall also ascertain whether any additional facilities other than those shown on the plans may be present.

1.04 STANDARD SPECIFICATIONS

- A. The Standard Specification for Highway and Bridge Construction, Series of 2009, Iowa Department of Transportation, as modified by these Special Provisions, or other appropriate special provisions shall apply to this project.
- B. The installation of the traffic control signals and appurtenances shall be in conformance with the Manual on Uniform Traffic Control Devices, latest edition.

1.05 RIGHT OF WAY

- A. The Contractor shall confine construction operations to the right-of-way, and shall use due care in placing construction tools, equipment, excavated materials, construction materials and supplies, so as to cause the least possible damage to property. The Contractor shall promptly repair at their own expense any such damages that may occur.

1.06 PROTECTION OF WORK AND CLEAN UP

- A. The Contractor shall care for all work until final completion and acceptance by the Contracting Authority. Contractor shall repair all damage done to existing improvements caused by them. The Contractor shall remove all surplus material and rubbish from the work as it accumulates and before they make the application for the acceptance of the work.

1.07 REGULATIONS AND CODE

- A. All electrical equipment shall conform to the standards of the National Electric Manufacturers Association (NEMA). In addition to the requirement of the plans and these Special Provisions, all material and work shall conform to the requirements of the National Electrical Code, the Standards of the American Society for Testing Materials (ASTM), the American Standards Association (ASA), and local ordinances.

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

1.08 CERTIFICATION OF EQUIPMENT

- A. Certification from the manufacturers of all electrical equipment, signal supports, conduit and cable shall be supplied by the Contractor stating said material complies with these Special Provisions.

1.09 REJECTED MATERIALS

- A. Rejected materials shall be immediately removed from the work site by the Contractor and shall not again be brought upon the work site. Work shall be commenced and continued at such points as may be approved by the Engineer and shall be carried out diligently and without unnecessary or unreasonable delay.

1.10 CONTRACTOR'S INVESTIGATION OF WORK

- A. It shall be the responsibility of the Contractor to examine the site of the work to determine what is required and the equipment and labor necessary for the performance of the contract. Contractor represents, by submission of a proposal for the work, that they have investigated the character of the work and conditions which may be encountered, and the quantities and types of related work, and agrees that they will complete the contract in accordance with the Plans and these Special Provisions for the prices specified in the proposal without making claim for any extras.

1.11 COPIES OF PLANS AND SPECIFICATIONS

- A. The Contractor will be furnished without cost, copies of all construction Plans and Special Provisions together with any and all addenda thereto. The Contractor shall keep one copy of all such Plans and Special Provisions constantly accessible on the work site.

1.12 TRAFFIC CONTROL

- A. The Contractor at all times shall conduct the operation in such a manner as to insure the safety of the motorist, the pedestrian, and their own employees. The Contractor shall perform work in such a manner and sequence as to maintain vehicular and pedestrian traffic at all times and to maintain access to adjacent private properties.
- B. Where excavations occur in the sidewalks or other pedestrian-ways, the Contractor shall provide a safe and orderly pedestrian passage around the excavation area. The pedestrian passage shall not subject pedestrians to hazards from traffic or construction operations nor cause pedestrians to walk upon unsuitable or hazardous surfaces.
- C. At the end of each day's work and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway or sidewalk normally open for traffic.
- D. The Contractor shall furnish, install, and maintain all devices for directing, warning and rerouting traffic flow, including warning lights, barricades, and other devices necessary to adequately inform the motorist of unusual or unsafe conditions and guide them safely through the Project work area.
- E. All required barricades and signs shall be in accordance with Part VI of the Manual On Uniform Traffic Control Devices For Streets and Highways and applicable Iowa DOT Supplemental Specifications and Standard Plans for traffic control. The total required barricades and signs would depend on the approved schedule of operation. A traffic control layout shall be submitted by the Contractor and approved by the Engineer prior to any field operations.

1.13 SCHEDULE OF UNIT PRICES

- A. Prior to any payment by the Contracting Authority for work completed on this project, the Contractor shall complete and forward to the Contracting Authority for approval three copies of a list of unit costs for each item listed on the Schedule of Unit Prices attached to the Special Provisions. The sum of the costs for each item shall equal the total Contract Lump Sum price for the traffic signal installation. Contracting Authority will make monthly estimates of the work performed on the project and the unit costs will be used to prepare progress payments to the Contractor. The unit costs will also be used to establish the total cost for any extra work orders related to traffic signal installation work items.

1.14 TESTING OF SIGNAL EQUIPMENT

- A. After the project is open to normal traffic, the Contractor shall notify the Engineer the date the signal or signal system will be ready for testing.

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

1.15 SIGNAL MAINTENANCE DURING CONSTRUCTION

- A. After signal turn on and prior to final acceptance of the completed traffic signal system, the Contractor shall respond, within 24 hours, to perform maintenance or repair of any failure or malfunction reported.

1.16 GUARANTEE

- A. In addition to the warranties or guarantees on specific traffic signal equipment listed elsewhere in these Special Provisions, the Contractor shall fully guarantee the traffic control signal installation against defective equipment, materials, and quality. Should any defect develop under normal and proper operating conditions within 12 months after acceptance of the completed installation by the Contracting Authority, this malfunction shall be corrected by, and at the expense of the Contractor, including all labor, materials, and associated costs.
- B. Contractor shall provide this guarantee in writing on Company or Corporation letterhead stationery to the Contracting Authority prior to final acceptance. The Contractor shall transfer all required equipment warranties on the date of final acceptance to the Contracting Authority.

1.17 METHOD OF MEASUREMENT

- A. The Traffic Signal Installation(s) as indicated on the plans, complete-in-place and accepted, will be measured as a unit lump sum quantity for all work necessary.

1.18 BASIS OF PAYMENT

- A. The Traffic Signal Installation(s) 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 2 INSTALLATION REQUIREMENTS

This part of the Special Provisions consists of the installation details and requirements necessary during the construction of the traffic signal installation(s) complete, in place and operative as described in the project plans and these Special Provisions.

2.01 HANDHOLES

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

The Contractor may furnish poured in place concrete handhole, with cast iron ring and cover, or precast concrete handhole, with cast iron ring and cover.

- a. The body of the precast handhole shall meet the requirements for Class 1500D concrete pipe insofar as applicable.
 - b. Cast iron ring and cover may be rated light duty for non-traffic areas (145 pounds minimum); but shall be rated heavy duty for traffic areas (320 pounds minimum) where shown on plans. Deviations in weights shall not exceed plus or minus five percent.
 - c. The cover shall have the words TRAFFIC SIGNAL cast on the top of the cover.
 - d. Cable hooks – Four cable hooks shall be provided in all handholes as detailed on the plans. Cable hooks shall be galvanized steel with a minimum diameter of 3/8 inch and a minimum length of five inches and anchored in the wall of the handhold utilizing appropriate anchoring devices.
2. Type HHIII shall be of pre-cast polymer concrete, polyester resin materials. The junction box shall be 30 inch x 48 inch style stackable type assembly with legend "Traffic Signal" on the lid and having the two stainless steel bolt lid, or approved equal by the Engineer. A minimum of four cable hooks shall be installed in each junction box to support the traffic signal cables.
 3. Handholes shall be installed in a neat and professional manner. When the use of forms is required, they shall be set level and of sufficient thickness to prevent warping or other deflections from the specified pattern. A means shall be provided for holding conduit runs rigidly in place while the concrete is placed. All conduits shall enter the handhole at a depth of 12 inches from the top of the handhole. The Engineer shall approve any deviations from this requirement. The ends of all conduits leading into the handholes shall fit approximately two inches beyond the inside wall. An aggregate drain conforming to the dimensions shown on the plan details shall be provided. Frames and covers for handholes shall be set flush with the sidewalk or pavement surface. In unpaved areas, the top surface of the handhole shall be set with the surface of the ground.

2.02 CONDUIT SYSTEM

- A. Conduit shall be placed as shown on the plans. Change in direction of conduit shall be accomplished by bending the conduit. Bends shall be made so that the conduit will not be injured or its internal diameter changed. Bends shall be of uniform curvature and the inside radius of curvature of any bend shall not be less than six times the internal diameter of the conduit.
- B. When it is necessary to cut and thread steel conduit, no exposed threads will be permitted. All couplings shall be tightened until the ends of conduits are brought together so that an electrical connection will be made throughout the entire length of the conduit run. All conduit and fittings shall be free from burrs and rough places and all conduit runs shall be cleaned, swabbed and reamed before cables are installed. Nipples shall be used to eliminate cutting and threading where short lengths of conduit are required. Where the galvanized finish on conduit has been injured in handling, such places shall be painted with zinc rich paint. All fittings used with rigid steel conduit shall be galvanized steel only.
- C. Approved conduit bushings shall be installed on the exposed ends of rigid steel conduit. Bell end fittings shall be installed on the exposed ends of PVC conduit.
- D. Conduit buried in open trenches shall be placed a minimum of 24 inches deep unless otherwise directed by the Engineer. Open trench methods of placing conduit will be permitted except where the conduit is to be placed under existing pavement. Conduit in pavement areas shall be placed to a minimum depth of 24 inches below the finished pavement surface or as directed by the Engineer. Interconnect conduit shall be placed a minimum 48 inches deep unless otherwise directed by the Engineer.
- E. The backfill material from the placement of conduit in open trenches 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. All cinders, broken concrete or other hard or abrasive materials

shall be removed and shall not be used in the backfill material. All surplus material shall be removed from the public right-of-way.

- F. Whenever excavation is made across parkways, driveways or sodded areas, the sod, topsoil, crushed stone or gravel shall be replaced or restored as nearly as possible to its original position and the whole area involved shall be left in a neat and presentable condition. Concrete sidewalks, pavements, base courses and bituminous surfaces shall be replaced with new materials. Excavation across highways or city streets will not be permitted.
- G. When the Plans require the conduit be placed without disturbing the existing pavement 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. The size of a bored hole shall not exceed the outside diameter of the conduit that is to be placed. Tunneling under the pavement or water jetting will not be permitted. Pits for boring shall not be closer than two feet to the back of curb unless otherwise directed by the Engineer.
- H. All conduit openings in the controller cabinet, handholes, and bases shall be sealed with an approved sealing compound. This compound shall be readily workable soft plastic. It shall be workable at temperatures as low as 30° F, and shall not melt or run at temperatures as high as 300° F.
- I. All conduit shall include one polypropylene Pull Rope with a minimum 600 lb proper tensile strength. All PVC and innerduct Conduit installed shall include a 1c No. 10 Tracer Wire with the exception of 1 inch conduit. The Contractor shall install, splice, and test the tracer wire for continuity. All conduit will be proofed upon completion to verify continuity and integrity of the duct.

