PROJECT SPECIAL PROVISIONS

FINAL

TIP U-4736

PREPARED BY:

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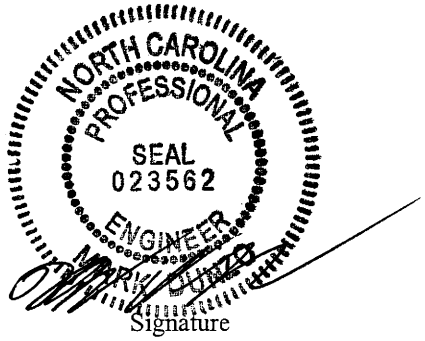
PREPARED FOR:

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

TRAFFIC MANAGEMENT SYSTEMS SECTION



Signature

12/22/05
Date:

Prepared by: KWS/MWD

Project Special Provisions

Intelligent Transportation Systems & Signals Unit

Prepared By: KWS / MWD

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Contents

1. GENERAL REQUIREMENTS

1.1. DESCRIPTION

A. General

Furnish, install, and fully integrate new fiber optic communications cable, existing fiber optic communications cable, wireless communications links, commercial public telephone network based communications products, new traffic signal controllers and cabinets, new closed-circuit television units and control cabinets, new central hardware and software, modify existing traffic operations center to form a complete and operational central distributed processing traffic signal system for the City of Gastonia in North Carolina.

Furnish, install, and fully integrate new 2070L traffic signal controllers and new model 332 and 336 style cabinets to replace existing controllers and cabinets at locations shown in the Plans. Integrate signal controllers with fiber optic communications network. Where shown in the plans, integrate signal controllers using dial-up telephone service or wireless radio communications.

Complete traffic signal upgrades as shown in the Plans. Furnish, install, and fully integrate new signal heads, inductive loops, detector cards, signs, and other equipment as directed in the Plans.

Furnish, install, and fully integrate new fiber optic communications cable for traffic signal system as shown on the Plans by lashing to existing twisted pair cable, lashing to new messenger cable installed under this project, and utilizing new conduit systems.

Furnish and install new fiber optic communications cable to be used by City of Gastonia Electric Department. Gastonia Electric cable will be installed as shown on the Plans by lashing to existing twisted pair cable, lashing to new messenger cable installed under this project, and utilizing new conduit systems. Gastonia Electric cable will be installed concurrently with signal system cables. The installation of Gastonia Electric cable shall be at the discretion of the Engineer, as it is dependent on City of Gastonia funding. In the event that the Engineer directs the Contractor to not install Gastonia Electric cable, there will be no renegotiation in the price allowed for fiber optic cable or splice enclosures.

Furnish and install new closed-circuit television (CCTV) camera assemblies at locations shown in the Plans. Fully integrate camera assemblies with the fiber optic communications network.

Complete and fully integrate a modified traffic operations center (TOC) to be housed at the Municipal Operations Center located at 1300 North Broad Street in Gastonia. Terminate all fiber optic communications cables at the modified TOC. Complete and fully integrate a new remote

operations center (ROC) to be housed at the Garland Municipal Business Center located at 150 South York Street in Gastonia. Integrate with existing City of Gastonia fiber optic communications network to establish a connection between the TOC and ROC.

Integrate remote access capabilities for the NCDOT Highway Division 12 Office located at 1710 East Marion Street in Shelby, North Carolina and the NCDOT Metrolina Regional Transportation Management Center (MRTMC) located at 2327 Tipton Drive in Charlotte, North Carolina.

B. Standard Specifications

Conform to these Project Special Provisions, the Plans, and the NCDOT 2002 Standard Specifications for Roads and Structures (also referred to as the "Standard Specifications"). Also conform to the regulations and codes described in Section 1700 of the Standard Specifications.

In the event of a conflict between these Project Special Provisions and the Standard Specifications, these Project Special Provisions shall govern.

1.2. MATERIAL

A. Qualified Products

Furnish new equipment, materials, and hardware shown on the plans and/or described in these Project Special Provisions. Permanently inscribe the manufacturer's name, model number, serial number, and any additional information needed for proper identification on each piece of equipment housed in a case or housing.

The Department has a signal and ITS equipment Qualified Products List (QPL) available for the contractor's use. The QPL web site is:

- HTTP://www.doh.dot.state.nc.us/preconstruct/traffic/TMSSU/SMS/QPL/

Attention is directed to the fact that certain signal and ITS equipment, material, and hardware are required to be pre-approved on the QPL by the date of equipment installation. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project. Consult the QPL web site to obtain pre-approval procedures.

B. Submittal Requirements

Provide written certification to the Department that all contractor-furnished equipment is in accordance with the plans and specifications. When requested by the Department, provide additional certifications from independent testing laboratories and sufficient data to verify that the item meets applicable specifications. Ensure that the additional certification states that the testing laboratory is independent of the equipment manufacturer and that neither the laboratory nor the manufacturer has

a vested interest in the other.

Identify all proprietary parts in contractor-furnished equipment. The Department reserves the right to reject equipment that uses proprietary components that are not commercially available through electronic supply houses.

For contractor-furnished equipment that is listed on the QPL, furnish submittals in the format defined by the QPL.

For contractor-furnished equipment that is not on the QPL, furnish three copies of a list of the equipment including three copies of catalog cuts. Identify the proposed equipment on the catalog cuts by a reproducible means. Equipment lists must contain the material description, brand name, manufacturer's address and telephone number, stock number, size, identifying trademark or symbol, and other appropriate ratings.

Do not fabricate or order equipment until receipt of the Engineer's approval.

C. Observation Period

The 90-day Observation Period is considered to be part of the work included in the total contract time and must be completed prior to acceptance of the Project. All documentation required in these Project Special Provisions shall be completed prior to the end of the 90-day Observation Period.

D. Warranties

Unless otherwise required herein, provide manufacturer's warranties on contractor furnished equipment for material and workmanship that are customarily issued by the equipment manufacturer and that are at least two years in length from successful completion of the 90 day observation period. Include unconditional coverage for all parts and labor necessary or incidental to the repair of defective equipment or workmanship and malfunctions that arise during the warranty period.

Ensure that all contractor-furnished equipment, including pieces and components of equipment, hardware, firmware, software, middleware, internal components, and subroutines which perform any date or time data recognition function, calculation, or sequencing will support a four digit year format for a period of at least 50 years.

Upon successful completion of the 90-day observation period, transfer manufacturer's warranties with proper validation by the manufacturer to the Department or its designated maintaining agency.

E. Firmware Licensing and Upgrades

Provide the Department with a license to duplicate all programmable devices in the equipment for maintenance and software upgrades. Provide binary or hexadecimal format files for each device

that may be programmed by the Department. Ensure that files are provided on 1.44 Megabyte PC compatible diskettes or other approved media.

Ensure that software firmware performance upgrades that occur during the contract period are available to the Department at no additional cost.

Make software firmware upgrades that are developed to correct operating characteristics available to the Department at no additional cost until the warranty period expires.

F. Plan Quantity Measurements

For those items that provide for payment by "Plan Quantity," the quantities may or may not represent the exact quantity of material to be furnished and installed. Where plan quantity measurement is specified for an item, adjustment of the quantities will be made as follows:

If the quantities measured as outlined under "Method of Measurement" vary from those shown in the proposal by more than 5 percent, either party to the contract may request, in writing, an adjustment of the quantities by each separate bid item. The party to the contract which requests the adjustment will present to the other, one copy of field measurements and calculations showing the revised quantities in question. These revised quantities when approved, together with all other quantities under the same bid item, will constitute the final quantity for which payment will be made.

When quantities are revised by a change in design, the "Plan Quantity" will be increased or decreased by the amount involved in the design change.

G. Wire and Cable

Furnish wire and cable on reels. When requested by the Department, furnish samples of the wire and cable to the Department at no additional cost for inspection and testing by the Department.

Except for grounding conductors, provide signal cable conductors of size Number 16 AWG that are fabricated from stranded copper. **Number 16 AWG cable can only be used with an all LED traffic signal intersection**. Repairs to a non-LED traffic signal intersection must use Number 14 AWG cable.

Provide either 0.05 x 0.30 inch aluminum wrapping tape or 0.06 inch stainless steel lashing wire for the purpose of lashing cables, except fiber-optic communications cables, to a messenger cable. Use 0.045-inch stainless steel lashing wire for the aerial installation of fiber-optic communications cable to messenger cable or existing communications cable.

H. Painting

Where painting of signal equipment cabinets, signal heads, signal poles, and pedestals is

required, apply painting at the factory. No field painting will be allowed except when the paint on portions of equipment has been scratched or marred. In such cases, apply two field coats of enamel of the same color and grade as the original paint to the scratched or marred portions.

1.3. CONSTRUCTION METHODS

A. General

Before beginning signal work, verify that all existing signal equipment is in satisfactory working order. Report all defective signal equipment to the Engineer so as not to be held responsible for the defects.

Do not remove and replace more than one controller and cabinet per day, unless otherwise approved by the Engineer. Once controller and cabinet replacement has begun at a given location, complete the removal and replacement work at that location before beginning removal and replacement of a controller and cabinet at another location.

Determine the exact location of the existing conduit, cable runs, inductive detector loops, lead in cables/wires, junction boxes, and detection equipment before installing or using equipment that may damage or interfere with such facilities. The location of existing inductive detection loops, associated junction boxes and conduits where shown on the Plans are approximate.

Locate all underground utilities before beginning drilling, digging, or trenching operations.

Immediately cease work and notify the Engineer and the affected owners if damage to existing utilities, cables, or equipment occurs. Make all required repairs and replacements at no additional cost to the Department.

Utilize IMSA Level II Technicians to perform all cabinet placement, cabinet wiring and controller programming. Program the controllers and wire the cabinets so that the phasing, type of operation (time-based, volume density, or special sequences), loop to phase assignments, and phase numbering assignments match the existing assignments, unless otherwise directed by the Engineer.

At the end of each workday, clean and clear the work site of excess excavation, waste packing material, wire, and all other debris that results from traffic signal system work. Haul and dispose of all waste as required by Section 802 of the Standard Specifications.

B. Contractor's Office

Throughout the project, the Contractor shall maintain an office with storage and testing facilities within the Gastonia City Limits.

C. System Integration

Integrate all components of the system. Compliance with the operational and technical specifications of these Project Special Provisions pertaining to individual elements of the system does not in itself meet the requirement to provide a complete, fully functional, and integrated traffic signal system.

D. Sequence of Construction

As shown on the Sequence of Construction Detail in the Plans, each traffic signal location has been defined a Zone. Zone A includes traffic signals that are not part of the existing Gastonia Signal System. Zone B includes traffic signals that are part of the existing Gastonia Signal System. Zone C includes traffic signals along Franklin Boulevard and along the existing communications route to the Municipal Operations Center building.

Construction at Zone A traffic signals may be completed at any time during this project.

Construction at Zone B traffic signals may be completed at any time during this project, but with minimal disruption to the existing signal system operations. After taking down an existing communication channel, the contractor must complete all construction for traffic signals in that channel in a time period no greater than one day per traffic signal in that channel.

Construction at Zone C traffic signals may not begin until all construction of Zone B traffic signals are complete. After taking down an existing communication channel, the contractor must complete all construction for traffic signals in that channel in a time period no greater than one day per traffic signal in that channel.

Construction at CCTV and other non-signal locations may be completed at any time during this project.