2.03 WIRING

- A. Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, yellow to yellow, and green to green. Circuits shall be properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables.
- B. All cable runs shall be continuous from connections made in the handhole compartment of signal pole bases to the terminal compartment in the controller cabinet. Splicing will not be allowed in underground handholes unless specifically called for on the plans.
- C. Power lead-in cable runs shall be continuous from the Power Company service point to the meter socket and from the meter socket to the controller cabinet. The size and number of conductors shall be as shown on the plans.
- D. Slack for each cable shall be provided by a 4 foot length in each handhole and a 2 foot length in each signal pole or pedestal and controller base (measured from the handhole compartment in the pole to the end of the cable).
- 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 cables out of conduits into handholes. Only vegetable lubricants may be used to facilitate the pulling of cable.
- F. Loop detectors shall be connected to the controller by a 2-conductor shielded cable. These cables shall be continuous from the terminal compartment in the controller cabinet to a splice made with the detector loop leads in the first handhole or pole base provided adjacent to the detector.

2.04 CONCRETE BASES

- A. Concrete bases for poles and controllers shall conform to the dimensions shown on the plans. Excavations for these bases shall be made in a neat and professional manner. The bottom of all foundations shall rest securely on firm undisturbed ground. The material for the forms shall be of sufficient thickness to prevent warping or other deflections from the specified pattern. The forms shall be set level or sloped slightly to blend with the adjacent ground level and means shall be provided for holding them rigidly in place while the concrete is being deposited. All conduits and anchor bolts shall be installed and held rigidly in place before concrete is deposited in the forms. A ground rod shall be placed at each pole and controller base as shown on the plans. Anchor bolts for the signal poles or the controller pads shall be set in place by means of a template constructed to space the anchor bolts in accordance with the manufacturer's requirements. The center of the template and the center of the concrete base shall coincide unless the Engineer shall direct otherwise. Concrete shall be consolidated by vibration during placement.
- B. The top of the base shall be finished level and the top edges shall be rounded with an edger having a radius of $\frac{1}{2}$ inch. The top 10 inches of the base shall be formed square. In sidewalk areas, adjacent to sidewalks, or in other paved areas, the top of the base shall be flush with the surrounding paved area and preformed expansion material shall be provided between the base and the other paved area. When installed in an earth shoulder away from the pavement edge, the top of the concrete base shall be approximately 2 inches above the surface of the ground. The exposed surface of the base shall have a rubbed surface finish.
- C. After the foundation or base has been poured, absolutely no modification of any sort may be made. If the anchor bolts, conduit, or any part of the foundation or base is installed in an incorrect manner as determined by the Engineer, the entire foundation or base shall be removed and a new foundation or base installed at the Contractor's expense.
- D. Prior to setting poles, the anchor bolts shall be covered in such a manner as to protect them against damage and to protect the public from possible injury. The foundations must be given seven days to cure before poles are erected.

2.05 BONDING AND GROUNDING

- A. All conduit, steel poles and pedestals shall be bonded to form a continuous system, and be effectively grounded. Bonding jumpers shall be No. 6 A.W.G. bare copper wire or equal connected by approved clamps.
- B. Grounding of the conduit and neutral at the service point shall be accomplished as required by the National Electric Safety Code, except bonding jumpers shall be No. 6 A.W.G. or equal.
- C. Ground electrodes shall be provided at each signal pole and pedestal and at the controller as detailed on the plans.
- D. A No. 6 A.W.G. bare copper ground wire shall be installed in all PVC conduit that carries 120-volt signal cables.

2.06 SIGNAL APPURTENANCES

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

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

B. Controller Cabinet

1. The controller cabinet shall be installed at the location indicated on the plans with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller, unless otherwise directed by the Engineer.
2. All conduit openings in the controller cabinet shall be sealed with an approved sealing compound. This compound shall be a readily workable soft plastic. It shall be workable at temperatures as low as 30° F, and shall not melt or run at temperatures as high as 300° F. The controller cabinet shall be installed on pre-placed caulking material on the concrete base. After the cabinet is installed in place, the Contractor shall also place caulking material around the base of the cabinet.

C. Pole Erection

1. All poles shall be erected vertically, with mast arms oriented at 90 degrees to the curb line, unless otherwise specified. The bases shall be securely bolted to the cast-in-place concrete foundations. Leveling shall be accomplished by the use of metal shims and/or one nut or two nuts on each anchor 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 turned into place loosely and the pole adjusted to the vertical position by adjusting both the upper and lower nuts. After leveling the poles, mortar shall be troweled between the pole base and the foundation. Where metal shims are used for leveling, caulking material shall be placed between the pole base and foundation. If grout or caulk is placed around the pole base, a weep hole shall be left in the material to allow water to drain from inside the base.
2. Exposed edges of mortar shall be neatly finished to present a pleasing appearance. Mortar shall be of the expansive type. Each pole shall be grounded by installing a No. 6 A.W.G. bare copper ground wire between the pole and the ground rod at the foundation.

D. Painting

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

2.07 REPLACING DAMAGED IMPROVEMENTS

- A. Improvements such as sidewalks, curbs, driveways, roadway pavement and any other improvements removed, broken, or damaged by the Contractor shall be replaced or reconstructed with the same kind of materials found on the work or with materials of equal quality. The new work shall be left in serviceable condition satisfactory to the Engineer. Whenever a part of a square or slab of existing concrete sidewalk, driveway, or pavement is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed.
- B. Surface restoration shall be considered incidental to the bid items of the project and will not be paid for separately.

2.08 LOOP DETECTOR INSTALLATION

- A. The detector loop wire shall be inserted into a flexible plastic tubing for the full length from the point of splicing and placed into the slot with the number of turns specified. The tubing shall be of a continuous length from the point of splicing of the loop wire to the lead-in cable. The field loop conductors installed in the pavement shall run continuously from the terminating handhole or base with no splices permitted. The field loop conductors shall be spliced to the lead-in cable and the lead-in cable shall run continuously from the terminating handhole or base to the detector-sensing unit except on multiple loop installations where additional loop conductors may be spliced

- to the lead-in cable as directed by the Engineer. At the time of placing the loop wire in the sawed slots, the ends of the tubing shall be sealed to prevent any entrance of moisture into the tubing.
- B. All lengths of loop wires and tubing that are not embedded in the pavement shall be twisted with at least five turns per foot, including lengths in conduits and handholes.
- C. The electrical splice between the loop lead-in cable to the controller and the loop wire shall be soldered using resin core solder and provided with a watertight protective covering for the spliced wire, the shielding on the loop lead-ins and the end of the tubing containing the loop wires. **The use of open flame to heat the wire connection will not be permitted. The Contractor shall use a soldering iron, gun, or torch equipped with a soldering tip.** The splice shall be made by the following method:
1. Remove all lead-in cable coverings leaving 4 inches of insulated wire exposed.
 2. Remove the insulation from each conductor of a pair of lead-in cable conductors and scrape both copper conductors with knife until bright.
 3. Remove the plastic tubing from the loop wires for 1 1/2 inches.
 4. Remove the insulation from the loop wires and scrape both copper conductors with knife until bright.
 5. Wash the exposed copper conductors with turpentine spirits to clean the conductors.
 6. A soldered "Western Union" type splice, wrapped with waterproof tape and coated with a watertight protective covering shall connect the conductors.
 7. Cover the exposed shielding, ground wire and end of any unused loop lead-in where the sheathing was cut, with liquid silicone rubber. Apply rubber polymer tape sealant between the wires and completely cover the silicone rubber. As an acceptable alternate, the Contractor may use a Scotchcast Kit for splices.
- D. The saw used to cut saw slots shall be equipped with a depth gauge and horizontal guide to assure proper depth and alignment of the slot. The blade used for the saw cut shall provide a clean, straight, well-defined 3/8 inch wide saw cut without damage to adjacent areas. The depth of the saw cut shall be 2 inches. Where the loop changes direction, the saw cuts shall be overlapped to provide full depth at all corners. Right angle or corners less than 90 degrees shall not be used.
- E. Before installing the loop wire, the saw cuts shall be checked for the presence of jagged edges or protrusions. Should these exist, they must be removed. The slots must be cleaned and dried to remove cutting dust, grit, oil, moisture or other contaminants. Cleaning shall be achieved by flushing clean with a stream of water under pressure, and following this, the slots should be cleared of water and dried using oil-free compressed air.
- F. Loop detector conductor shall be installed using a 3/16 inch to 1/4 inch thick wood paddle. If the wire does not lie close to the bottom of the saw cut, it shall be held down by means of a material such as tape or doubled-over pieces of the plastic tubing.
- G. Each loop shall be coiled as indicated by the Engineer and the beginning conductor banded in the terminating handhole or base with a symbol "S" to denote start of conductor. Phase or function shall further identify each loop as shown on the project plans, with durable tags, or as directed by the Engineer. Loops which are physically adjacent in an individual lane or adjacent lanes shall be wound with opposite rotation (i.e. #1 CW, #2 CCW, #3 CW, etc.). Rotation reversal can be accomplished by reversing leads at the handhole.
- H. Multiple loop configurations, spliced to a single lead-in loop, to be connected in series shall have the "S" conductor of one loop connected to the unbanded conductor of the adjacent loop.
- I. After the installation of loops, the Contractor should meter the loops by test instruments capable of measuring electrical values of installed loop wires and lead-ins to measure inductance in microhenries and leakage resistance in megohms. The Contractor shall also provide the

Engineer with a report on company letterhead indicating the inductance and leakage to ground test values for each loop. The test shall be conducted from the curbside handhole. An inductance and leakage to ground test shall also be conducted and reported for the total detector lead-in and loop system with the test being conducted at the controller cabinet. Before beginning the required test period, the Engineer may independently meter any or all loops. Should any loop be found unacceptable, the Contractor may be required to complete additional tests, as required, at their own expense. The values indicated are for tests on a single loop at curbside.

An acceptable loop installation shall be defined as follows:

Inductance:

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

Leakage to Ground:

Deflection of the pointer to above 100 megohms.

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

An unacceptable loop installation shall be defined as follows:

Inductance:

The inductance reading is below the calculated value.

Leakage to Ground:

Deflection of the pointer to below 100 megohms.

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

2.09 STREET NAME SIGNS

- A. All signs shall be handled and installed carefully to prevent any damage to the sign faces. Any sign faces which are damaged prior to or as a result of improper installation will be rejected. Undamaged replacement signs shall then be promptly sent, at no extra cost to the City of North Liberty.