E. Related Projects

The Plans and these Project Special Provisions assume that NCDOT project U-2408, which installs fiber optic communications cable along Bessemer City Road between Franklin Boulevard and Interstate 85, will be completed prior to construction of this project. Coordinate with Engineer if U-2408 construction is not complete for actions to be taken until construction is complete.

F. Regulations and Codes

Furnish material and workmanship conforming to the National Electric Code (NEC), the National Electric Safety Code (NESC), and all local safety codes in effect on the date of advertisement. Comply with Article 4, Chapter 87 of the North Carolina General Statutes (Licensing of Electrical Contractors). Comply with all regulations and codes imposed by the owner of affected

utility poles. In the event of a conflict between these documents and the specifications contained herein, the cited documents will govern.

Notify the Engineer, local traffic enforcement agency, local utility company, and any affected railroad companies seven business days before operational shutdowns to coordinate connection or disconnection to an existing utility or system.

Install standoffs, meter bases, and service disconnects as required by the NESC, the NEC, local utility companies, and ordinances.

G. Electrical Requirements

Ensure that an IMSA certified, or equivalent, Level II traffic qualified signal technician is standing by to provide emergency maintenance services whenever work is being performed on traffic signal controller cabinets and traffic signal controller cabinet foundations. Stand by status is defined as being able to arrive, fully equipped, at the work site within 30 minutes ready to provide maintenance services.

All electrical equipment shall conform to the applicable standards of the National Electrical Manufacturers Association (NEMA), the Electronic Industries Association (EIA), the International Municipal Signal Association (IMSA), the Rural Electrification Administration (REA), the National Electric Code (NEC), and the National Electrical Safety Code (NESC).

Furnish materials and workmanship conforming to the latest requirements of the Standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI); and all local ordinances and regulations.

H. Utility Services

Coordinate all work to ensure that electrical power of the proper voltage, phase, frequency, and ampacity is available to complete the work. Use electrical service cables that have THW insulation.

When electrical and telecommunication service is not furnished by the Department and is required, contact the utility company and make application to ensure that all work can be completed. Obtain authorization for service in the Department's name and make application for service in the Department's name.

The Department will be responsible for direct payment of utility company charges.

I. Maintenance and Repair of Materials

Furnish the Engineer with the name, office telephone number, cellular (mobile) telephone number, and pager number of the supervisory employee who will be responsible for repair calls

during all hours. An up to date list of these names and phone numbers shall be given to the Engineer. Any changes in personal affecting this list shall be immediately communicated to the Engineer in writing.

Once the controller and cabinet have been replaced at an intersection, maintain the new cabinet, controller and all other items furnished and installed with this contract. For these items, begin to make necessary repairs to failures, malfunctions, or damages within two (2) hours of notification and complete the necessary repairs within eight (8) hours of notification. Remove all material that fails and install replacement material. Replace failed material with new material at no additional cost to the Department.

Maintain traffic flow according to Section 150 of the Standard Specifications during maintenance and repair operations.

Repair scratches, dents, or other damage to the cabinet that occur while the cabinet is under your responsibility.

Should you fail to make necessary repairs to the traffic signal installation within the specified time, the Department or its agent may make the repairs and deduct the cost from any money due you. The inability to contact the supervisory employee or a prearranged alternate shall not extend the response time requirements

Except for damages and malfunctions caused by the contractor's work activities, the contractor will not be held responsible for pre-existing conditions that were reported to the Engineer before starting traffic signal work at the specific intersection. The contractor will assume responsibility for all maintenance and emergency services necessary once traffic signal work has begun at the specific intersection, and for all damages and malfunctions caused either directly or indirectly by the contractor's work activities.

In the event the contractor fails to perform in accordance with the plans and specifications within the time frame specified, the Department reserves the right to perform the maintenance and emergency service necessary to assure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option will be deducted from the payment due the contractor, plus a $2,500 liquidated damage per occasion, per day, or any portion thereof, until corrected. The liquidated damages are due to increased public hazard resulting from the malfunction.

Perform yearly maintenance on all Traffic Signal Conflict Monitors. The year shall be defined from the date of installation of the controller and cabinet at an intersection. Use the Signal Monitor Tester described in **Section 38**. Ensure that the Signal Monitor Tester is maintained and calibrated

per the manufactures recommendation. Provide to the Engineer a copy of the manufacture's certification that the Signal Monitor Tester has been certified before testing any Traffic Signal Conflict Monitors. Perform the test on each Traffic Signal Conflict Monitor per the manufactures recommendation. Provide one (1) copy of the Traffic Signal Conflict Monitor test results to the Engineer. Place one (1) copy in the Traffic Signal Cabinet. Perform these yearly tests for the life of the project.

Items reused (that are unmodified), such as signal heads, signal cable, local detector loops and lead-in cable, will be maintained by others. Maintain traffic signal system equipment until completion of the 90-day Observation Period and written notification of final acceptance of the project has been received from the Engineer.

J. Removal of Traffic Signal Equipment

Remove all Department-owned traffic signal equipment, including (but not limited to) messenger cable, communications cable not being used as support strand for newly installed communications cable, controllers, cabinets, cabinet foundations, wood poles, guy assemblies, and supporting hardware that will not be reused. Assume ownership of the removed messenger cable, communications cable, cabinet foundations, wood poles, guy assemblies, and supporting hardware. Return all other traffic signal equipment and material to the Division 12 Traffic Services Office, located at 230 Kemper Road in Shelby, between 8:00 AM and 12:00 PM, Monday through Thursday, or at a time mutually agreed to by the Contractor and Engineer. Replace or repair all material lost or damaged during its removal and transit. Label all returned equipment and material to indicate the location from which it was removed.

Remove all City of Gastonia owned traffic signal equipment, including (but not limited to) detector cable, controllers, cabinets, cabinet foundations, wood poles, guy assemblies, and supporting hardware that will not be reused. Assume ownership of the removed cabinet foundations, wood poles, guy assemblies, and supporting hardware. Return all other traffic signal equipment and material to the City of Gastonia Traffic Services, located at 1300 North Broad Street, between 8:00 AM and 12:00 PM, Monday through Thursday, or at a time mutually agreed to by the Contractor and the City Traffic Operations Supervisor. Replace or repair all material lost or damaged during its removal and transit. Label all returned equipment and material to indicate the location from which it was removed.

K. Railroad Preemption

Where railroad preemption is required, coordinate all work with the railroad company. Do not place signals into operation until signal equipment has been interconnected with required railroad-

highway crossing devices and railroad preemption is working properly. Ensure that preemption sequences begin immediately after activation of train detection.

Contact and coordinate with the railroad company to schedule interconnection of the signal to the railroad controller cabinet. Install lead-in cable between the signal controller cabinet and the railroad company control cabinet for the railroad crossing. Install wire from the signal controller cabinet to a railroad company furnished and installed lockable junction box. Interconnection will be made by the railroad company.

Provide fail-safe operation such that removal of voltage from the railroad side of the isolation relay will initiate the railroad preemption sequence.

L. Vehicle Preemption Systems

Where vehicle preemption systems are required, implement and install vehicle preemption systems. Coordinate vehicle preemption work with the proper operating authority. Contact the proper operating authority and schedule installation of preemption equipment.

M. Timing of Signals

Implement timing values for signal controllers.

Reinstall all existing time-based coordination. As directed, make modifications to existing coordination to account for changes in signal phasing.

The Department reserves the right to make, or have the contractor make at no cost to the Department, field timing changes necessary for pattern optimization and to eliminate identifiable, potential hazards to the motoring public. The Engineer will notify the contractor of timing changes made.

N. Wire and Cable

For installation in a conduit system, lubricate cable and wires prior to installing in conduit. Use lubricant that will not physically or chemically harm the cable jacket, wire insulation, and conduit.

Splice all electrical wire and cable at recessed-screw, barrier type terminal blocks or in junction boxes. Unless specifically allowed, connect no more than two conductors to the same terminal screw.

Maintain color coding of wires through splices.

Protect ends of wire and cable from water and moisture.

Install all wire and cable with necessary hardware including, but not limited to deadend

strandvises, shoulder eyebolts, washers, nuts, thimbleyelets, three-bolt clamps, J-hooks, split bolt connectors, grounding clamps, and lashing material.

O. Grounding

Provide a grounding system at all new and revised electrical service points unless otherwise noted. Conform to the provisions of the Standard Specifications at all times, unless noted in these Project Special Provisions.

Provide a length of marker tape at a depth of 1 to 1.5 feet directly over grounding electrodes and conductors.

P. Electrical Bonding

Using an approved termination means, connect a Number 14 AWG min. 19-strand copper conductor (Type THW) with green insulation to serve as an equipment grounding conductor to metal poles with mast arm supports, vehicular and pedestrian signal pedestals, and other metallic components which are not otherwise bonded through means approved by the Engineer. Only bond equipment installed by the Contractor.

Q. Requirements for Cables Crossing Railroads

Copies of all executed railroad agreements and related correspondence may be obtained from the Resident Engineer prior to selection of the project Contractor.

Q.1. Railroad Crossings

Do not commence cable routings over or under railroad-owned facilities until notification and coordination with Engineer and the appropriate railroad company has occurred. All affected railroad facilities on this project are listed below and owned by the North Carolina Department of Transportation Rail Division (NCDOTRD) or Norfolk Southern Railway Company (NSRC). Install fiber optic communications cable as shown on the plans.

Encroachment	Near	Agency	Route
Trenton Street	Airline Avenue	NSRC	Overhead Crossing
Marietta Street	Davidson Avenue	NSRC	Overhead Crossing
Long Avenue	Broad Street	NSRC	Sub-Grade Crossing
Second Avenue	Broad Street	NSRC	Overhead Crossing
Garrison Avenue	Marietta Street	NSRC	Overhead Crossing
Long Avenue	Poplar Street	NCDOTRD	Overhead Crossing

New Hope Road	Ozark Avenue (North)	NCDOTRD	Overhead Crossing
New Hope Road	Ozark Avenue (South)	NSRC	Overhead Crossing
Wilkinson Boulevard	Grove Street	NSRC	Overhead Crossing
York Road	Hudson Boulevard	NSRC	Overhead Crossing and Parallel

Q.2. Requirements for Insurance

In addition to any other forms of insurance or bonds required elsewhere in the contract documents and prior to commencing any work, the Contractor will be required to provide coverage conforming to the requirements of the Federal-Aid Policy Guide outlined under 23 CFR 646A for all work to be performed on the Railroad right of way under the terms of the contract. The Contractor shall maintain railroad insurance at all times until the final inspection and acceptance of the project.

The Contractor shall carry insurance of the following kinds:

Q.2.1. Contractor's General Liability and Property Damage Insurance

Furnish a copy of the certificate of insurance to the Department of Transportation as evidence that, with respect to the operations performed on railroad right of way, Contractor's General Liability Insurance providing for limits of liability as follows:

Coverage	Minimum Combined Limits Of Liability
Bodily Injury Liability	$2,000,000 Per Occurrence
Property Damage Liability	$2,000,000 Aggregate

If any part of the work is sublet, similar insurance and evidence thereof in the same amounts as required of the Prime Contractor, shall be provided by the subcontractor to cover his operations on railroad right of way. As an alternative, the Prime Contractor may provide for the subcontractor by means of separate and individual policies.

Certificates of Insurance holders are to be the addresses given below. Certificates shall make reference to the project, milepost and county.

NCDOT Rail Division
1 South Wilmington Street
Raleigh NC 27601

Norfolk Southern Railway Company
Real Estate and Contract Services
Suite 1650, One Georgia Center
600 West Peachtree Street, N.W.
Atlanta, GA 30308-3603

Q.2.2. Railroad Protective Liability Insurance

Furnish to the Department of Transportation two originals and one duplicate of the Railroad Protective Liability Insurance Policy with limits of liability as follows:

Coverage	Minimum Combined Limits Of Liability
Combined Protective Bodily Injury Liability, Protective Property Damage Liability, and Physical Damage to Property	$2,000,000 Per Occurrence, $6,000,000 Aggregate Per Annual Policy Period

The Railroad Protective Liability Policy is to be written on the ISO/RIMA Form No. CG 00 35 10 93 (or updates thereof) including Endorsements CG 28 31 11 85 and IL 00 21 or their equivalents.

The named insured, description of the work and designation of the job site to be shown on the Policy are as follows:

Names Insured: NCDOT Rail Division
1 South Wilmington Street
Raleigh NC 27601

Norfolk Southern Railway Company
Suite 1650, One Georgia Center
600 West Peachtree Street, N.W.
Atlanta, GA 30308-3603

Description and Designation: Installation of fiber optic communications cable (over/under) tracks of the NCDOT Rail Division/Norfolk Southern Railway Company, _____ County near Railroad Milepost _____ identified as State Project _____ and Federal Project _____.

The Railroad Protective Liability Policy, all other policies and certificates shall contain a clause requiring that thirty (30) days written notice be given the Department of Transportation and the

Railroad Company prior to cancellation or change. The notices shall make reference to the project, milepost and county.

Notice To:	Norfolk Southern Railway Company Suite 1650, One Georgia Center 600 West Peachtree Street, N.W. Atlanta, GA 30308-3603
Copy Notice To:	Division of Highways Department of Transportation c/o State Contractual Services Engineer P.O. Box 25201 Raleigh, NC 27611

It is understood that the amounts specified are minimum amounts and that the Contractor may carry insurance in larger amounts if he so desires. As to "aggregate limits", if the insurer establishes loss reserves equal to or in excess of the aggregate limit specified in any of the required insurance policies, immediately notify the Department of Transportation and cease all operations until the aggregate limit is reinstated. If the insurer establishes loss reserves equal to or in excess of one/half of the aggregate limit, arrange to restore the aggregate limit to at least the minimum amount stated in these requirements. Any insurance policies and certificates taken out and furnished due to these requirements shall be approved by the Department of Transportation and the Railroad Company as to form and amount prior to beginning work on railroad right of way.

No extra allowance will be made for the insurance required hereunder. The entire cost shall be included in the unit contract bid price for other pay items.

Furnish evidence of insurance as required above for review to the Department of Transportation at the address shown below after which it will be forwarded by the Department of Transportation to the Railroad.

Send to Department:	Division of Highways Department of Transportation c/o State Contractual Services Engineer 1509 Mail Service Center Raleigh, NC 27699-1509

Q.3. Delays Caused By Operations of Others

Neither the Department of Transportation nor the Railroad Company assumes any responsibility for any work performed by others in connection with the construction of the project, and the Contractor shall have no claim whatsoever against the Department of Transportation, or the Railroad Company for any inconvenience, delay, or additional cost incurred by him on account of such operations by others.

Q.4. Cooperation with Others

Cooperate with others participating in the construction of the project to the end that all work may be carried on to the best advantage.

Q.5. Authority of Railroad Engineer

The authorized representative of the Railroad Company hereinafter referred to as the Railroad Engineer, shall have the final authority in all matters affecting the safe maintenance of railroad traffic of his company.

Q.6. Interference with Railroad Operations

Arrange and conduct work so that there will be no interference with railroad operations, including train, signal, telephone and telegraphic services, or damage to the property of the Railroad Company or to the poles, wire, and other facilities of tenants on the rights of way of the Railroad Company. Wherever work is liable to affect the operations or safety of trains, the method of doing such work shall first be submitted to the Railroad Engineer for approval, but such approval shall not relieve the Contractor from liability.

Should conditions arising from or in connection with the work, require that immediate and unusual provisions be made to protect train operations and property of the Railroad Company, it shall be a part of the required services by the Contractor to make such provisions and if, in the judgment of the Railroad Engineer such provisions are insufficient, the Railroad Engineer or the Department of Transportation, may at the expense of the Contractor, require or provide such provisions as may be deemed necessary.

Q.7. Storage of Materials

Materials and equipment shall not be stored where they will interfere with railroad operations, nor on the rights of way of the Railroad Company without first having obtained permission from the Railroad Engineer, and such permission will be with the understanding that the Railroad Company will not be liable or damage to such material and equipment from any cause and that the Railroad Engineer may move or require the Contractor to move, at the Contractor's expense, such material

and equipment.

Q.8. Flagging Protection or Watchman Service

The Contractor shall give 72 hours advance notice to the Railroad Company in order that flagging service can be arranged and provided. No work shall be undertaken until the flagman is at the job site.

Q.9. Completion and Acceptance of Work

Upon completion of the work, remove from within the limits of the railroad right of way all machinery, equipment, surplus materials, or rubbish and leave said rights of way in a neat and orderly condition. After the final inspection has been made and work found to be completed in a satisfactory manner acceptable to the Department of Transportation and the Railroad Company, the Department of Transportation will be notified of the Railroad Company's acceptance in writing by the Railroad Company.

1.4. BASIS OF PAYMENT

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section.

2. MOBILIZATION

2.1. DESCRIPTION

This work consists of preparatory work and operations, including but not limited to the movement of personnel, equipment, supplies, and incidentals to the project site, for the establishment of offices, buildings, and other facilities necessary for work on the project; the removal and disbandment of those personnel, equipment, supplies, incidentals, or other facilities that were established for the prosecution of work on the project; and for all other work and operations which must be performed for costs incurred prior to beginning work on the various items on the project site.

2.2. COMPENSATION

All work covered by this section will be paid for at the contract lump sum price for "Mobilization."

Partial payments for the item of "Mobilization" will be made with the first and second partial pay estimates paid on the contract, and will be made at the rate of 50% lump sum price for "Mobilization" on each of these partial pay estimates, less than the retainage provided for in Article 109-4 of the Standard Specifications, provided the amount bid for "Mobilization" does not exceed 5 percent of the total amount bid for the contract. Where the amount bid for the item of "Mobilization" exceeds 5 percent of the total amount bid for the contract 2 1/2 percent of the total amount bid will be paid on each of the first two partial pay estimates, and that portion exceeding 5 percent will be paid on the last partial pay estimate. All such payments will be made less the retainage provided for in Article 109-4 of the Standard Specifications.

Payment will be made under:

Mobilization ..... Lump-Sum

3. SIGNAL HEADS

3.1. DESCRIPTION

Furnish and install signal heads and signal cable with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

The City of Gastonia and NCDOT will modify all existing signal heads on this project to include LEDs. The Contractor is not responsible for modifying existing signal heads to include LEDs. The Contractor is responsible for installing all new signal heads on this project.

Furnish vehicle signal heads with light emitting diode (LED) sections, visors, interconnecting brackets, reflectors, wire entrance fittings, glass lenses, signal lamps, messenger cable mounting assemblies, mast arm mounting assemblies, pedestal mounting assemblies, signal cable, side-of-pole mounting assemblies, lashing wire, pedestrian push buttons, R10-3B signs, grounding systems and all necessary hardware.

3.2. MATERIAL

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

A. General

Fabricate vehicle signal head housings and end caps from die-cast aluminum. Fabricate 12 inch and 16 inch pedestrian signal head housings and end caps from die-cast aluminum. Fabricate 9 inch pedestrian signal head housings, end caps, and visors from virgin polycarbonate material. Provide visor mounting screws, door latches, and hinge pins fabricated from stainless steel. Provide interior screws, fasteners, and metal parts fabricated from stainless steel or corrosion resistant material.

Fabricate tunnel and traditional visors from sheet aluminum.

Paint all surfaces inside and outside of signal housings and doors. Paint outside surfaces of tunnel and traditional visors, messenger cable mounting assemblies, pole and pedestal mounting assemblies, and pedestrian pushbutton housings. Have electrostatically applied, fused-polyester paint in highway yellow (Federal Standard 595A, Color Chip Number 13538) a minimum of 2.5 to 3.5 mils (64 to 89 μm) thick. Provide dull black polycarbonate visors. Impregnate color into polycarbonate signal heads. Do not apply paint to the latching hardware or rigid vehicle signal head mounting brackets.

Have the interior surfaces of tunnel and traditional visors painted an alkyd urea black synthetic baking enamel with a minimum gloss reflectance and meeting the requirements of MIL-E-10169, "Enamel Heat Resisting, Instrument Black."

For pole mounting, provide side of pole mounting assemblies with framework and all other hardware necessary to make complete, watertight connections of the signal heads to the poles and pedestals. Fabricate the mounting assemblies and frames from aluminum with all necessary hardware, screws, washers, etc. to be stainless steel. Provide mounting fittings that match the positive locking device on the signal head with the serrations integrally cast into the brackets. Provide upper and lower pole plates that have a 1 1/4 inch vertical conduit entrance hubs with the hubs capped on the lower plate and 1 1/2 inch horizontal hubs. Ensure that the assemblies provide rigid attachments to poles and pedestals so as to allow no twisting or swaying of the signal heads. Ensure that all raceways are free of sharp edges and protrusions, and can accommodate a minimum of ten Number 14 AWG conductors.

For pedestal mounting, provide a post top slipfitter mounting assembly which matches the positive locking device on the signal head with serrations integrally cast into the slipfitter. Provide stainless steel hardware, screws, washers, etc. Provide a minimum of six 3/8 x 3/4 inch square head bolts for attachment to pedestal. Provide a center post for multi-way slipfitters.

B. Vehicle Signal Heads

Comply with the ITE standard "Vehicle Traffic Control Signal Heads (VTCSH)" in effect on the date of advertisement. Provide housings with provisions for attaching backplates.

Provide visors that are 8 inches in length for 8 inch vehicle signal head sections. Provide visors that are 10 inches in length for 12 inch vehicle signal heads.

Provide a termination block with one empty terminal for field wiring for each indication plus one empty terminal for the neutral conductor. Have all signal sections wired to the termination block. Provide barriers between the terminals that have terminal screws with a minimum Number 8 thread size and that will accommodate and secure spade lugs sized for a Number 10 terminal screw.

Mount termination blocks in the yellow signal head sections on all in-line vehicle signal heads. Mount the termination block in the red section on five-section vehicle signal heads.

Furnish vehicle signal head interconnecting brackets. Provide one piece aluminum brackets less than 4.5 inches in height and with no threaded pipe connections. Provide brackets that match the positive locking device on the signal head and with the serrations integrally cast into the bracket. Provide brackets with raceways free of sharp edges and protrusions, and that are able to

accommodate a minimum of ten Number 14 AWG conductors. Provide hand holes on the bottom of the brackets to aid in installing wires to the signal heads. Lower brackets that carry no wires and are used only for connecting the bottom signal sections together may be flat in construction.

For messenger cable mounting, provide messenger cable hangers, wire outlet bodies, balance adjusters, bottom caps, wire entrance fitting brackets, and all other hardware necessary to make a complete, watertight connections of the vehicle signal heads to the messenger cable. Fabricate mounting assemblies from malleable iron and provide serrated rings made of aluminum. Provide messenger cable hangers and balance adjusters that are galvanized before being painted. Fabricate balance adjuster eyebolt and eyebolt nut from stainless steel or galvanized malleable iron. Provide messenger cable hangers with U-bolt clamps. Fabricate washers, screws, bolts, clevis pins, cotter pins, nuts, and U-bolt clamps from stainless steel.