Sign mounting hardware shall include stainless steel bolts, washers, strapping, mounting brackets, etc.

Overhead mount:	18 inches x 48 inches - minimum of 2 places
	18 inches x 60 inches - minimum of 3 places
	18 inches x 72 inches - minimum of 3 places

Pole mount:	12 inches x 36 inches - mount on bracket which is banded directly to pole. Greater than 36 inches - add stiffener
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PART 3 MATERIAL REQUIREMENTS

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

3.01 GENERAL MATERIAL REQUIREMENTS

- A. All materials used in the fabrication or assembly of the items listed below shall comply with the applicable parts of Section 2523 "Highway Lighting" of the "2009 Standard Specifications" with the additions as stated herein.
- B. Unless otherwise noted on the plans or in these Special Provisions all materials furnished shall be of new stock. New materials shall be the products of reputable suppliers and manufacturers approved by the Engineer. Miscellaneous electrical equipment and materials shall be UL approved.
- C. Materials delivered to the project shall be stored at a secure site and shall be protected from damage due to inclement weather prior to installation.
- D. Upon request by the Engineer, appropriate quantities of materials shall be made available by the Contractor for material testing purposes.

3.02 CONCRETE

- A. Concrete for concrete bases shall be Class C structural concrete meeting the requirements of Section 2403 of the Standard Specifications.

3.03 CONDUIT

- A. General
 - 1. The number, type, and size of conduit shall be as shown on the plans.
 - 2. Conduit shall meet the requirements of Sections 2523.10 and 4185.10 of the Standard Specifications.
- B. Rigid Steel Conduit
 - 1. Conduit shown on the plans as rigid steel shall be galvanized steel meeting the requirements of ANSI Standard Specification C80.1, latest revision.
- C. Polyvinyl Chloride Conduit
 - 1. Conduit shown on the plans as polyvinyl chloride (PVC) shall be rigid polyvinyl chloride conduit meeting the requirements of NEMA TC-2, Type 2, and applicable UL Standards.

3.04 REINFORCING STEEL

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

3.05 TRAFFIC SIGNS

- A. Traffic signs shall conform to the requirements of Section 4186 of the Standard Specifications.
- B. Street name signs shall be manufactured utilizing "VIP Diamond grade" reflectorized sheeting material. The letters shall be Series B or C Caps, with a height of 8 inches. The legend and border shall be white and the background shall be green. The border shall be 0.75 inches in width. The signs shall be single faced. The corners of the sign blank shall have a 1.5 inch radius.
- C. Traffic signs and street name signs shall be mounted on the mast arms utilizing a universally adjustable mast arm mounted street name sign bracket.

3.06 ELECTRICAL CABLE

A. General

1. Electrical cable for intersection signalization shall be rated 600 volts minimum.
2. The number of conductors and size of all electrical cable shall be as shown on the plans.
3. All wire shall be plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.

B. Power Lead-In Cable

1. Power lead-in cable shall be of the sizes as shown on the plans.
2. Power lead-in cable shall be 600 volt, single conductor, stranded copper, Type USE, with UL approval.

C. Signal Cable

1. Signal cable shall be 600 volt, multi-conductor, with copper conductors of the number and size shown on the plans.
2. Signal cable shall meet the requirements of the International Municipal Signal Association (IMSA) Specification 19-1, latest revision thereof for polyethylene insulated, polyvinyl chloride jacketed signal cable. All conductors shall be No. 14 A.W.G. unless otherwise specified on the plans.

D. Loop Detector Wire (With Plastic Tubing)

1. The loop wire shall meet the requirements of the International Municipal Signal Association (IMSA) Specifications 51-5, latest revision thereof for polyvinyl chloride insulated, nylon jacketed, loosely encased in a polyvinyl chloride or a polyethylene tube loop, detector wire. The conductor shall be No. 14 A.W.G. unless otherwise specified on the plans.

E. Detector Lead-In Cable

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

F. Video Cable

1. The video cable to be used between the video detection camera and the controller cabinet shall be a hybrid composite, 6 conductor, 2 element video cable with a 20 gauge solid bare copper conductor with foam polyethylene insulation, and a 5 conductor 18 gauge 7/26 bare copper with polyethylene insulation. The overall assembly shall be jacketed with black PVC. This cable shall be suitable for installation in conduit or overhead with appropriate span wire and shall be manufacturer by Isotec Inc.

G. Luminaire Wire

1. Cable for streetlights shall be THHN (90 degree C) stranded No. 8 AWG. Use for lighting circuits.

H. Tracer Wire

1. A tracer wire shall be installed in all conduits with signal cables, detector cables, or communications cables.
2. The tracer wire shall be a No. 10 A.W.G. wire.
3. The tracer wire shall be a single conductor, stranded copper, Type THHN, with UL approved and an orange colored jacket.
4. The tracer wire shall be spliced in the handholes to form a continuous network.

3.07 LOOP DETECTOR SAW SLOT FILLER

- A. The saw slot filler shall be a rapid cure, high viscosity, liquid epoxy, or approved equal, formulated for use in sealing inductive wire loops and leads embedded in asphaltic concrete and portland cement concrete. The saw slot filler shall be usable on grades of 15 percent or less without excessive flow of material, unless otherwise approved by the Engineer.
- B. The epoxy sealer shall be a two component system that consists of a resin constituent identified as pourable and a hardener identified as quick setting.
- C. The cured sealer shall be unaffected by oils, gasoline, grease, acids and most alkalis. The mixing of components and the filling of the cut shall be in accordance with the directions of the manufacturer.

PART 4 EQUIPMENT REQUIREMENTS

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

4.01 GENERAL REQUIREMENTS

- A. All materials used in the fabrication or assembly of the items listed below shall comply with the applicable parts of Section 2523 "Highway Lighting" of the "2009 Standard Specifications" with the additions as stated herein.
- B. Unless otherwise noted on the plans or in this specification, all materials furnished shall be new and in so far as practicable, major items of signal control equipment should be of the same type and consist of products of the same supplier in order to secure uniformity, single responsibility and most satisfactory service. Unless specifically noted otherwise, all signalization equipment shall be similar to the best grade of this type of equipment.
- C. The Contractor shall install all of the equipment and wiring necessary for intersection signalization as indicated on the plans and in accordance with this specification.
- D. The traffic signal system shall be complete, and the Contractor shall furnish and install all equipment necessary for the satisfactory operation of electrical apparatus and for the complete operation of the traffic signal system whether specifically mentioned or not.

4.02 ACTUATED CONTROLLER, CABINET AND AUXILIARY EQUIPMENT

- A. General
 - 1. The local intersection controller shall be series 820A OSAM Traffic Controller as manufactured by IDC Multisonics Corporation. The controller shall be fully compatible and interchangeable with the existing local controllers and operated with OSAM32 master system in the City of North Liberty.
 - 2. The controller to be provided shall provide two through eight-phase operation.
 - 3. The controller shall provide fully prompted, menu driven programmability.
 - 4. The controller shall provide the following internal functions:
 - a. Provision of a local time base scheduler including automatic accommodation for day light savings time.
 - b. Provision for local coordination control.
 - c. Provision for local preemption control with at least four (4) programmable internal preemption sequences.
 - d. Provide local control of remotely selected NEMA and special functions.
 - 5. The controller shall be microprocessor type, modular, solid state providing the phasing and operation as shown on the plans. The controller shall be designed for use on nominal 120 volt, 60 Hz, single-phase alternating current.
 - 6. The controller unit shall utilize digital timing concepts for interval settings for all phases and shall contain vehicular and pedestrian circuits and timing functions for all phases.
 - 7. The controller equipment furnished shall be new, of the latest model, fabricated in a first-class professional manner from good quality material. The manufacturer shall replace free of charge to the Contractor and/or Contracting Authority any part that fails in any manner by reason of defective material or quality within a period of 12 months from the date that the equipment was placed into operation following installation.
- B. Components
 - 1. The controller unit shall use modern integrated circuits and computer technology to the fullest extent feasible and incorporate digital timing techniques.

2. All component parts and terminals shall be readily accessible when the controller modules are removed from the enclosure for adjustments, testing or service.
3. The controller unit shall be designed so that the length of interval, portion, period or unit extension shall not deviate by more than plus or minus 100 milliseconds from its set value at a power source frequency of 60 Hz.

C. Chassis

1. The controller unit shall be modular in design. Modules shall be removable and inserted without the use of any tools. Modules of unlike function shall be mechanically keyed or electrically inter-locked to prevent insertion into the wrong opening. All modules of the same function shall be interchangeable.
2. The front panel of the unit shall be permanently marked to identify the fuses, indicators, switches, controls, etc. so that the operation of the controller shall be readily apparent.
3. The control devices, indicators, fuse holders, switches, input/output connectors, and other components required for the operation and adjustment of the timer shall be mounted on the front panel.
4. Certification of a manufacturer's controller assembly by an independent testing laboratory shall be provided to the Engineer. This certification shall indicate that the manufacturer's controller assembly is in accordance with the environmental standards and meets the test procedures as specified in the NEMA Standard No. TS1-1983.
5. All components shall be amply de-rated with regard to heat dissipating capacity and rated voltage so that, with maximum ambient temperatures and maximum applied voltage, a material shortening of life or shift in values shall not occur.
6. The design life of all components under 24 hours a day operating conditions in their circuit applications shall not be less than five years.
7. Controller timing shall be set by means of a front-panel keyboard. Momentary contact pushbuttons shall be used for entering numeric data.