For mast-arm mounting, provide rigid vehicle signal head mounting brackets and all other hardware necessary to make complete, watertight connections of the vehicle signal heads to the mast arms and to provide a means for vertically adjusting the vehicle signal heads to proper alignment. Fabricate the mounting assemblies from malleable iron or aluminum, and provide serrated rings made of aluminum.

C. Light Emitting Diode (LED) Sections

C.1. Vehicular

Provide light emitting diode (LED) traffic signal modules (hereafter referred to as modules) that consist of an assembly that utilizes LEDs as the light source in lieu of an incandescent lamp for use in traffic signal sections. Use LEDs that are aluminum indium gallium phosphorus (AlInGaP) technology for red and yellow indications and indium gallium nitride (InGaN) for green indications. Install the ultra bright type LEDs that are rated for 100,000 hours of continuous operation from -40°F to +165°F. Design modules to have a minimum useful life of 60 months, and to meet all parameters of this specification during this period of useful life.

Ensure, unless otherwise stated in these specifications, that each module meets or exceeds the requirements of the Interim Purchase Specification of the ITE VTCSH part 2 (Light Emitting Diode (LED) Vehicular Traffic Signal Modules (hereafter referred to as VTCSH-2). Ensure arrow displays meet or exceed the electrical and environmental operating requirements of VTCSH-2 sections 3 and 5, chromaticity requirements of section 4.2, and the requirements of sections 6.3 (except 6.3.2) and 6.4 (except 6.4.2).

Provide modules that meet the requirements of **Table 1**. Design the modules to operate from a 60 ±3 HZ AC line voltage ranging from 80 volts to 135 volts. Ensure that fluctuations of line voltage

have no visible effect on the luminous intensity of the indications. Design the module to have a normal operating voltage of 120 VAC, and measure all parameters at this voltage.

Table 1. Maximum Power Consumption (in Watts) at 77°F

	Red	Yellow	Green
300 mm circular	17	34	24
200 mm circular	10	16	12
300 mm arrow	9	10	11

Certify that the module has a power factor of 0.90 or greater, and that total harmonic distortion (THD) (current and voltage) induced into an AC power line by the module does not exceed 20 percent for modules with power ratings above 15W, and 40 percent for modules with power ratings of 15W or less. Design the module's onboard circuitry to include voltage surge protection to withstand high repetition noise transients as stated in Section 2.1.6 of NEMA Standard TS-2, 1992. Ensure all wiring meets the requirements of Section 13.02 of the ITE Publication: Equipment and Material Standards, VTCSH-2. Provide spade terminals appropriate to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard signal head.

Ensure that the module is compatible with signal load switches and conflict monitors. Design the module to provide sufficient current draw to ensure proper load switch operation while the voltage is varied from a regulated 80 Vrms to 135 Vrms. Design off-state for green and yellow modules to be 30 Vrms or greater, and on-state to be 40 Vrms or greater. Design the voltage decay to 10 Vrms or less to be 100 milliseconds or less for green and yellow modules. Ensure that the control circuitry prevents current flow through the LEDs in the off state to avoid a false indication.

Design all modules to meet existing NCDOT monitor specifications for each of the following types of signal monitors: NEMA TS-1 conflict monitors (including so-called NEMA plus features such as dual indication detection and short yellow time detection); NEMA TS-2 Malfunction Management Units (MMU); and 170 cabinet Type 210ECL and 2010ECL conflict monitors (including red monitoring and so-called plus features such as dual indication detection and short yellow time detection).

Ensure that the modules and associated onboard circuitry meet Class A emission limits referred to in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

Provide modules that meet the requirements of **Table 2**, **Table 3**, and **Table 4**. Test all ball modules for luminous intensity at 77°F to meet 115% of values in **Table 2** and **Table 4**. Design and

certify the modules to meet or exceed the maintained minimum luminous intensity values throughout the warranty period based on normal use in a traffic signal operation over the operating temperature range. Test the Red and Green modules for maintained luminous intensity (**Table 2**, **Table 3**, and **Table 4**) at 165°F (ITE 6.4.2.2). Use LEDs that conform to the chromaticity requirements of VTCSH-2, Section 8.04 throughout the warranty period over the operating temperature range. Make chromaticity coordinate compliance measurements at 77°F.

Table 2. Specification for 12 inch Extended View Signals

Minimum Luminous Intensity Values (In Candelas)				
Expanded View Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
+/-2.5	2.5	339	678	678
	7.5	251	501	501
	12.5	141	283	283
	17.5	77	154	154
+/-7.5	2.5	226	452	452
	7.5	202	404	404
	12.5	145	291	291
	17.5	89	178	178
	22.5	38	77	77
	27.5	16	32	32
+/-12.5	2.5	50	101	101
	7.5	48	97	97
	12.5	44	89	89
	17.5	34	69	69
	22.5	22	44	44
	27.5	16	32	32
+/-17.5	2.5	22	44	44
	7.5	22	44	44
	12.5	22	44	44
	17.5	22	44	44
	(Not Extended View) 22.5	20	41	41
	(Not Extended View) 27.5	16	32	32
+/-22.5	2.5	20	40	40
	17.5	20	40	40

Notes
1. Design signal modules to meet these requirements as a minimum throughout the warranty period.
2. Design signal modules to have a minimum initial intensity equal to 115% of Table 2 at 25°C.
3. Independent laboratory test reports are required to validate the initial intensity.

Table 3. Minimum Initial and maintained Intensities for Arrow Indications (in cd/m2)

	Red	Yellow	Green
Arrow Indication	5,500	11,000	11,000

Table 4. Specification for 8 inch Extended View Signals

Minimum Luminous Intensity Values (In Candelas)for circular indications				
Expanded View Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
+/-2.5	2.5	133	267	267
	7.5	97	194	194
	12.5	57	113	113
	17.5	25	48	48
+/-7.5	2.5	101	202	202
	7.5	89	178	178
	12.5	65	129	129
	17.5	41	81	81
	22.5	18	37	37
	27.5	10	20	20
+/-12.5	2.5	37	73	73
	7.5	32	65	65
	12.5	28	57	57
	17.5	20	41	41
	22.5	12	25	25
	27.5	9	16	16
+/-17.5	2.5	16	32	32
	7.5	14	28	28
	12.5	10	20	20
	17.5	9	16	16
	(Not Extended View) 22.5	6	12	12
	(Not Extended View) 27.5	4	9	9

Notes

1. Design signal modules to meet these requirements as a minimum throughout the warranty period.
2. Design signal modules to have a minimum initial intensity equal to 115% of Table 4 at 25°C.
3. Independent laboratory test reports are required to validate the initial intensity.

Table 5. Chromaticity Standards (CIE Chart)

Red	Y: not greater than 0.308, or less than 0.998 - x
Yellow	Y: not less than 0.411, nor less than 0.995 - x, nor less than 0.452
Green	Y: Not less than 0.506 -.519x, nor less than 0.150 + 1.068x, nor more than 0.730 - x

Design the modules as retrofit replacements for installation into standard incandescent traffic sections that do not contain the incandescent lens, reflector assembly, lamp socket and lens gasket. Ensure that installation does not require special tools or physical modification for the existing fixture other than the removal of the incandescent lens, reflector assembly, lamp socket, and lens gasket.

Provide modules that are rated for use in the operating temperature range of –40° F to +165° F. Ensure that the modules (except yellow) meet all specifications throughout this range. Fabricate the module to protect the onboard circuitry against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal components.

Design the module to be a single, self-contained device with the circuit board and power supply for the module inside and integral to the unit.

Design the assembly and manufacturing process for the module to ensure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources. Wire the individual LEDs such that a catastrophic loss or the failure of one LED will result in the loss of not more than 20 percent of the signal module light output. Solder the LEDs to the circuit board.

Fabricate the lens and signal module from material that conforms to ASTM specifications. Ensure enclosures containing either the power supply or electronic components of the module are made of UL94VO flame retardant materials. The lens of the signal module is excluded from this requirement.

Permanently mark the manufacturer's name, trademark, model number, serial number, date of manufacture (month & year), and lot number as identification on the back of the module.

Permanently mark the following operating characteristics on the back of the module: rated voltage and rated power in watts and volt-amperes.

If a specific mounting orientation is required, provide permanent markings consisting of an up arrow, or the word "UP" or "TOP" for correct indexing and orientation within the signal housing.

Provide a lens that is integral to the unit with a smooth outer surface and UV stabilized to withstand ultraviolet exposure for a minimum period of 60 months without exhibiting evidence of deterioration. Coat the front of a polycarbonate lens to make it more abrasion resistant. Seal the lens to the module to prevent moisture and dust from entering the module.

Tint the red and yellow lens to match the wavelength (chromaticity) of the LED. Provide a green lens that is either colorless or tinted to match the wavelength (chromaticity) of the LED.

For 12-inch arrow modules, ensure that the module meets specifications stated in Section 9.01 of the ITE VTCSH for arrow indications. Design arrow displays to be solid LEDs (spread evenly across the illuminated portion of the arrow or other designs), not outlines. **Determine the luminous intensity using the CALTRANS 606 method or similar procedure**.

Provide test results for ball modules from an independent testing laboratory showing wattage and compliance with ITE VTCSH-2 specifications 6.4.2, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.5, and 6.4.6.1 as a minimum. Ensure the 6.4.2.1 test meets the requirements of **Table 2** and **Table 4** of this specification. The 6.4.2.2 test is for Red and Green only. Ensure that the LED signal modules tested are typical, average production units.

C.1.1. Burn In

Energize the sample module(s) (a sample of one module minimum) for a minimum of 24 hours, at 100 percent on-time duty cycle, at a temperature of +165°F before performing any qualification testing. Any failure of the module, which renders the unit non-compliant with the specification after burn-in, is cause for rejection. All specifications will be measured including, but not limited to:

- **Photometric (Rated Initial Luminous Intensity)** - Measure at +77°F. Measure luminous intensity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. Measure luminous intensity for yellow modules immediately upon energizing at the rated voltage.
- **Chromaticity (Color)** - Measure at +77°F. Measure chromaticity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. Measure chromaticity for yellow modules immediately upon energizing at the rated voltage.
- **Electrical** - Measure all specified parameters for quality comparison of production quality assurance on production modules. (rated power, etc)

C.1.2. Equipment Compatibility

In addition to the 6.4.4.5 test of modules for compatibility with controllers, conflict monitors, and load switches, perform the following test, and certify the results. Connect each signal module to the output of a standard load switch connected to a variable AC voltage supply (95 to 135 VAC). With the load switch "off," vary the AC voltage from 95 Vrms to 135 Vrms, and measure the drop across the module. Readings greater than 15 Vrms are unacceptable.

NCDOT evaluates and approves all LED Traffic Signal modules for the QPL by a standard visual inspection and blind operational survey, a compatibility test, current flow, and other random tests, in addition to reviewing the lab reports and documentation from the manufacturer. The tests are conducted at the Traffic Electronics Center in Raleigh. Ensure each 12-inch ball module is visible at 450 feet during sway conditions (extended view) until obscured by the visor. Ensure each 8-inch ball and 12-inch arrow modules are visible at 300 feet during sway conditions (extended view) until obscured by the visor. Sufficient luminance during the extended views will be determined during this blind survey evaluation.

In addition to meeting the performance requirements for the minimum period of 60 months, provide a written warranty against defects in materials and workmanship for the modules for a period of 60 months after shipment acceptance of the modules. Provide replacement modules within 30 days of receipt of modules that have failed at no cost to the State. Provide warranty documentation to the Department prior to QPL acceptance. Provide luminous intensity testing at an independent lab, to determine degradation, for two modules of each color provided by NCDOT at the end of two and four years of operation.

Provide testing at an independent laboratory for a designated module to be tested for maintained luminous intensity at 77°F once each year during the five year warranty period.

D. Signal Cable

Furnish signal cable that complies with IMSA specification 20-1 and the Standard Specifications. Furnish signal cable that matches the type and size of the existing signal cable at the intersection.

3.3. CONSTRUCTION METHODS

A. General

Install vehicle signal heads with light emitting diode (LED) sections, visors, reflectors, wire entrance fittings, glass lenses, signal lamps, interconnecting brackets, messenger cable mounting assemblies, mast arm mounting assemblies, pedestal mounting assemblies, signal cable, side of pole

mounting assemblies, lashing wire, pedestrian push buttons, R10-3B signs, grounding systems, and all necessary hardware.

Bag new vehicle signal heads with burlap bags or bags made of nonripping material specifically designed for covering signal heads until the signal heads are placed in operation.

When new signal heads are placed into operation, immediately bag and remove signals heads that are not to be reused.

Vertically and horizontally adjust each signal head so that light output will be of maximum effectiveness for the traffic. Do not tilt signal heads forward.

Reposition signal heads as required for various construction phases.

B. Vehicle Signal Heads

Install vehicle signal heads at the heights required in the North Carolina Supplement to the MUTCD in effect on the date of advertisement.

Where vehicle signal heads are installed on messenger cable, install mounting hardware consisting of a messenger cable hanger, balance adjuster, bottom cap, wire entrance fitting bracket, and insulating bushings.

Where vehicle signal heads are installed on mast arms, install mounting hardware consisting of rigid vehicle signal head mounting brackets.

Install signal cable in continuous lengths between signal controller cabinets and signal heads. Route signal cable to minimize the length of cable installed, and the number of cables and conductors in each run. Pull 36 inches of additional signal cable into controller cabinets. Do not install more than six signal heads on one neutral conductor.

Wrap signal cable to messenger cable with at least four turns of wrapping tape spaced at intervals less than 15 inches or lash signal cable to messenger cable with one 360 degree spiral of lashing wire per 12 inches.

Make electrical connections inside each signal head, signal controller cabinet, and termination compartment in metal poles. Do not splice cable outside signal heads.

Coil sufficient signal cable beside each vehicle signal head to accommodate head shifts during various construction phases. For all cables entering or leaving vehicle signal heads at final head locations, provide a minimum of 36 inches of signal cable coiled beside each head.

3.4. METHOD OF MEASUREMENT

Actual number of signal heads of each type, size, and number of sections with mounting hardware furnished, installed, and accepted.

Linear feet of signal cable shown on the plans as being necessary to complete the work. Where signal plans have been revised, the quantity as shown on the revised signal plans. No measurement for payment will be made for this pay item, and no adjustment in the contract unit price or quantity will be made for any variation from the approximate quantity shown except in accordance with Article 1098-1(F) of the Standard Specifications.

No measurement will be made of light emitting diode (LED) sections, visors, reflectors, wire entrance fittings, glass lenses, signal lamps, interconnecting brackets, messenger cable mounting assemblies, mast arm mounting assemblies, pedestal mounting assemblies, side of pole mounting assemblies, lashing wire, pedestrian push buttons, and R10-3B signs as these will be considered incidental to furnishing and installing signal heads.

No measurement will be made for signal cable that does not match the existing type of signal cable in use at the intersection.

3.5. BASIS OF PAYMENT

The quantity of signal heads, measured as provided above, will be paid for at the contract unit price each for "_____ Signal Head (_____)."

The quantity of signal cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Signal Cable."

Payment will be made under:

Vehicle Signal Head (12", 3 Section) ..... Each

Vehicle Signal Head (12", 4 Section) ..... Each

Vehicle Signal Head (12", 5 Section) ..... Each

Signal Cable ..... Linear Foot

4. SIGNS INSTALLED FOR SIGNALS

4.1. DESCRIPTION

Furnish and install signs for signals and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish signs with cable hangers, rigid sign mounting brackets, U-channel post, and all necessary hardware.

4.2. MATERIALS

Comply with Article 901-2 (Sign Fabrication) of the Standard Specifications.

Use Type III reflective sheeting, except for black sheeting. Use non-reflective for black sheeting.

Conform to the message layout, size, and color as required in the MUTCD.

For messenger cable mounting, furnish either messenger cable hangers with free-swinging, 360 degree adjustable sign brackets or three bolt clamps as directed. Furnish aluminum, galvanized steel, or stainless steel messenger cable mounted sign supporting hardware.

For ground mounting, furnish steel, 3 lb., U-channel posts with hardware for ground mounting. Comply with Article 903-2 (Sign Supports) of the Standard Specifications.

For mast-arm mounting, furnish rigid aluminum, galvanized steel or stainless steel sign mounting brackets.

4.3. CONSTRUCTION METHODS

Install signs with applicable mounting hardware. Comply with sign offsets and mounting heights as shown in the MUTCD and Standard Drawing numbered 904.50.

For messenger cable mounting, install signs a minimum of 6 inches from signal heads.

For ground mounting, comply with Article 903-3 of the Standard Specifications.

For signs mounted on mast arms, install attachment brackets to signs to allow the positions to be adjusted so that signs:

- are aimed in the required direction,
- are plumb as viewed from their respective approaches,
- may be tilted forward or backward as required,

- and may be raised or lowered on the mast arm throughout the full length of the sign.

4.4. METHOD OF MEASUREMENT

Actual number of signs for signals, without regard to the different mounting methods, furnished, installed, and accepted.

4.5. BASIS OF PAYMENT

The quantity of reflective sheeting signs, measured as provided above, will be paid for at the contract unit price each for "Sign for Signal."

Payment will be made under:

Sign for Signals.....Each

5. LED BLANKOUT SIGNS

5.1. DESCRIPTION

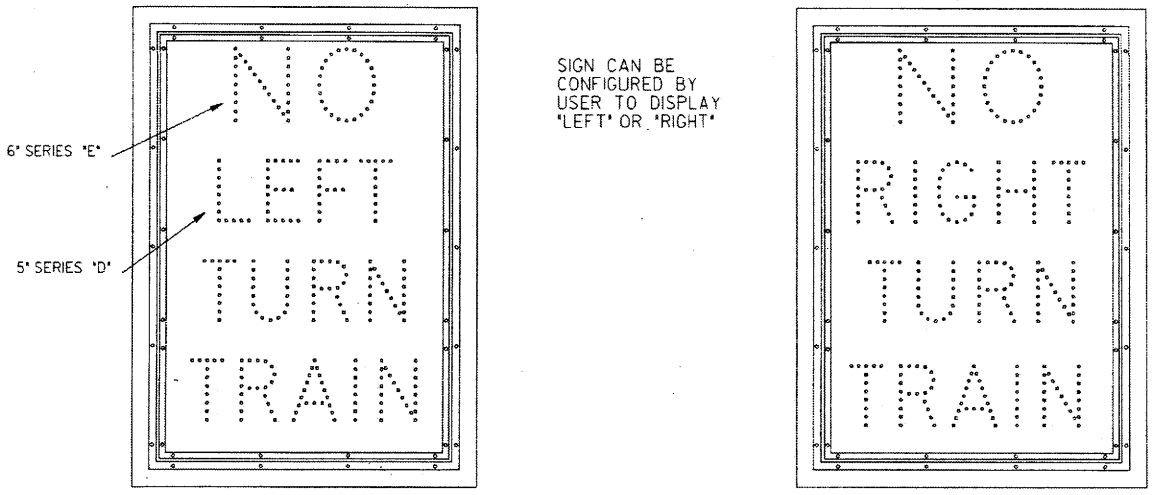
Furnish and install Light Emitting Diode (LED) blank out signs with all necessary hardware as set forth in the plans and specifications. Design the signs with the options to display "NO (LEFT or RIGHT) TURN TRAIN". Fabricate the sign to be between 27 inches and 29 inches wide, between 37 inches and 39 inches high, and approximately 8 inches deep. Comply with the provisions of Section 1700 of the Standard Specifications.

5.2. MATERIALS

Provide a modular design with the following self-contained modules: message display, rack mounted message drivers, driver rack assembly, and enclosure. Ensure that all internal components are adequately supported to withstand mechanical shock and vibration from ratings meeting AASHTO's requirements of 80 mph with a 30% gust factor. Design the display to operate without moving parts.

Provide a message display that is a PCB matrix with a mat black solder mask that has a minimum thickness of 0.093 inches and a silk screened component identifier. Mount the LEDs on the front of the PCB matrix. Mount all other components on the back of the black matrix. Ensure that a person with 20/20 vision can read a fully intensified, legible message from 500 feet in front of the sign under any light conditions. Ensure the message is not legible when the sign is off, even if in direct sunlight

Use white LEDs that are the latest InGaN technology or better with a minimum luminous intensity of 6,000 mcd at 20 mA. Distribute the LEDs evenly. Ensure that the maximum distance, center to center, between consecutive LEDs is 0.5 inches, plus or minus 10%. Connect the individual LED light sources so that failure of a single LED will result in a loss of no more than 5 LEDs. Ensure the sign is still legible. Fabricate the message using 6 inch high Series "E" letters for "NO" and 5 inch high Series "D" letters for "LEFT/RIGHT TURN TRAIN."



MESSAGE NO LEFT TURN TRAIN

- SINGLE STROKE MESSAGE
- WHITE LED's

MESSAGE NO RIGHT TURN TRAIN

- SINGLE STROKE MESSAGE
- WHITE LED's

Protect and seal the rear side of the PCB with a molded polymeric back cover. Mount the display PCB with back cover into the front door, which consist of an aluminum frame and face lens. Provide a clear 0.25-inch, non-glare, mat finish polycarbonate lens with a UV resistant surface treatment. Ensure that the lens has light transmission properties equal to or greater than 80%

Design the entire display face and door as a one piece, self contained module that can be removed from the sign housing in less than one minute without using tools. Seal the module against dust and moisture intrusion to meet the requirements of NEMA Standard 250-1991 sections 4.7.2.1 and 4.7.3.2 for type 4 enclosures.

Mount the module on the sign housing with three stainless steel "lift-off" hinges, and latch it with a minimum of two stainless steel ¼ turn link locks. Provide a retaining rod to hold the door in the open position. Configure the front door frame assembly to cover a gutter surrounding the full perimeter of the housing body and fit flush to the exterior of the body.

Fabricate the weatherproof housing out of 0.125 inch aluminum with all corner seams welded their full length. Weld the full length of all corner seams using tungsten inert gas method. Provide a 1-inch diameter vent plug in four bottom corners of the housing to prevent the collection of water from possible gasket leaks. Ensure each vent plug has a corrosion resistant screen, which allows the

passage of water but does not allow insects to enter the housing. Install a terminal block that accommodates a spade lug sized for a number 10 terminal screw. Provide 4 terminals with each having 2 terminal screws that have a shorting bar between them.

Fabricate a mounting fitting and entrance for wires to be compatible with standard traffic signal mounting hardware using Pelco type die cast aluminum mounting hubs with 1.5 inch threaded nipples. Provide stainless steel nuts, bolts, screws, washers, lock washers, etc. Do not use self-tapping fasteners on the exterior of the sign. Ensure that all mechanical fasteners are stainless steel.