D. Interval Programming

1. The controller unit shall provide for setting of the timing of each interval or period by means of keyboard pushbutton switches.
2. The controller unit shall utilize fully prompted, menu programmability to input controller data.
3. The keyboard and switches shall be on the front panel of the unit. They shall be easily identifiable and it shall not be necessary to remove or change wires or contacts or to use any tools in making interval adjustments.
4. Each phase shall have identical control parameters that may be independently set for each phase.
5. The controller unit shall be capable of providing functions with the following minimum timing ranges and timing increments:

FUNCTION	RANGE (SEC)	INCREMENTS (SEC)
Minimum Green	0-99	1.0
Passage	0-9.9	0.1
Maximum Green 1	0-99	1.0
Maximum Green 2	0-99	1.0
Yellow Clearance	3-9.9	0.1
Red Clearance	0-9.9	0.1
Red Revert	2-9.9	0.1
Walk	0-99	1.0
Pedestrian Clearance	0-99	1.0
Seconds Per Actuation	0-9.9	0.1
Time to Reduce	0-99	1.0
Time Before Reduction	0-99	1.0
Minimum Gap	0-9.9	0.1

6. Indications shall be provided and appropriately labeled to facilitate the determination of the operation of the controller unit. These indications shall consist of the following, as a minimum:
 - a. Phase or phases in service.
 - b. Phase or phases next to be serviced.
 - c. Presence of vehicle call, including memory and detector actuations.
 - d. Presence of a pedestrian call.
 - e. Ring status indicators, including the following: Minimum Green; Passage; Yellow Clearance; Red Clearance; Walk; Pedestrian Clearance; Reason for Termination; and Rest State.
 7. The controller unit shall be capable of programming each phase to operate in the following modes through the keyboard push button switches or separate function switches.
 - a. Nonlocking vehicle detector memory.
 - b. Locking vehicle detector memory.
 - c. Vehicle recall.
 - d. Pedestrian recall.
 - e. Recall to maximum green.
 8. All operator keyboard entered data shall be retained in a memory medium that does not require battery backup.
 9. Means shall be provided to control the flashing of pedestrian signals during the pedestrian clearance interval(s).
 10. The signal phasing and interval sequence shall be as shown on the plans.
- E. Operational Requirements
1. The controller shall provide multi-phase operation and shall be fully actuated with means for receiving actuation on all phases.
 2. The controller shall permit a non-actuated mode of operation on any of the phases by assertion of the vehicle recall function of the desired phase.
 3. The actuation of a vehicle detector during the extendible portion of an actuated traffic phase having the right-of-way shall cause the retention of right-of-way by the traffic phase for the set Passage Time from the end of the actuation but subject to the Maximum. The

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

4. The timing of the Maximum Green shall commence with one of the following:
 - a. With the first actuation or demand for right-of-way on a traffic phase not having the right-of-way.
 - b. At the beginning of the Green interval if an actuation or demand for right-of-way has been previously registered on a traffic phase not having right-of-way.
5. In the absence of detector actuations or assertion of recall switches, the right-of-way indications shall remain on the traffic phase on which the last actuation occurred.
6. The transfer of right-of-way to conflicting phases shall occur only after the display of the appropriate change clearance intervals.
7. 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.
8. 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.
9. When pedestrian actuation is received a WALK interval shall be provided concurrently with the associated Green traffic phase interval. A flashing DON'T WALK Pedestrian Clearance interval shall follow the WALK interval during which the Green traffic phase continues to be displayed. A steady DON'T WALK shall follow the flashing DON'T WALK.
10. In absence of pedestrian actuation or the assertion of pedestrian recall function, pedestrian signals shall remain in a steady DON'T WALK condition.
11. Pedestrian actuations received by a phase during steady or flashing DON'T WALK indications of that phase shall be remembered and shall cause the controller to provide pedestrian timing functions for that phase at the next opportunity in the normal phase sequence. Successive pedestrian actuations shall not cause extension of pedestrian intervals.
12. During coordination operation, if phases are placed in a pedestrian recall mode of operation to operate the controller as a pretimed controller, the WALK intervals of the non-coordinated phases shall automatically adjust with changes in the timing plans to provide the maximum amount of WALK interval possible in the phase. The adjustment of the WALK interval for the non-coordinated phases shall be similar to the adjustment in the WALK interval for the coordinated phases with timing plan changes.

F. Cabinet

1. The controller and all associated equipment shall be furnished completely housed in a sturdy aluminum cabinet. The cabinet shall be of clean-cut design and appearance having no sharp edges, corners or projections. The size of the cabinet shall be such as to provide ample space for housing the controller and all associated electrical and auxiliary devices which are to be furnished with it as herein specified. A hinged door, with an approved doorstop assembly, shall be provided permitting complete access to the interior of the cabinet. When closed, the door shall fit closely to neoprene or other suitable gasketing material, making the cabinet weatherproof and dust-tight. The door shall be provided with a strong lock and two sets of keys. The door hinges and pins shall be of a non-corroding material.
2. In addition to the main door of the controller cabinet, there shall be an auxiliary police door provided in the main door provided with a strong lock and keys of different design than that of the main door of the cabinet. The panel behind the auxiliary police door shall contain a switch to change from normal function to flashing and vice versa. When placed in the flashing operation, the switch shall cause the signals to display the flashing indication identified in the signal sequence diagram. The signal control shall remain in full operation. A signal on-off switch shall also be provided to interrupt power to the signal heads only and continue controller operation.

3. The aluminum exterior surfaces of the controller cabinet shall be unpainted.
4. The cabinet shall contain strong mounting tables, sliding ways, or other suitable supports for the controller and associated equipment.
5. All field terminals shall be suitably identified and accessible without removal of equipment contained in the cabinet.
6. A heavy-duty clear plastic envelope, securely attached to the inside wall of the cabinet or cabinet door, shall be provided for stowing cabinet electrical prints. Minimum dimensions shall be 9 inches wide x 11 inches deep.
7. The cabinet shall be furnished with all of the hardware necessary for assembly and installation. The cabinet shall be base mounted.
8. The cabinet shall contain a ventilating fan controlled by a thermostat and suitable dust filters for the capacity of the ventilating system. The filters shall be of the dry type and easily removed and replaced and be of standard dimensions commercially available.
9. The cabinet shall be provided with at least a 16-position back panel. The 16-position back panel shall be wired for 16 load switches to control 8 vehicle phases, 4 overlap movements, and 4 pedestrian phases consecutively from left to right.
10. The cabinet shall be mounted on an 18-inch high aluminum riser manufactured from the material similar to the cabinet.

G. Electrical Design

1. The distribution of the 117 VAC throughout the cabinet shall not occur until the AC+ has first passed through the power protection devices.
2. The cabinet shall be provided with power protection devices that include the main AC+ power circuit breakers, radio interference suppressors, and lightning and surge protectors. These devices shall be in addition to any protection devices furnished with the controller and auxiliary equipment. The protection devices shall be mounted on a panel that is securely fastened to an interior wall of the cabinet.

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

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

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

- a. The unit must be capable of withstanding repeated 20,000-ampere surges (minimum of 25).
- b. The unit must have internal follow current limiters (resistive elements).
- c. The unit shall contain a minimum of three active clamping stages.
- d. The unit must self-extinguish within 8.3 milliseconds after trailing edge surge.
- e. Parallel impedance of limiters must be less than 15 ohms.
3. External surge protection to the communications cables is required. The communications cable surge protector shall meet the following requirements:
 - a. The unit must be a two-stage protector intended for use on data or communications pairs.
 - b. The peak surge current for the unit shall be 10K amperes.
 - c. The unit must be able to withstand at least 100 2,000-ampere surges.
 - d. The response time for the unit shall be less than 5 nanoseconds.
 - e. The unit shall be epoxy encapsulated.

4. The controller shall contain a connector enabling outgoing and incoming electrical circuits to be connected or disconnected easily without the necessity of installing or removing individual wires. The connector may be a multiple pin jack, a spring connected mounting, or approved equivalent mounting. 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.
5. Electrical connections from the controller and auxiliary devices to outgoing and incoming circuits shall be made in such a manner that the controller or auxiliary device can be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires. This may be accomplished by means of a multiple plug, a spring connected mounting or approved equivalent arrangement.
6. All cabinet wiring shall be neatly trained throughout the cabinet and attached to the interior panels using nonconductive clamps or tie-wraps. Bundles of cables shall be laced or tied or enclosed in a sheathing material. The cabinet wiring shall not interfere with the entrance, training, or connection of the incoming or outgoing field conductors. Except where terminated by direct soldering, all wires shall be provided with terminal lugs for attachment to terminal blocks using screws. All wires shall be identified and labeled in accordance with the cabinet wiring prints. All wire insulation shall have a minimum rating of 600 volts.
7. A maintenance panel containing test switches shall be located on the inside of the main door. These switches shall include the following:
 - a. Controller Power Switch.
 - b. Detector Test Switches.
 - c. Stop Time Switch.
 - d. Signal Flash Switch.
8. An AC+ convenience outlet with a 3-wire grounding type receptacle shall be provided and be easily accessible. This receptacle and the incandescent lamp shall be separately fused from the main AC+ circuit breaker. The outlet shall be provided with ground fault protection.
9. The unit shall contain a power and flash transfer relay assembly to transfer the AC+ power and operation from the controller and load switches to the solid state flasher. Either the "AUTO-FLASH" mode switch located on the Police Panel or the conflict monitor shall control this transfer relay assembly. The flasher shall remain operational with the controller removed from the cabinet. The rate of flash shall be 50-60 flashes per minute with equal on and off intervals. The cabinet shall be wired to flash as shown on the plans. The plug-in transfer relays shall be rated at a minimum of 10 amps per pole and shall be enclosed in a transparent case for protection against dust and for visual observance of operation.
10. The cabinet shall be furnished with two incandescent lamps. One lamp shall have a goose neck assembly. The lamp shall be equipped with a 25 Watt, R14 bulb. The second lamp receptacle shall be mounted on the interior wall of the cabinet and shall accommodate a standard base light bulb. Manual switches mounted on the maintenance panel shall control these lamps. The lamps shall be fused and connected with the convenience outlet as referenced above.
11. The cabinet duct fan unit shall be fused separately and wired after the main AC+ circuit breaker.
12. Molded composition barrier type terminal blocks shall be used for termination of the incoming and outgoing signals within the cabinet assembly. Each terminal block shall be of one-piece construction with a minimum of 12 terminals. Each terminal shall have a threaded contact plate with a binder head screw. The terminal blocks shall have a minimum rating of 600 volts.

All terminals shall be identified and labeled in accordance with the cabinet-wiring diagram.

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

The minimum terminals are as follows:

- a. Terminal with circuit breaker with integral power line switch for the incoming power line.
- b. Terminal unfused for the neutral side of the incoming power line.
- c. Terminals and bases for each vehicle and pedestrian signal circuit. The terminals for the vehicle and pedestrian signal circuits shall be provided with lug type connectors.
- d. Terminals for vehicle phase detector and pedestrian pushbutton cables. Terminals for vehicle detectors include AC+, AC neutral, relay common, relay closure, and the loops or probes from the field.
- e. Terminals and bases for signal flasher and outgoing signal field circuits.
- f. Terminals for all controller input and output circuits including those circuits not used on the project.
- g. Terminals for all required auxiliary equipment.

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.