Provide a standard 7-inch deep sun visor made of 1/16-inch aluminum. Paint the inside of the visor with two (2) coats of dull black paint. Paint the exterior and interior of the sign case and the outside of the visor Federal Standard 595A yellow by the dry powder method. Apply the yellow finish by electrostatic spray and heat cure. Ensure the thickness of the finish is a minimum of 2.5 mils (64 μm) thick. Apply no paint to the latching hardware.

Provide an aluminum driver rack assembly that is a single part, self-contained module consisting of an interconnect PCB and an anodized aluminum frame. Ensure that it is vented from top to bottom and has latches to lock the modules in place. Design the driver rack assembly to be easily removable in less than one minute without the use of tools.

Design the driver modules to be industry standard 6.5 x 4.5 inches rack mounted. Provide driver modules that consist of a PCB with aluminum front plate and handle as used for inductive loop detectors. Ensure that the LED current does not exceed the manufacturer's maximum current rating. Ensure that the driver modules are fused. Provide voltage surge protection to withstand high repetition noise transients and low repetition high energy transients as stated in section 2.1.6 of the NEMA Standard TS-2, 1992.

Ensure compatibility and proper triggering and operation with load switches and conflict monitors in signal controllers currently used by the Department. Ensure the on-board circuitry meets FCC title 47, sub-part B, section 15 regulations on the emission of electronic noise. Design the driver modules to maintain a constant LED drive current regardless of the outside temperature.

Design the driver modules to automatically reduce the light intensity of the display by 35% based on the ambient light to reduce long term degradation of the LEDs. Include a 30-second delay to prevent interference caused by extraneous light. Provide an alarm signal that will appear as a high impedance to the power source from the controller cabinet if the display is not operational. Provide a green LED for power status and a red LED for alarm status on the drive module.

Design the interconnect PCB to include terminals for all field wiring, 120 VAC controls, external

photocell, and alarm signals. Design all interconnections within the sign to be accomplished through the PCB with no internal wiring with the exception of a single cable for the message display and wires from the input terminal block. Provide a multi-conductor cable with an individual 2-pin connector for each word. Identify all connectors and terminals by the silk screen identifier on the surface of the PCB. Mount all PCBs vertically to facilitate air-cooling and to prevent collection of dust and moisture

Design and certify the LED blank out sign to operate over a temperature range of -35° F to 165° F with an operating voltage range of 105 to 130 volts (60 Hertz). Ensure that all electronic components are standard industry items that are available from wholesale electronics distributors. Provide components that are "solid state" type. Do not use electro-mechanical components such as relays, transformers or solenoids.

Guarantee the materials and workmanship of all equipment provided under this section for a period of five years. All warranties and guarantees that are customarily issued by the equipment manufacturers that exceed this requirement will be acceptable to the Department. Begin the warranty period on the date of the final acceptance of all work if contractor supplied, or on the date of installation if supplied to the Department by a manufacturer or manufacturer's representative. Guarantee all parts and labor necessary or incidental to the repair of any defect in equipment or workmanship and malfunctions that arise during the guarantee period. Provide the guarantee to the Department in writing prior to final acceptance of the work and material. Obtain the Engineer's approval of the guarantee's wording.

Ensure that the manufacturer's warranties and guarantees delivered to a contractor includes the provision that they are subject to transfer to the Department or its designated maintaining agency, and provide proper validation from the manufacturer. Transfer warranties and guarantees to the Department at the time of acceptance of the work.

The state has the discretion to perform warranty work at the Traffic Electronics Center by NCDOT electronics technicians or to have warranty work performed by the vendor. The vendor will provide bench repair training on the manufacturer's equipment as required by the bid document or plans at no additional cost to the State unless otherwise specified. In addition to any formal training requirements, the vendor agrees to provide the following upon request: 1) Prompt technical support to the State repair personnel during the contract and for a period of one year after the end of the warranty period at no cost to the State; 2) Provide parts to the Traffic Electronics Center for all warranty repairs at no cost to the State (defective parts replaced under warranty by the Traffic Electronics Center will be returned to the vendor for examination at the vendor's request); 3)

Provide schematics and other documentation required to perform bench repair to the Traffic Electronics Center within two weeks of request. Upon request from the vendor, the Department agrees not to divulge any proprietary information contained in those documents.

At the request of the State, the vendor will perform warranty repairs to equipment that fails during the warranty period at no cost to the State including freight costs to ship repaired equipment back to the NCDOT Traffic Electronics Center. The State will pay freight charges to ship equipment to the vendor or manufacturer. Ensure all equipment is repaired and returned to the Department Traffic Electronics Center within 21 calendar days of receipt by the vendor.

5.3. CONSTRUCTION METHODS

Install LED blank out signs with wire entrance fittings, span wire cable mounting assemblies, pedestal mounting assemblies, signal cable, lashing wire, and all necessary hardware.

5.4. METHOD OF MEASUREMENT

Actual number of LED blankout signs with mounting hardware furnished, installed, and accepted.

5.5. BASIS OF PAYMENT

The quantity of LED blankout signs, measured as provided above, will be paid for at the contract unit price each for "LED Blankout Sign."

Payment will be made under:

LED Blankout Sign.....Each

6. MESSENGER CABLE

6.1. DESCRIPTION

Furnish and install messenger cable (spanwire) with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish messenger cable with cable clamps, machine bolts, eyebolts, strandvises, eyenuts, split-bolt connectors, and all necessary hardware.

6.2. MATERIAL

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Comply with ASTM A 475-89 for extra high strength grade wire strand, Class A zinc coating. Fabricate messenger cable from seven steel wires that are twisted into a single concentric strand.

Provide universal grade strandvises used for extra high strength steel messenger cable.

Provide pole line hardware constructed of hot-dipped galvanized steel. Provide machine bolts, eyebolts, and thimbleye bolts with a minimum tensile strength of 12,400 lbs.. Provide galvanized nuts, washers, and thimbleyelets.

6.3. CONSTRUCTION METHODS

Install guy assemblies prior to installing messenger cable.

Bond messenger cable installed for the purpose of supporting communications cable at intervals not to exceed 1,300 feet. Use existing pole grounds when available. Should existing poles not have a grounding system, install a new grounding system that complies with Article 1720-3 of the Standard Specifications.

Use 3/8 inch messenger cable for spans supporting vehicle signal heads, or signs, or signal heads and signs.

Use 1/4 inch messenger cable for spans supporting only cables unless otherwise shown on the plans.

For messenger cable crossing over railroad tracks, provide a minimum of 30 feet of vertical clearance, unless otherwise shown on the Plans.

For permanent installation, install messenger cable in continuous lengths with no splices except

where an insulator is required. For temporary installations and with prior approval, existing messenger may be extended instead of installing a new messenger cable.

Tension messenger cable to eliminate appreciable sag and to match the sag of surrounding utilities. Otherwise, allow a sag of three to four percent of the length of the span between poles.

Provide 3-bolt clamp assemblies consisting of 5/8 inch diameter machine bolts, j-hooks, washers, and square nuts to attach messenger cable to wood poles. Provide machine bolts that are 3 inches longer than the pole diameter.

Attach messenger cable to poles using cable clamps with J-hooks in mid-runs and deadend strandvises at termination poles.

Use 5/8 inch diameter eyebolts with washers and nuts (or eyenuts where required) to attach strandvises to wood poles at controller cabinets and poles where cable is terminated into a strandvise.

On joint use poles at signal and ITS equipment installations (i.e. Controller Cabinets, CCTV Cabinets, DMS Cabinets, etc.), do not use existing utility company grounds. Install a grounding system for the signal and ITS equipment.

Bond messenger cable installed for the purpose of supporting communications cable at intervals not to exceed every 1300 feet. Use existing pole grounds when available. Should existing poles not have a grounding system, install a new grounding system for bonding the messenger cable.

Install ground wires so as to minimize damage from vandalism and environmental exposures. Use Number 6 AWG solid copper ground wire. Install ground wire up the pole to a point adjacent to the uppermost span. To secure the ground wire to poles, use hotdipped galvanized wire staples on 12 inch centers from ground level to 8 feet. Above 8 feet, use wire staples on 24 inch centers. Install a 5/8 inch x 8 foot ground rod at the base of the pole and exothermically weld the ground wire to the ground rod. Bond the messenger cable to the ground wire using a Burndy Clamp (UCG25RS) or equivalent.

Maintain electrical continuity at all splices.

6.4. METHOD OF MEASUREMENT

Measured horizontal linear feet of messenger cable furnished, installed and accepted. Sag and vertical segments will not be paid for as these distances will be considered incidental to the installation of the messenger cable.

No measurement will be made of cable clamps, machine bolts, eyebolts, strandvises, 3 bolt

assemblies, eyenuts, split bolt connectors, messenger cable bonding, or pole grounding system as these will be considered incidental to furnishing and installing messenger cable.

6.5. BASIS OF PAYMENT

The quantity of messenger cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Messenger Cable (_____)."

Payment will be made under:

Messenger Cable (3/8") ..... Linear Foot

Messenger Cable (1/4") ..... Linear Foot

7. UNDERGROUND CONDUIT

7.1. DESCRIPTION

Furnish and install underground conduit systems with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

7.2. MATERIALS

A. General

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Comply with Article 1018-2 of the Standard Specifications for backfill requirements. Comply with Articles 545-2 and 545-3 of the Standard Specifications for graded stone requirements.

B. Non-Metallic Conduit

Furnish factory lubricated, low friction, coilable, conduit constructed of virgin high-density polyethylene (HDPE). Furnish conduits with nominal diameter as required by the plans. Provide individual conduits with smooth outer walls and ribbed inner walls and ensure the conduit is capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation without affecting its properties or performance.

Provide conduit that is suitable for underground use in an ambient temperature range of -30 to 130 degrees F without degradation of material properties.

Provide conduit that is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil, gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate, and transformer oil, and is protected against degradation due to oxidation and general corrosion.

Provide conduit(s) with an outer diameter to minimum wall thickness ratio that complies with ASTM-D3035, Standard Dimension Ratio (SDR) 13.5.

Provide conduit(s) that meets or exceeds the following:

ASTM-D638	Tensile Strength	3,000 psi, minimum
	Elongation	400 percent, minimum
ASTM-D1238	Melt Index	0.4 maximum
ASTM-D1505	Density	0941-0955 g/cc
ASTM-D1693	Condition B	20 percent failure, maximum

ASTM-D2444	Impact	NEMA Standards Publication Number TC7
ASTM-D3350	Cell classification	334420 or 344420

Furnish conduits with a coefficient of friction of 0.09 or less in accordance with Belcore GR-356.

Dependent upon the number of conduits required, furnish conduits in black, orange, blue and white colors. Provide conduits that are factory extruded with the appropriate colors.

Furnish conduit organizers at all points where multiple conduits enter and exit a junction box or cabinet. Furnish conduit organizers that are appropriately sized with regards to the conduits. Provide conduit organizers that are removable.

Furnish duct plugs that provide a watertight barrier when installed in an unused conduit. Furnish duct plugs sized in accordance with the conduit furnished. Provide duct plugs that are removable.

Furnish mechanical sealing devices that provide a watertight barrier between the conduit and communications cable. Furnish mechanical sealing devices sized in accordance with the conduit furnished and with appropriately sized penetration holes for the communications cable. Provide mechanical sealing devices that are removable.

Furnish conduit spacers to bind the individual conduits together when installed in a common trench. Furnish conduit spacers that are appropriately sized with regards to the conduits.

Furnish ½-inch, prelubricated, woven polyester tape, pull line with a minimum rated tensile strength of 2,500 lb in all conduit(s).

Furnish non-detectable underground marker tape with the wording "WARNING – Fiber Optic Cable" in all trenches.

C. Metallic Conduit

Use metallic conduit and duct which is rigid hot-dipped galvanized steel and meets the requirements of UL Standard 6 "Rigid Metallic Conduit", with rigid full weight sherardized or galvanized threaded fittings.

7.3. CONSTRUCTION METHODS

A. General

In non-used/spare conduits, seal each end of the conduit with a duct plug. Secure each end of the pull line to the duct plug prior to installing the duct plug. Ensure that the placement of the pull line does not interfere with the installation of the duct plug and provides a watertight seal.

In conduits containing communications cable, seal the conduit with an approved mechanical sealing device. Ensure the installation provides a watertight seal.

For underground polyethylene conduit installations (trenched or plowed), backfill in accordance with Article 300-7 of the Standard Specifications.

B. Tracer Wire

Pull the tracer wire simultaneously with the fiber-optic communications cable in a continuous length. When multiple pulls of fiber-optic cable are required, only one tracer wire is required. Where tracer wire is spliced, provide waterproof butt splices. Splicing is allowed only in cabinets and junction boxes. Label all tracer wires. Terminate tracer wire to equipment ground bus as specified in the plans.

C. Underground Polyethylene Conduit Installation in Trench

Install underground polyethylene conduit system along the route of the trench. Install conduit organizers at points where multiple conduits enter or exit the junction box or cabinet, etc.

Maintain a minimum trench depth of 30 inches below finished grade or 6 inches below roadway subgrade, whichever is deeper.

Install longitudinal runs of conduit at a minimum of 1 foot from the back of curb or 6 feet from the edge of pavement in the absence of curb.

Use one common trench with approved conduit spacers to bind the individual conduits together at no more than every 50 feet. Install the non-detectable marker tape approximately 15 inches below the finished grade.

Extend the ends of the conduits such that upon completion of the installation the conduits will extend a minimum of 2 inches above concrete surfaces and 4 inches above crushed stone bases.

Remove all rock and debris from backfill material. Remove excess material from the site and compact the excavation according to Article 300-7 of the Standard Specifications.

Backfill the trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided, thus causing a deviation in the elevation height of the underground polyethylene conduit system. The purpose of the backfill is to provide a gradual change in the elevation of the trench, from the bottom elevation to the highest point of the obstruction such that excessive bending and stress will not be transferred to the conduits once the underground polyethylene conduit system is installed.

After the installation of the conduits and upon completion of the tamping and backfill process,

perform a mandrel test on each individual conduit to ensure that no conduit has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred replace the entire length of conduit.

C.1. Unpaved Trenching

Install polyethylene conduit in all unpaved trenching areas. Install 2-inch polyethylene conduit in quantities stated in the Plans.

Finish unpaved areas flush with the surrounding natural ground. Restore damaged grassed areas. Seed and mulch within 7 days after the occurrence of the damage.

C.2. Paved Trenching

Install metallic conduit in all paved trenching areas. Paved areas include streets, sidewalks, paved driveways, and parking lots.

Except on concrete surfaces, neatly cut and replace the width of the trench with like material. On concrete surfaces, replace the entire joint of concrete unless otherwise directed by the Engineer.

D. Jack and Bore

For all jack and bore areas, comply with Article 342-3 of the Standard Specifications.

For all jack and bore areas, install metallic conduit at a minimum depth of 30 inches below finished grade or 6 inches below roadway sub-grade. Provide 3 feet of conduit from back of curb or from edge of pavement. Terminate ends of conduit into junction boxes.

Perform work that complies with the NCDOT Policies and Procedures for accommodating Utilities on Highway Rights-of-Way in effect on the date of advertisement.

E. Multi-Duct Installation in Outer-Duct

At locations called for jack and bore in the Plans, install multi-duct conduit system in single outer-duct conduit that was installed during jack and bore. Simultaneously install the individual colored conduits in the outer-duct conduit. Install the multi-duct conduits using an approved cable pulling lubricant.

Use a dynamometer (clutch device) so as not to exceed the maximum allowable pulling tension. Do not use a motorized vehicle to generate pulling forces.

Keep tension on the conduit(s) and the pulling line at the start of each pull. Do not release the tension if the pulling operation is halted. Restart the pulling operation by gradually increasing the tension until the multi-ducts are in motion. Once the multi-duct system is installed in the outer-duct,

install the duct organizers at the point where the multi-duct system enters or exits the junction box or cabinet.

Extend the ends of the multi-duct conduit such that upon completion of the installation, the conduits will extend a minimum of 2 inches above concrete surfaces and 4 inches above crushed stone bases.

After installation of the multi-duct conduits, perform a mandrel test on each individual conduit to ensure that no conduits have been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred replace the entire length of conduit.

F. Splicing of Underground Polyethylene Conduits

Splicing or joining of underground polyethylene conduits is prohibited. With the Engineer's approval, install a junction box at all locations where splicing or coupling of the underground polyethylene conduits is necessary due to problems encountered with the installation method.

G. Plan of Record Drawings

Upon completion of the underground polyethylene conduit system installation, furnish the Engineer with a plan of record profile drawing and plan drawing showing the horizontal and vertical locations of the installed conduit system.

7.4. METHOD OF MEASUREMENT

Measured horizontal linear feet of each conduit system (containing the individual conduit(s) called for in the plans) that is furnished, installed in a trench, and accepted. Measurement of the conduit system will be from point to point horizontally along the approximate centerline.

Measured horizontal linear feet of jack and bore for underground conduit installation furnished and accepted. Measurement will be along the approximate centerline of the bore from junction box to junction box. Vertical segments will not be paid for as these distances will be considered incidental to installation of underground conduit.

Measured horizontal linear feet of each multi-duct conduit system (containing the individual conduit(s) called for in the plans) that is furnished, installed in outer-duct and accepted. Measurement of the multi-duct conduit system will be from point to point horizontally along the approximate centerline. Vertical segments will not be paid for as these will be considered incidental to the installation of the conduit system.

Measured horizontal linear feet of tracer wire furnished, installed and accepted. Measurement

will be along the approximate centerline of the trench. Vertical segments will not be paid for as these distances will be considered incidental to the installation of the tracer wire. No payment will be made for excess tracer wire in junction boxes and/or cabinets.

No additional payment will be made for seeding and mulching, removal of excess material, furnishing and placing incidental stone, furnishing and placing paved material, marker tape, pull lines, mechanical sealing devices, duct plugs, pulling lubricants, conduit organizers, mandrel test, and plan of record drawings, as they will be considered incidental.

7.5. BASIS OF PAYMENT

The quantity of polyethylene conduit installed in an unpaved trench, measured as provided above, will be paid for at the contract unit price per linear foot as "Trench polyethylene conduit(s), (size)(quantity of conduits) and (size)(quantity of conduits)."

The quantity of metallic conduit installed in an paved trench, measured as provided above, will be paid for at the contract unit price per linear foot as "Trench metallic conduit(s), (size)(quantity of conduits) and (size)(quantity of conduits)."

The quantity of jack and bore, measured as provided above, will be paid for at the contract unit price per linear foot as "Jack and Bore."

The quantity of multi-duct conduit installed in outer-duct, measured as provided above, will be paid for at the contract unit price per linear foot as "Multi-Duct (size) in Outer-Duct (quantity of conduits)."

The quantity of tracer wire, measured as provided above, will be paid for at the contract unit price per linear foot as Tracer Wire."

Payment will be made under:

Trench Polyethylene Conduit, (2")(2) ..... Linear Foot

Trench Polyethylene Conduit, (2")(1) ..... Linear Foot

Trench Metallic Conduit, (2")(1) ..... Linear Foot

Jack and Bore ..... Linear Foot

Multi-Duct (1.25") in Outer-Duct (4) ..... Linear Foot

Tracer Wire ..... Linear Foot

8. DIRECTIONAL DRILLING

8.1. DESCRIPTION

Furnish and install conduit(s) and all necessary hardware by using the horizontal directional drilling method in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

8.2. MATERIALS

A. General

Provide conduit that is suitable for underground use in an ambient temperature range of -30 to 130 degrees F without degradation of material properties.

Provide conduit that is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil, gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate, and transformer oil, and is protected against degradation due to oxidation and general corrosion.

Provide conduit(s) with an outer diameter to minimum wall thickness ratio that complies with ASTM-D3035, Standard Dimension Ratio (SDR) 13.5.

Provide conduit(s) that meets or exceeds the following:

ASTM-D638	Tensile Strength	3,000 psi, minimum
	Elongation	400 percent, minimum
ASTM-D1238	Melt Index	0.4 maximum
ASTM-D1505	Density	0941-0955 g/cc
ASTM-D1693	Condition B	20 percent failure, maximum
ASTM-D2444	Impact	NEMA Standards Publication Number TC7
ASTM-D3350	Cell classification	334420 or 344420

Furnish conduits with a coefficient of friction of 0.09 or less in accordance with Belcore GR-356.

Dependent upon the number of conduits required, furnish conduits in black, orange, blue and white colors. Provide conduits that are factory extruded with the appropriate colors.

Furnish ½-inch, prelubricated, woven polyester tape, pull line with a minimum rated tensile strength of 2,500 lb.

B. Polyethylene Conduit

Furnish factory lubricated, low friction, coilable conduit constructed of virgin high-density polyethylene (HDPE). Furnish conduits with inside diameter as required by the plans. Provide conduit with a smooth outer wall and ribbed inner wall and ensure the conduit is capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation without affecting its properties or performance.

Furnish duct plugs that provide a watertight barrier when installed in an unused conduit. Furnish duct plugs sized in accordance with the conduit furnished. Provide duct plugs that are removable.

Furnish mechanical sealing devices that provide a watertight barrier between the conduit and communications cable. Furnish mechanical sealing devices sized in accordance with the conduit furnished and with appropriately sized holes for the communications cable. Provide mechanical sealing devices that are removable.

8.3. CONSTRUCTION METHODS

A. Pre-Approvals and Minimum Depth Requirements

Obtain the Engineer's approval prior to beginning drilling operations.

At all points where the proposed conduit will traverse under city streets, state roads, driveways, sidewalks, and/or "Controlled Access Areas" including entrance/exit ramps, ensure the conduit(s) maintains a minimum depth of 4 feet or 8 times the back reamer's diameter, whichever is deeper. For an installation that runs parallel to a controlled access area or entrance and exit ramps ensure the conduit maintains a minimum depth of 30 inches below grade. Maintain a minimum clearance of 30 inches below grade when crossing ditch lines. For the following man-made structures, the minimum clearance requirements are shown in the table below:

Man-made Structure	Minimum Clearance Requirement
Bridge foundation	5' horizontal & 4' vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10' horizontal should be no deeper than 8')
Drainage pipes less than 60"	1' above or below [while maintaining a minimum depth of 30" below grade]
Drainage pipes greater than 60"	1' above or 4' below [while maintaining a minimum depth of 30" below grade]
Box Culverts	1' above or 4' below [while maintaining a minimum depth of 30" below grade]
Slope protection	2' below
Slope protection foundation footing	5' below

Guarantee the drill rig operator and digital walkover locating system operator are factory-trained to operate the make and model of the equipment provided and have a minimum of one year's experience operating the make and model of drill rig. Submit written documentation of the operators' training and experience for review by the Engineer at least two weeks prior to commencing directional drilling operations.