13. The outgoing signal circuit shall be of the same polarity as the line (+) side of the power service. The incoming signal indication conductors shall be common and of the same polarity as the grounded (-) side of the power service. The neutral (-) side of the power service shall be connected to the cabinet in an approved manner to a copper ground bus located on the panel with the main AC+ circuit breaker. The cabinet shall, in turn, be connected to an earth ground through a ground rod.
14. All load switches shall conform to the triple-signal solid state type load switch as specified in the NEMA Standard No. TS1-1983. Dual-signal type load switches shall not be allowed. LED indicator lights shall be provided on the front of the load switch to designate the active circuit.
15. A Solid State conflict monitor shall be provided and located within the cabinet external to and electrically independent of the controller unit and enclosed in a finished metal case. The monitor shall detect the occurrence of conflicting Green, Yellow or Walk indications and shall cause the signals to go into predetermined flashing operation with stop timing applied simultaneously to the time should conflicts be sensed. The conflict monitor shall conform to the specifications of NEMA TS1-1983 and shall be compatible with the controller.

The conflict monitor shall utilize liquid crystal displays providing four indicators that display an active Red, Yellow, Green, and Walk input for each channel monitored. The conflict monitor shall be equipped with an Ethernet communications port.

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

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

Flashing shall be at the rate of not less than 50 or more than 60 flashes per minute with approximately 50 percent on and 50 percent off periods. Flashing rate shall not vary so long as the power source remains within the specified limits.

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

17. Cabinets shall each be equipped with a splice/termination enclosure. This enclosure shall be mounted in a convenient location for all cabinet installations. The enclosure shall be provided with two each 12 position splice trays and 24 each termination ST connectors, ceramic ferrule, in front panel mounted ST Couplers arranged in two rows. Each row of ST Couplers shall have two sets of 6 each couplers. The top row shall be for fiber incoming and the bottom row shall be fiber departing, or as shown on the plans as terminated fibers. Enclosures shall be Model WIC-024 Series or approved equal.

H. Documentation

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

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

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

2. The controllers shall be provided with the most current software and documentation.

I. Guarantee

1. The equipment furnished under this specification shall be new, of the latest model, fabricated in a first-class professional manner from good quality material.
2. The entire controller unit shall be warranted to be free from defects in quality and materials for a minimum of one year from date of acceptance. Any parts found to be defective shall, upon concurrence of the defect by the manufacturer, be replaced free of charge.
3. The Contracting Authority shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, then a list of those exceptions must be detailed on the certification.

4.03 INDUCTIVE LOOP VEHICLE DETECTOR

A. General

1. This specification contains the minimum design and operating requirements for solid state, digital inductive loop vehicle detectors capable of detecting the presence of a moving or standing vehicle.
2. A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and a sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.
3. Detectors shall be dual channel units, NEMA card rack compatible, and Group 5 level operation.

B. Sensor (Amplifier) Unit

1. The sensor unit shall be solid state, digital, providing detection channel(s) with a minimum inductance range of 50 to 1500 micro-henries. Output circuits of the sensor unit shall be provided by relays. Vehicle presence shall result in a continuous call indication.
2. The use of dual channel detector units is encouraged to minimize the number of detector units in the cabinet.
3. The sensor unit shall have the following qualities:
 - a. Sensitivity adjustment to allow as a minimum the selection of high, medium or low sensitivity.
 - b. Be capable of providing reliable detection of licensed motor vehicles.
 - c. Provide an indicator light for visual indication of each vehicle detection.
 - d. Will not require external equipment for tuning or adjustment.
 - e. Provide operation in the pulse mode or presence mode. Mode to be switch selective on the front panel of the unit.
 - f. Provide a self-tuning system that is activated automatically with each application of power. Automatic and continuous fine-tuning shall be provided to correct for environmental drift of loop impedance.
 - g. Provide for fail-safe operation (continuous call) in the event of detector loop failure.
 - h. Each detector channel shall respond to an absolute change (ΔL) rather than as a percentage of the total inductance ($\Delta L/L$).
4. Where sensor units with delay timing are specified, the delay feature shall be selected and adjusted externally on the sensor unit housing. Timing shall be digitally derived and be selectable in 1 second increments from 0 to 30 seconds. Delay timing shall inhibit detector output until presence has been maintained for the time selected. Each new detection shall restart the delay timer. The sensor unit shall be capable of disabling delay timing by external means during that detector's associated green phase. The delay inhibit on each detector unit shall be in effect during the associated green phase unless otherwise specified on the detector summary.
5. The sensor unit shall be capable of normal operation without interference and false calls between sensor units ("crosstalk") when installed in the physical environment of the controller cabinet and the electrical environment of the associated electronic equipment installed therein, including other detectors.
6. It shall be possible to install the connecting cable in the same conduit as the signal cables, power cables and other detector cables without affecting the normal operation of the detector.
7. Loop detector sensor units shall conform to current requirements of NEMA Standard TS1-1983.
8. A documentation package shall be supplied with the sensor units that shall include two complete sets of schematic diagrams; descriptive parts lists; and instructions for maintenance and operation of the units.

C. Guarantee

1. The equipment furnished under this specification shall be new, of the latest model, fabricated in a first-class professional manner from good quality material.
2. The detector sensor unit shall be warranted to be free from defects in quality and materials for one year from date of shipment. Any parts found to be defective shall, upon concurrence of the defect by the manufacturer, be replaced free of charge.
3. The Contracting Authority shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, then a list of those exceptions must be detailed on the certification.

- A. The Video Traffic Detection System utilized on the project shall be the Traficon VIP 3d.2 System manufactured by Traficon, or approved equal. The equipment must be fully compatible with the City's existing wireless communications system.
- B. The video detection system shall meet the following minimum requirements:
 - 24 Zones per Camera
 - 32 Outputs per Unit
 - 6 Cameras per Processor Unit (When more than 6 cameras or 32 detection outputs are required, an additional 6 camera processor unit will be added)
 - 32 Total Outputs using the SDLC
- C. The camera shall be provided with a single, user focus adjustable lens that can cover two phases to include six lanes of traffic. The manufacturer or representative shall assist the Contracting Authority in the final camera placement and the manufacturer or representative assist with the installation of the system and program the units. The manufacturer or representative shall provide a training period of at least 4 hours with the first unit(s) installed.
- D. The video cable to be used between the video detection camera and the controller cabinet shall be a hybrid composite, 6 conductor, 2 element video cable with a 20 gauge solid bare copper conductor with foam polyethylene insulation, and a 5 conductor 18 gauge 7/26 bare copper with polyethylene insulation. The overall assembly shall be jacketed with black PVC. This cable shall be suitable for installation in conduit or overhead with appropriate span wire and shall be manufacturer by Isotec Inc.
- E. The video from each camera shall be capable of being selected and displayed on an NTSC video monitor provided in the cabinet utilizing the video output on the video processing unit. The use of a computer for programming the video processing unit shall not be necessary. The unit shall be programmable using an NTSC video monitor and mouse.
- F. The programming of the loops shall be capable of being remotely programmed via a fiber optic RS-232 link.
- G. Software will be provided that will allow the ability to upload and save to a laptop computer on site and programmable for modifications. Software shall also be provided that will provide the ability to remotely select and reprogram loops from a central computer via a separate fiber optic link, if the city does not already possess such software. This software shall support up to 64 detector sites to be individually addressed and share a common RS-232 fiber optic link.
- H. Additional Video Image Processor (VIP) communication boards and media converters/ethernet switches will be provided and installed at other existing traffic signal locations that utilize video detection, as shown on the plans. These VIP communication boards and media converters/ethernet switches will be compatible with the video detection devices at each location. The additional communication boards shall be part of the "LUMP SUM – Communications and Network Interface". Communications and Network Interface shown as a separate line item on the quantities. The communication boards at the new traffic signal installations are considered accessories to the video detection systems.

4.05 VEHICULAR SIGNAL HEADS

- A. General
 - 1. This section of the specifications describes the minimum acceptable design and operating requirements for vehicular signal heads with 12 inch diameter lens openings, including all fittings and brackets as shown on the plans.

2. All components of the vehicular signal heads furnished under this specification shall comply with the latest version of the Institute of Transportation Engineers Standard(s) for Adjustable Face Vehicle Traffic Control Signal Heads.
- B. Signal Head Assembly
1. The housing for the individual signal sections shall be made of a durable polycarbonate. It shall be clean, smooth and free from flaws, cracks, blowholes, and other imperfections. It shall be designed as a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together. It shall be equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane. Doors and lenses shall be provided with suitable watertight gaskets and doors shall be suitably hinged and held securely to the body of the housing by simple locking devices of non-corrosive material.
 2. The optical system shall be so designed as to prevent any objectionable reflection of sunrays even at times of the day when the sun may shine directly into the lens.
 3. Lenses shall be 12 inches in diameter as specified on the plans. Lenses shall be polycarbonate. Glass lenses are not acceptable. Red, yellow, and green LED lenses shall be used in all signal heads. LED lenses shall meet the following ITE specification: Vehicle Traffic Control Signal Heads – Part 2: Light Emitting Diode (LED) Vehicle Traffic Control Signal Modules, An Interim Purchase Specification of the Institute of Transportation Engineers.
 4. The visors for each signal section shall be durable polycarbonate not less than 0.10 inches in thickness. It shall be designed to fit tightly against the door, and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be of the tunnel-type at least 8 inches long for all 12 inches rectangular pedestrian signals, at least 9 ½ inches long for 12 inch diameter signals, shall angle slightly downward, and shall be of the type specified on the plans.
- C. Specialized Options
1. One section of each three-section signal shall be equipped with a six position terminal block for termination of field wiring. Each five-indication signal shall be equipped with an eight position terminal block.
 2. The color of all polycarbonate signal heads shall be black in their entirety. The color shall be an integral part of the materials composition.
 3. Signal mounting hardware for side of pole mounted signals shall consist of 1 1/2 inch pipe and appropriate fittings, each painted with one coat of primer and two coats of black enamel. Banding brackets may be aluminum or black finish.
 4. Mast arm signal head assemblies shall be rigid mounted utilizing a suitable assembly consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes. Mast arm brackets shall be aluminum.
 5. Where shown on the plans, 5 inch backplates shall be furnished and attached to the signal faces to provide a dark background for signal indications. Backplates shall be construction of one-piece durable black plastic capable of withstanding a 100 M.P.H. wind.
- D. Miscellaneous Requirements
1. The signal heads shall be constructed of the highest quality materials. High-grade quality shall be used throughout. Each head shall have a smooth surface both inside and outside and shall contain no sharp fins or sharp projections of any kind.
- E. Certification
1. The Contracting Authority shall be furnished with a certification from the manufacturer of the signal head that the equipment furnished under this specification complies with all provisions of this specification. If there are any items that do not comply with this specification, a list of those exceptions must be detailed on the certification.

4.06 PEDESTRIAN SIGNAL HEADS WITH COUNTDOWN DISPLAY

A. General

1. Pedestrian signal heads shall meet the requirements outlined in the most current ITE specifications for LED pedestrian traffic signal control heads.
2. The general construction shall include a single piece cast aluminum or polycarbonate housing, a single piece double parabolic reflector, a 3-line two color message lens, a single piece cast aluminum or polycarbonate swing down door frame, a blankout sun visor, LED modules, and other hardware.

All LEDs shall be rated for 100,000 hours or more (@ 77°F and 30 mA).

3. The individual symbols shall each be a minimum of 12 inches in height and 7 inches in width. Message configuration color and size shall be ITE Equipment Standard "Pedestrian Traffic Signal Control Signal Indications" most recent version. Internal illumination shall be provided by an LED module without transformer.
4. Optically, the pedestrian signal shall be capable of displaying, brightly and uniformly, the alternate messages "Hand" symbol in portland orange and "Walking Person" symbol in white. When subjected to strong ambient light conditions, the messages shall "blankout" when the signal is not energized. The signal shall be furnished with the LED module and hardware. The signal shall be designed so that all components are readily accessible from the front by merely opening the signal door.

B. Main Body Assembly

1. The housing shall be one piece corrosion resistant aluminum alloy die casting or polycarbonate complete with integrally cast top, bottom, sides, and back. Four integrally cast hinge lug pairs, two at the top and two at the bottom of each case. The case, when properly mated to other pedestrian signal components and mounting hardware shall provide a dustproof and weatherproof enclosure and shall provide for easy access to and replacement of all components.
2. The door frame shall be one piece corrosion resistant aluminum alloy die casting or polycarbonate, complete with two hinge lugs cast at the bottom and two latch slots cast at the top of each door. The door shall be attached to the case by means of two ASTM A193, Type 304 stainless steel spring pins. Two stainless steel hinged bolts with captive stainless steel spring pins. Latching or unlatching the door shall require no tools.
3. Each signal shall be provided a sun visor designed to eliminate sun phantom. The optical system shall be designed so as to minimize the return of outside rays entering the unit from above horizontal (sun phantom). The optical system shall consist of; a three-line two color message lens, a double parabolic reflector, LED modules, and a sun visor. The inside face of each message section shall be silkscreened with a transparent coating of an appropriate color in the word message areas to produce a portland orange "Hand" symbol and an white "Walking Person" symbol when illuminated by LED traffic signal lamp operating at rated voltage. The entire background shall be a fired ceramic mask, black in color.

C. Specialized Options

1. All screws, latching bolts, and hinge pins shall be stainless steel to prohibit rust and corrosion. Prior to final assembly, the case, door frame, side of pole mounting brackets, and visor (aluminum portion only) shall be thoroughly cleaned and then etched with an iron phosphate solution. An appropriate chemical sealer shall then be applied with a top grade T.G.I.C. polyester powder then being electrostatically applied and oven baked. The housing shall be black with the visor being black.

D. Miscellaneous Requirements

1. The pedestrian heads shall be constructed of the highest quality materials. High-grade workmanship shall be used throughout. Each head shall have a smooth surface both inside and outside and shall contain no sharp fins or sharp projections of any kind.
2. All components of the vehicular traffic signal heads furnished under this specification shall comply with the latest Institute of Transportation Engineers Standards on Adjustable Face Vehicle Traffic Control Signal Heads.

E. Countdown Pedestrian Indicator

1. The countdown pedestrian indicator unit shall fit in a traditional 16 inch X 16 inch pedestrian signal head housing. The unit shall display a digital numerical count in addition to the graphic display to show how much time remains to clear the intersection. The unit shall be able to monitor the timing sequence from the traffic signal controller and adjust the countdown to match the "WALK" and flashing "DON'T WALK" time intervals without the need for any additional adjustments to the settings of the unit. The unit shall automatically learn any new sequences and adjust its countdown accordingly.
2. The unit shall be set at the factory to operate in the "clearance countdown" option that counts down during the flashing "DON'T WALK" time interval only. The count down shall start with the digital display in the blinking mode at the same time the graphic hand is displayed in blinking mode. The digital display shall finish counting down at the same instance that the hand is displayed in non-blinking mode. The digital countdown shall remain off through the walk interval until the controller once again displays the graphic hand in blinking mode.
3. To accommodate the emergency and manual preemption, the unit shall compare each countdown interval to the one prior to it. When the intervals are not equal, the unit shall blank out the count down digits and the traffic signal controller shall then mandate what indicator is displayed.

F. Certification

1. The Contracting Authority 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 complied with all provisions of this specification. If there are any items that do not comply with the specification, a list of those exceptions must be detailed on the certification.

G. Warranty

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

4.07 PEDESTRIAN PUSH BUTTONS

A. General

1. Pedestrian push button detectors shall be of the direct push contact type and shall be ADA compliant.
2. The push button shall be weatherproof and of sturdy design. The entire assembly shall be weather tight, secure against electrical shock, and able to withstand continuous hard usage. The contacts shall be normally open with no current flowing except at the moment of actuation.
3. The housing shall be made of aluminum alloy and furnished with suitable mounting hardware.
4. Push button signs shall be furnished and shall conform to the requirements of the Manual On Uniform Traffic Control Devices (M.U.T.C.D.). Signs shall be R10-3D, as indicated on the plans.
5. The Owner shall be furnished with a certification from the equipment manufacturer stating that the equipment furnished under this specification complies with all provisions of this specification. If there are any items, which do not comply with this specification, then a list of those exceptions must be detailed on the certification.

4.08 TRAFFIC SIGNAL POLES

A. General

1. This section of the Special Provisions describes minimum acceptable design, material, and fabrication requirements for traffic signal poles.
2. The traffic signal mast arm and pole assemblies shall be designed to support the number of signal heads (use weight and projected areas of diecast aluminum signal heads) and signs as shown on the plans. The mast arm and pole assemblies shall be designed to support a minimum of two signal heads.
3. The mast arm and support poles shall be continuous tapered, round, steel poles of the anchor base type as shown on the plans. The poles shall be fabricated from low carbon (maximum carbon 0.30 percent) steel of U.S. Standard gauge. After manufacture, they shall have a minimum yield strength of 48,000 PSI. The base and flange plates shall be of structural steel conforming to AASHTO M183 (ASTM A36) and cast steel conforming to ASTM A27, Grade 65-35 or better.

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

- a. All longitudinal butt welds, except within one foot of a transverse butt-welded joint, shall have a minimum 60 percent penetration for plates 3/8 inch and less in thickness, and a minimum of 80 percent penetration for plates over 3/8 inch in thickness.
 - b. All longitudinal butt welds on poles and arms within one foot of a transverse butt-welded joint shall have 100 percent penetration.
 - c. All transverse butt welds for connecting sections shall have 100 percent penetration achieved by back-up ring or bar.
4. Pole manufacturers shall certify that only certified welding operators in accordance with AWS D1.1-80 were used and only electrodes as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel for Highway Bridges were used.

B. Mast Arm

1. The mast arm shall be designed to support traffic signals and/or signs as shown on the plans and indicated in these Special Provisions. They shall be certified by the fabricator that the mast arms are capable of withstanding winds up to 80 MPH with a 1.3 gust factor without failure. The mast arms shall be galvanized inside and out in accordance with ASTM 123, latest revision.

C. Poles

1. The pole shall be designed to support the traffic signals and/or signs as shown on the plans. The pole shall be galvanized inside and out in accordance with the requirements of ASTM A123, latest revision. The pole shall be equipped with a nominal 5 inches x 8 inches handhole and cover located 1.5 feet above the base of the pole. Securing of the cover to the base shall be done with the use of simple tools. All hardware shall be corrosion resistant.

D. Combination Pole

1. Where a combination street lighting/signal pole is specified on the plans, the above applies with the luminaire arm to be mounted in the same vertical plane as the signal arm unless otherwise indicated on the plans or by the Engineer.
2. The luminaire arm shall be of the single member tapered arm type.
3. The luminaire arm shall provide the spread as shown on the plans and a rise sufficient to provide for a nominal mounting height of 40 feet when attached to the pole.

E. Pole Finish

1. The signal supports to include poles, mast arms and luminaire arms shall be finish coated with smooth powder coat, color matching Lumec Black, over galvanizing. Prior to the application of the powder coat, the surfaces shall be prepared by removing rolled-in mill scale, impurities, and non-metallic foreign materials. After assembly, all weld flux shall be mechanically removed. Iron or steel surfaces shall then be degreased by immersion in an agitated 4.5-6 percent concentrated caustic solution elevated to a temperature ranging from 150° F-180° F. The product shall then be pickled by immersion in a heated sulfuric acid solution of 6-13 percent concentration, controlling the temperature at 150° F. The product shall then be rinsed clean of any residual effects of the caustic or acid solutions by immersion in a circulating fresh water bath. The product shall then be immersed in a concentrated zinc ammonium chloride flux solution heated to 130° F. The solution's acidity content shall be maintained between 4.5-5.0 pH. The product shall be air dried prior to zinc coating. Next, the product shall be hot-dip galvanized to the requirements of either ASTM A123 or ASTM A153 by immersion in a molten bath of prime western grade zinc maintained between 810° F-850° F. Maximum aluminum content of the bath shall be 0.01% and the flux ash shall be skimmed from the bath surface prior to immersion and extraction. Galvanized exterior surfaces visually exposed shall be coated with a Urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder to a minimum dry film thickness (DFT) of 2.0 mils. The surfaces shall be mechanically etched by brush blasting and the zinc coated substrate shall be preheated to 450° F for a minimum of one hour in a gas-fired convection oven. Finally, the coating shall be electrostatically applied and cured by elevating the zinc-coated substrate temperature to a minimum of 400° F in a gas-fired convection oven. To prevent damage during delivery, small poles shall be wrapped in 0.188 inch thick ultraviolet-inhibiting, plastic-backed foam and larger poles shall be cradled in a 1.0 inch rubberized foam base.

F. Hardware

1. The mast arm and poles shall be equipped with all necessary hardware, shims and anchor bolts to provide for a complete installation without additional parts.
2. The anchor bolts shall meet the requirements of ASTM A36 or better.
3. The anchor bolts shall be hot dipped galvanized for the entire length.
4. The anchor bolts shall be threaded a minimum of six inches at one end and have a minimum four-inch long, 90-degree bend at the other end.

G. Shop Drawings

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

H. Certifications

1. The fabricator shall certify that the mast arms are capable of withstanding winds up to 100 MPH with a 1.3 gust factor without failure; that only certified welding operators in accordance with AWS D1.1-80 or latest revisions were used; and that only electrodes as modified by AASHTO 1981 Standard Specifications for Welding of Structural Steel for Highway Bridges were used.

4.09 TRAFFIC SIGNS

- A. Traffic signs shall conform to the requirements of Section 4186 of the Standard Specifications.
- B. Traffic signs shall be mounted on the mast arms utilizing a universally adjustable mast arm mounted sign bracket.

4.10 UNINTERUPPTABLE POWER SUPPLY

The Contractor shall supply an uninterruptible power supply (UPS), in all new signal cabinet installations, and all its accessories that will provide 4 hours of full colors operation and 8 hours of all red operation. The unit shall be a Signal Sense SH1200UR as manufactured by Sense Products, LLC or equivalent. The UPS should be able to automatically switch from full colors to all red flash when the batteries reach a critical power percentage. The UPS shall include all necessary hardware and wiring to provide a complete and fully functional power backup system.

The UPS shall provide reliable emergency power to the traffic signals in the event of a power failure or interruption. The transfer from utility power to battery power and visa versa shall not interfere with the normal operation of traffic controller, conflict monitor/malfunction management unit, or any other peripheral device within the traffic controller assembly.

The UPS module, batteries, and all its components shall be of physical size to be installed within the controller cabinet.

- A. Contractor shall supply and install a Signal Sense SH1200UR power module or approved equivalent. The power module should have enough power to run the intersection with full colors for four hours and in all flash after that. The units should be able to switch to an all red flash when the battery reaches 40 percent power.
- B. Contractor shall supply gelled or absorbed glass mat, non-spillable, valve regulated batteries. The batteries typical recharge time shall be eight (8) hours or less. The contractor shall provide and install enough batteries for a fully functionally signal.

4.11 FIBER OPTIC SPECIFICATIONS

This work shall consist of furnishing fiber optic cable of the type, size and number of fibers specified, and fiber optic components as shown on the plans.

A. General Requirements

Materials and Equipment

1. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. The fiber optic shall be OFS BrightWave conforming to the following specifications. All materials and equipment furnished shall be completely free from defects and poor workmanship. All fibers shall be glass and be manufactured by Lucent, Corning, or approved equal. The cable shall be rated for gigabyte data bandwidth. All fiber shall be loose tube construction for both indoor and outdoor installation. Indoor cabling shall use plenum rated conduit to within less than 50 foot of point of termination eliminating the requirement to convert to indoor cable.
2. General Considerations
The cable shall meet all requirements stated within this specification.
The cable shall be new, unused, and of current design and manufacture.
3. Fiber Characteristics
All fibers in the cable must be usable fibers and meet required specifications.

Multi-mode Fiber

Core diameter: 62.5 +2.5um

Cladding diameter: 125.0 +2.0um

Core-to-cladding concentricity: <1.5um

Coating diameter 245 +5um

Graded Index

Attenuation uniformity: No point discontinuity shall be greater than 0.2 dB at either 850nm or 1300nm. The coating shall be a layered UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically removable without damaging the fiber.

Single-Mode Fiber

Typical core diameter: 8.3um

Cladding diameter: 125 +0.7um by fiber end measurement

Core-to-cladding concentricity: <0.5um

Coating diameter: 245 +5um

Attenuation uniformity: No point discontinuity shall be greater than 0.1 dB at either 1310nm or 1550nm. The coating shall be a layered UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically removable without damaging the fiber.

B. Fiber Specification Parameters

1. All fibers in the cable shall meet the requirements of this specification. Multimode fibers shall have attenuation of 2.9 db/km or less at 850 nm and 0.6 db/km or less at 1300 nm.
2. The attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable.
3. The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.20 dB/km at 1550 nm, with 80 percent of the measured values no greater than 0.10 dB/km at 1550 nm. Attenuation of single mode fiber shall be less than 0.40 db/km at 1310 nm and 0.18 db/km at 1550 nm.

C. Cable Installed in Ducts and Conduits

1. A suitable cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct off the reel. It shall be carefully inspected for jacket defects. If defects are noticed, the pulling operation shall be stopped immediately and the Engineer notified. Precautions shall be taken during installation to prevent the cable from being "kinked" or "crushed". A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. A pulling swivel shall be used to eliminate twisting of the cable. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Dynamometers or breakaway pulling swing shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed on a cable during installation shall not be such that the cable is twisted or stretched. The pulling of cable shall be hand assisted at each controller cabinet. The cable shall not be crushed kinked or forced around a sharp corner. If a lubricant is used it shall be of water based type and approved by the cable manufacturer. Sufficient slack shall be left at each end of the cable to allow proper cable termination, minimum of 20 feet. This slack shall be in addition to installation slack as hereinafter specified. Additional slack cable shall be left in each hub cabinet, handhole, and at the top of each conduit riser. Excess slack at hub cabinets shall be re-pulled into the nearest handhole to provide a neat and orderly installation. The minimum slack amounts shall be as follows:

Controller cabinet – 30 feet

Type 1 Handhole – 15 feet

Type 2 Handhole – 30 feet

Conduit riser – 30 feet

Rack and wall mount termination enclosure – 10 feet

Storage of minimum slack cable in controller cabinets and additional slack at pull boxes shall be coiled. The slack coils shall be bound at a minimum of 3 points around the coil parameter and supported in their static storage positions. The binding material and installation shall not bind or kink the cable. Storage of additional slack cable adjacent to conduit risers and support poles shall be as visibly marked/tagged as "CAUTION – FIBER OPTIC CABLE". Maximum length of cable pulling tensions shall not exceed the cable manufacturer's recommendations. Along with the fiber optic cable, one (1) #10

AWG THHN, 600 volt single conductor cable (identifier conductor), orange in color, shall be pulled with ten feet (10') slack in each pull box, except where rigid metallic conduit or other metallic conductors are installed.

D. Minimum Bend Radius

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

E. After the Fiber Optic Cable Installation

1. Each section of the cable shall be tested for continuity and attenuation as a minimum. If the attenuation is found not to be within the acceptable nominal values, the Contractor shall use an optical time domain reflectometer (OTDR) to locate points of localized loss caused by bends or kinks. If this is not successful the Contractor shall replace the damaged section of cable with no additional payment. Splices will not be allowed to repair the damaged section. After all fiber cable is installed between traffic controller cabinets and fiber links between fiber distribution points (FDP) complete links shall be tested with an OTDR and a power meter. The Contractor may jumper termination points at controller cabinets to minimize the number of tests and run a single OTDR test between several controller cabinets, subject to the range of the OTDR. Links between FDPs shall be tested separately. Multimode fiber may be tested using 1300 nm and single mode may be tested at 1310 nm. The results of the OTDR test shall be provided on an electronic media (disk) and paper printout. The OTDR wave, pictorial diagram of dB loss over the length of fiber tested, shall be provided along with the measured data values. The printout shall contain the manufacturer's fiber optic Index of Refraction to the third decimal point for the fiber provided. The Contractor shall provide the Engineer with a written report showing all the values measured compared to the calculated values for length and coupler/connector losses at the completion of these tests.
2. Data documentation shall include for each test between cabinets or between FDP sites, the length of fiber as measured by OTDR, frequency used in test on OTDR by each fiber type, distance to each splice, termination or patch cord jumper, dB loss rating by manufacture from spool documentation, index of refraction by type of fiber in section, and the dB loss of each section as measured in the final test for each fiber. A special test shall be made on all continuous spliced fiber from start to end that includes the total dB loss measured and the OTDR plot on electronic disk.

F. Cable Termination

1. Terminations shall be made using the method recommended by the connector manufacturer. All fibers shall utilize a fan-out kit of the size and type recommended by the manufacturer and of the number of fibers provided in each fiber tube. All fibers terminated shall utilize a ceramic ferrule (outdoor connections), ST, mechanical termination equal to Siecorm CamLite or Unicam connectors. Heat cured or epoxy type connections are not acceptable for this Project.

G. Termination Enclosures

1. The termination housing shall be installed within a wall or shelf mountable interconnect housing which shall provide for storing fibers, ample room for feed through cable, strain relief for multiple cables within unit, and accommodate ST compatible connectors. The enclosure shall be provided with two each 12- position splice trays and 24 each termination ST connectors, ceramic ferrule, in front panel mounted ST Couplers arranged in two rows. Each row of ST Couplers shall have two sets of 6 each couplers. The top row shall be for fiber incoming and the bottom row shall be fiber departing, or as shown on the plans as terminated fibers. Enclosures shall be SIECOR Model WIC-024 or approved equal.

Patch cords and pigtails shall be factory-manufactured assemblies and shall be fully compatible with the fiber optic interconnect cable and connecting modems and modules. The pigtails shall be equipped with connectors as described herein and shall be either three feet (3'), six feet (6'), or as required to fit in length. The length shall be sized to preclude possible damage in the utilization and moving of equipment within the controller cabinet. Fan out kits shall be utilized for all fiber terminations.

H. Splices

1. The fiber cable shall be installed in continuous runs between cabinets. No splices shall be allowed, unless shown on the plans or for testing. Mechanical splices will be allowed, only when specified. Splices, where specified, shall be by fusion splice and shall be installed using an automatic fusion splicer. Splices between two fibers leaving the cabinet shall be supported in splice trays installed in splice enclosures. Fibers being terminated in two separate termination/splice enclosures shall be supported between enclosures by the use of buffer tubing or approved equal support material or shall be pigtail patch cords. Termination / splice enclosures shall be separated by less than 12 inches unless a conduit is installed between enclosures.

I. Light Source

1. An LED light source with a wavelength that is the system wavelength, 850 and 1300 nm for multimode and 1310 and 1550 nm for single mode, shall be used. The LED shall be stable within 0.1 dB in intensity over a time period sufficiently long to perform the measurement. The output of the LED shall overfill the input end of the launch fiber/cable in both numerical apertures (NA) and core diameter.

J. Power Meter

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

K. Launch Reference Attenuator

1. The launch attenuator, one each for single and multimode fiber tester shall be provided for attachment to the light source and/or OTDR. The launch attenuator shall be of the same fiber core size and type as the fiber under test. The attenuator shall emulate a one hundred and fifty-foot fiber length, minimum. Special connectors shall be provided with each attenuator to connect the device to the test device, such as the OTDR.

L. Testing

1. **General**
The Contractor shall provide all personnel, equipment, instrumentation and supplies necessary to perform all testing. All testing shall be performed in an accepted manner and in accordance with the testing equipment manufacturer's recommendations. All data shall be recorded and submitted to the Traffic Engineer as hereinbefore specified.
2. **Attenuation**
The end-to-end attenuation shall be measured for each link after installation. The launch cable shall be connected to the light source and the receive cable to the power meter. The two reference cables shall then be connected via a termination hub.

The system link to be tested shall then be inserted between the launch and receive cables using 2 termination hubs (couplers). The direction of the test shall be recorded in the documentation to verify the quality of the termination.

3. Transmitter/Receiver Power Levels

The output power levels at the network hardware transmitters and receivers shall be measured and recorded for system documentation.

The power meter shall be connected to the transmitter side of the equipment with a system jumper. The transmit power level shall then be read and recorded. The transmitter is then re-connected to the cable link and the power meter connected to the receiver side of the equipment. The receive power level shall then be read and recorded.

4. Continuity

Continuity tests shall be used to determine whether a test or system jumper does or does not pass light. A continuity test shall also be used to assure the fibers have not been crossed over in the jumper and that the transmit fiber goes to the receiver fiber.

To perform continuity test, a high-intensity flashlight shall be aimed into the connector at one end, while an observer watches for a flicker of light at the other end. A 650 nm red NFL light source shall be provided to the Engineer at the completion of the continuity testing. This device shall be made available during testing of continuity to the Engineer to assist in verifying fault locations and connector bleeding.

M. OTDR Testing

1. An Optical Time Domain Reflectometer (OTDR) shall be used to evaluate the quality and length of cable reels prior to their use on the project. The fiber loss in dB/km and the length of each reel shall be recorded in the documentation. The maximum attenuation of the cable shall be as hereinbefore specified.

2. A hard copy of OTDR signature traces, electronically and in printed form, for all system links shall be made and provided in the documentation as specified.

N. Documentation

1. The result of all testing shall be recorded along with date of test, name of person performing test, brand name, model number, serial number of equipment used during test, and any other pertinent information and data.

O. Quality Assurance Provisions

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

2. All optical fibers shall be 100% attenuation tested at the manufacturer. The attenuation of each fiber shall be provided with each cable reel. The measured attenuation shall be for both 850 and 1300 frequency for multimode and 1310 or 1550 frequency for single mode. This documentation shall be provided with each spool. The Contractor shall designate on the Plans and on this (See 28.2.11) documentation the location where each spool has been installed and provide this data to the Engineer.

4.12 COMMUNICATIONS AND NETWORK INTERFACE

A. General Requirements

The contractor shall provide all line drivers necessary to implement traffic signal control, control video image detectors, and capture and display the video at the Street Department/Signal Shop, as video is transmitted from the traffic control cabinets.

Schedule of Unit Prices
Hwy 965 Total Project - Phase I

No.	Item Description	Plan Quantity	Units	Unit Price	Unit Extension
1	NEMA Controller, Cabinet, and Accessories	2	EA	\$	\$
2	Fiber Optic Accessories as per Specifications	1	LS	\$	\$
3	Four/Five Camera Video Detect Sys including Controller and Acc.	1	LS	\$	\$
4	Combo Signal Pole (40') With 20' Single Luminaire Arm	1	EA	\$	\$
5	Combo Signal Pole (45') With 20' Single Luminaire Arm	2	EA	\$	\$
6	Combo Signal Pole (50') With 20' Single Luminaire Arm	1	EA	\$	\$
7	Combo Signal Pole (55') With 20' Single Luminaire Arm	2	EA	\$	\$
8	Combo Signal Pole (60') With 20' Single Luminaire Arm	2	EA	\$	\$
9	Pedestal Pole	1	EA	\$	\$
10	5-Sec., 12" RYG Ball w/Y+G Left Turn Arr, w/Bkpl (as noted)	3	EA	\$	\$
11	3-Sec., 12" RYG Signal Head, w/Bkpl (as noted)	17	EA	\$	\$
12	1-Sec., 12" Hand/Man W/Countdown Clock Pedestrian Heads	10	EA	\$	\$
13	2" Rigid PVC Conduit, Trenched	90	LF	\$	\$
14	3" Rigid PVC Conduit, Trenched	58	LF	\$	\$
15	3" Rigid PVC Conduit, Pushed	415	LF	\$	\$
16	4" Rigid PVC Conduit, Trenched	79	LF	\$	\$
17	Pull Rope	861	LF	\$	\$
18	Tracer Cable 1c#10	861	LF	\$	\$
19	Bare Copper Ground #6	846	LF	\$	\$
20	1c#8 Power Supply Cable for Street Lighting	3140	LF	\$	\$
21	Hybrid Power/Coax Cable for Video Detection Cameras	2375	LF	\$	\$
22	2c#14 Signal Cable	2880	LF	\$	\$
23	5c#14 Signal Cable	4497	LF	\$	\$
24	7c#14 Signal Cable	1810	LF	\$	\$
25	12 Count -Multimode Fiber Optic Cable	756	LF	\$	\$
26	Wye Connectors	22	EA	\$	\$
27	Concrete Pedestal Base, Type FIII, 2.0' Dia x 5.0' deep	1	EA	\$	\$
28	Concrete Base, Type FIII, 3.0' Dia x 12.0' deep	1	EA	\$	\$
29	Concrete Base, Type FIII, 3.0' Dia x 13.0' deep	2	EA	\$	\$
30	Concrete Base, Type FIII, 3.0' Dia x 15.0' deep	1	EA	\$	\$
31	Concrete Base, Type FIII, 3.0' Dia x 16.0' deep	2	EA	\$	\$
32	Concrete Base, Type FIII, 3.0' Dia x 17.0' deep	2	EA	\$	\$
33	Concrete Pad, Controller Footing	2	EA	\$	\$
34	18" Controller Cabinet Riser	2	EA	\$	\$
35	Handhole, Type I 24" Poured or Precast, Ring & Cover	4	EA	\$	\$
36	Handhole, Type II 30" x 48" Tub	1	EA	\$	\$
37	Street Name Signs "HWY 965" (54"x 18")	4	EA	\$	\$
38	Street Name Signs "ASHLEY CT" (66"x 18")	2	EA	\$	\$
39	Street Name Signs "FAIRVIEW LN" (84"x 18") With Arrows	2	EA	\$	\$
40	Street Name Signs "GOLFVIEW DR" (84"x 18") With Arrows	2	EA	\$	\$
41	Left-Turn Yld On Gr Overhead Sign (24"x30") R10-12	3	EA	\$	\$
42	Left-Turn Only Overhead Sign (30"x36") R3-5L	8	EA	\$	\$
43	Right-Turn Only Overhead Sign (30"x36") R3-5R	4	EA	\$	\$
44	Pedestrian Pushbutton Sign (9" x 12") R10-3D	10	EA	\$	\$
45	Pedestrian Pushbutton	10	EA	\$	\$
46	Fiber Distribution Panels	2	EA	\$	\$
47	FSK/Fiber Optics Modem	2	EA	\$	\$
48	Fiber Optic Terminations	1	LS	\$	\$
49	Hardened Media Converter - min. 8-port (4-fiber, 4-ethernet)	2	EA	\$	\$

Total Lump Sum to Furnish and Install Traffic Signals and Interconnect \$

Approved: _____
 Project Engineer Date

Equipment and Materials List
Highway 965 Total Project - Phase I

Plan Quantity	Units	Item Description	Manufacturer	Catalog Number
2	EA	NEMA Controller, Cabinet, and Accessories		
1	LS	Fiber Optic Accessories as per Specifications		
1	LS	Four/Five Camera Video Detect Sys including Controller and Acc.		
1	EA	Combo Signal Pole (40') With 20' Single Luminaire Arm		
2	EA	Combo Signal Pole (45') With 20' Single Luminaire Arm		
1	EA	Combo Signal Pole (50') With 20' Single Luminaire Arm		
2	EA	Combo Signal Pole (55') With 20' Single Luminaire Arm		
2	EA	Combo Signal Pole (60') With 20' Single Luminaire Arm		
1	EA	Pedestal Pole		
3	EA	5-Sec., 12" RYG Ball w/Y+G Left Turn Arr, w/Bkpl (as noted)		
17	EA	3-Sec., 12" RYG Signal Head, w/Bkpl (as noted)		
10	EA	1-Sec., 12" Hand/Man W/Countdown Clock Pedestrian Heads		
90	LF	2" Rigid PVC Conduit, Trenched		
58	LF	3" Rigid PVC Conduit, Trenched		
415	LF	3" Rigid PVC Conduit, Pushed		
79	LF	4" Rigid PVC Conduit, Trenched		
861	LF	Pull Rope		
861	LF	Tracer Cable 1c#10		
846	LF	Bare Copper Ground #6		
3140	LF	1c#8 Power Supply Cable for Street Lighting		
2375	LF	Hybrid Power/Coax Cable for Video Detection Cameras		
2880	LF	2c#14 Signal Cable		
4497	LF	5c#14 Signal Cable		
1810	LF	7c#14 Signal Cable		
756	LF	12 Count -Multimode Fiber Optic Cable		
22	EA	Wye Connectors		
1	EA	Concrete Pedestal Base, Type FIII, 2.0' Dia x 5.0' deep		
1	EA	Concrete Base, Type FIII, 3.0' Dia x 12.0' deep		
2	EA	Concrete Base, Type FIII, 3.0' Dia x 13.0' deep		
1	EA	Concrete Base, Type FIII, 3.0' Dia x 15.0' deep		
2	EA	Concrete Base, Type FIII, 3.0' Dia x 16.0' deep		
2	EA	Concrete Base, Type FIII, 3.0' Dia x 17.0' deep		
2	EA	Concrete Pad, Controller Footing		
2	EA	18" Controller Cabinet Riser		
4	EA	Handhole, Type I 24" Poured or Precast, Ring & Cover		
1	EA	Handhole, Type II 30" x 48" Tub		
4	EA	Street Name Signs "HWY 965" (54"x 18")		
2	EA	Street Name Signs "ASHLEY CT" (66"x 18")		
2	EA	Street Name Signs "FAIRVIEW LN" (84"x 18") With Arrows		
2	EA	Street Name Signs "GOLFVIEW DR" (84"x 18") With Arrows		
3	EA	Left-Turn Yld On Gr Overhead Sign (24"x30") R10-12		
8	EA	Left-Turn Only Overhead Sign (30"x36") R3-5L		
4	EA	Right-Turn Only Overhead Sign (30"x36") R3-5R		
10	EA	Pedestrian Pushbutton Sign (9" x 12") R10-3D		
10	EA	Pedestrian Pushbutton		
2	EA	Fiber Distribution Panels		
2	EA	FSK/Fiber Optics Modem		
1	LS	Fiber Optic Terminations		
1	EA	Hardened Media Converter - min. 8-port (4-fiber, 4-ethernet)		
2	EA	Meter Sockets		

Approved: _____
 Project Engineer Date