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface such as a slurry pit. Provide measures to prevent drilling fluids from entering drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto sidewalks, other pedestrian walkways, driveways or streets. Immediately remove any drilling fluids/slurry that is accidentally spilled.

B. Directional Drill Operations

Provide grounding for the drill rig in accordance with the manufacturer's recommendations.

Place excavated material near the top of the working pit and dispose of as required. Backfill pits or trenches excavated to facilitate drilling operations immediately after the drilling has been completed.

Utilize a drill head suitable for the type of material being drilled and sized no more than 2 inches larger than the outer diameter of the conduit to be installed. Direct the drill head as needed to obtain

the proper depth and desired destination. Pressure grout with an approved bentonite/polymer slurry mixture to fill any voids. Do not jet alone or wet bore with water.

During each drilling operation, locate the drill head every 10 feet along the drill path and prior to traversing any underground utility or structure. Use the digital walkover locating system to track the drill head during the directional drilling operation. Ensure the locating system is capable of determining the pitch, roll, heading, depth and horizontal position of the drill head at any point. Unless otherwise approved, do not deviate from the proposed line and grade by more than two percent.

Once the drill head has reached its final location, remove the head, and install a reamer of appropriate size (no more than 2 inches larger than the outer diameter of the ducts) to simultaneously facilitate back drilling of the drill hole and installation of the conduit. The reamer is sized larger than the actual conduits to ensure the conduits are not subjected to extraneous deviations caused by the original drill operation and are as straight as possible in their final position.

The intent of these specifications is to limit the diameter of the actual drill shaft/hole such that it is no more than 2 inches larger than the conduit(s) outer diameter. The 2-inch larger diameter can be accomplished during the original bore or during the back reaming/conduit installation process.

Once the physical installation of the conduit has started, continue performing the installation without interruption to prevent the conduit from becoming firmly set. Ensure the bentonite/polymer slurry mixture is applied as the conduit installation process is occurring.

Upon completion of the conduit installation perform a mandrel test on the conduit system to ensure that no conduit(s) has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit.

Extend the ends of the conduit such that upon completion of the installation the conduit will extend a minimum of 2 inches above concrete surfaces and 4 inches above crushed stone bases.

C. Drilling Fluids

Furnish and use lubrication for subsequent removal of material and immediate installation of the pipe. The use of water and other fluids in connection with the directional drilling operation will be permitted only to the extent necessary to lubricate cuttings. Do not jet alone or wet bore with water. Use a drilling fluid/slurry consisting of at least 10 percent high-grade bentonite to consolidate excavated material and seal the walls of the drill hole.

Transport waste drilling fluid/slurry from the site and dispose of such slurry in a method that

complies with Local, State and Federal laws and regulations.

D. Splicing of the Conduit

Do not splice or join sections of conduit(s). Upon approval, a junction box may be installed at locations where splicing or coupling of the conduit is necessary due to problems encountered with the installation.

E. Duct Plugs and Mechanical Sealing Devices

Following the installation of the conduit(s) where the communications cable is not immediately installed use a duct plug to seal the ends of the conduit. Secure the pull line to the duct plug in such a manner that it will not interfere with the installation of the duct plug and provide a watertight seal.

In conduits containing communications cable, seal the conduit with an approved mechanical sealing device. Ensure the installation provides a watertight seal.

F. Plan of Record Drawings

Upon completion of the drilling operation and conduit installation furnish the Engineer with a plan of record profile drawing and a plan drawing for the drilled conduit showing the horizontal and vertical locations of the installed conduit.

8.4. METHOD OF MEASUREMENT

Measured horizontal linear feet of directionally drilled polyethylene conduit(s) furnished, installed and accepted. Measurement of the drill path will be from point-to-point horizontally along the approximate centerline.

No additional payment will be made for vertical and horizontal sweeps, excavation of drill pits, backfill, site restoration, seeding and mulching, removal of excess material, duct organizers, mechanical sealing devices, duct plugs, pulling lubricants, mandrel test, and plan of record drawings, as these will be considered incidental to the directional drill and/or conduit installation.

8.5. BASIS OF PAYMENT

The quantity of directional drilled polyethylene conduit(s), measured as provided above, will be paid for at the contract unit price per linear foot as "Directional Drill Polyethylene Conduit(s), (size)(quantity of conduits) and (size)(quantity of conduits)."

Payment will be made under:

Directional Drill Polyethylene Conduits, (2")(2).....Linear Foot

Directional Drill Polyethylene Conduits, (2")(1).....Linear Foot

9. JUNCTION BOXES

9.1. DESCRIPTION

Furnish and install junction boxes (pull boxes) with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish junction boxes with covers, graded stone, grounding systems, and all necessary hardware.

9.2. MATERIAL

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

A. Junction Boxes

A.1. General

Comply with the Article 1411-2 of the Standard Specifications except as noted herein:

Provide junction boxes and covers that have a minimum static coefficient of 0.5 as determined by ASTM D-1894 for all exposed surfaces. Provide junction boxes and covers that are sunlight resistant in accordance with ASTM G-53 and have a water absorption ratio no greater than 0.5 percent in accordance with ASTM D-570.

Unless otherwise required, provide junction boxes able to withstand a vertical load of 15,000 lbs. and tested up to a vertical lateral load of 22,533 lbs. Provide junction boxes able to withstand a lateral load of 800 lb/ft^2 and tested up to a lateral load of 1,200 lb/ft^2. Provide certification that testing methods complied with Western Underground Committee Guide 3.6.

Provide junction box covers with standard "Traffic Signal" or "NCDOT Fiber Optic" logos, pull slots, and stainless steel pins.

Do not provide a sealant compound between junction boxes and covers.

A.2. Standard Sized Junction Boxes

Provide standard sized junction boxes with minimum inside dimensions of 16(l) x 10(w) x 10(d) inches. Provide a depth range for vertical extension of the junction box of 6 to 12 inches.

A.3. Oversized Junction Boxes

Provide oversized junction boxes with minimum inside dimensions of 30(l) x 15(w) x 24(d)

inches.

A.4. Special Oversized Junction Boxes

Provide oversized junction boxes with minimum inside dimensions of 36(l) x 24(w) x 24(d) inches.

B. Graded Stone

Comply with Articles 545-2 and 545-3 of the Standard Specifications.

9.3. CONSTRUCTION METHODS

Comply with the Article 1411-3 of the Standard Specifications except as noted herein:

Install the junction boxes flush with finished grade. Do not install sealant compound between junction boxes and covers.

Install junction boxes at maximum intervals of 250 feet, or where shown on the plans and at locations where underground splicing of lead-in cable is necessary, whichever is less.

9.4. METHOD OF MEASUREMENT

The actual number of junction boxes of each size and type furnished, installed, and accepted.

No measurement will be made of covers, graded stone, and required grounding systems as these will be considered incidental to furnishing and installing junction boxes.

9.5. BASIS OF PAYMENT

The quantity of junction boxes, measured as provided above, will be paid for at the contract unit price each for "Junction Box (_____)."

Payment will be made under:

Junction Box (Standard Size).....Each

Junction Box (Over-Sized) .....Each

Junction Box (Special Over-Sized).....Each

10. WOOD POLES

10.1. DESCRIPTION

Furnish and install wood poles with grounding systems and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

10.2. MATERIALS

A. General

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Provide poles of treated southern pine or treated Douglas fir that meet the requirements of ANSI 05.1. Provide Class 3 or better wood poles that are a minimum length of 40 feet unless otherwise shown on the plans and are of a sufficient length to maintain minimum required distances above the roadway, obstructions and affected railroad tracks. Mark each pole in accordance with ANSI 05.01. First roof and bore poles and then give them a full-length preservative treatment.

Provide poles with pentachlorophenol or chromated copper arsenate (CCA) preservative, in accordance with AWPA Standard C4-99. Ensure the retention of preservative is a minimum of 0.45 lb. per cubic foot for pentachlorophenol and 0.6 lb. per cubic foot for CCA.

B. CCTV Wood Poles

Furnish wood poles to mount CCTV cameras and equipment cabinets that meet or exceed the requirements above. Furnish wood poles of a sufficient length such that the top of the pole is 45 feet above ground level when fully installed.

10.3. CONSTRUCTION METHODS

Mark final pole locations and receive approval prior to installing poles. Unless otherwise shown, locate poles a minimum of 6 feet behind face of curb or 10 feet from edge of travelway.

Drill or auger a hole for placement of the pole and to allow for compacting. Set the pole at the depth recommended by the manufacturer, but at a minimum depth of 5 feet and so that when the pole is fully loaded as required by the plans, the pole is within two degrees of vertical.

Backfill the hole with the pole installed and tamp backfill in 6 inch lifts with a mechanical tamp until compacted density is at least equal to surrounding density.

Install ground wire so as to minimize damage from vandalism and environmental exposures. Use Number 6 AWG solid copper ground wire. Install ground wire up the pole to a point adjacent to the uppermost span. To secure ground wire to poles, use hot-dipped galvanized wire staples on 12 inch centers from ground level to 8 feet. Above 8 feet, use wire staples on 24 inch centers. Install a 5/8 inch x 10 foot ground rod at the base of the pole and exothermically weld the ground wire to the ground rod.

10.4. METHOD OF MEASUREMENT

Actual number of wood poles for CCTV cameras and equipment cabinets with grounding systems furnished, installed, and accepted.

No measurement will be made for installing grounding systems as these will be considered incidental to furnishing and installing wood poles.

10.5. BASIS OF PAYMENT

The quantity of wood poles for CCTV cameras and equipment cabinets, measured as provided above, will be paid for at the contract unit price each for "Wood Pole."

Payment will be made under:

Wood Pole.....Each

11. GUY ASSEMBLIES

11.1. DESCRIPTION

Furnish and install guy assemblies with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish and install guy assemblies and all necessary hardware.

11.2. MATERIAL

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Furnish guy assemblies with anchor assemblies, guy cable, and guy cable guard.

Provide anchor assemblies with all miscellaneous hardware consisting of either expanding anchor with rod and tripleye attachment, screw anchor with extension rod and tripleye attachment, or expanding rock anchor with tripleye attachment. Ensure that the anchor assembly size is adequate for site conditions. Provide rods constructed of hotdipped galvanized steel sized according to the soil bearing conditions in the area. Provide tripleye guy attachments constructed of hot-dipped galvanized steel.

For the type of anchor assembly furnished, ensure that the following:

- Expanding anchor - provide steel construction with a protective paint or heat shrink of 6 mil plastic to protect the metal during shipping and storage.
- Screw anchor - provide hot-dipped galvanized steel construction.
- Expanding rock anchors - provide malleable iron and rust-resisting paint construction.

Provide full round guy cable guards that are 8 feet in length and constructed of ultraviolet stabilized, high impact, bright yellow, high density polyethylene.

Provide guy cables consisting of messenger cable of the same size as the largest sized messenger cable to be guyed.

11.3. CONSTRUCTION METHODS

Install guy assemblies with guy cable, guy guards, anchors, strandvises, three bolt clamps and associated fittings. Except as required below, where there is room on the pole to install a two bolt attachment in compliance with the NESC, attach the guy assembly and the guy cable to two separate bolts with one bolt for the span and one bolt for the guy cable. Provide 8 to 12 inch separation

between bolts or as required by the pole owner. If there is not sufficient room for two-bolt attachment, use a Department approved one-bolt attachment method for attachment of messenger cable and guy assemblies.

Use the Department approved one bolt attachment method for attachment of messenger cable and guy assemblies for all communications cable installations.

Ground guy assemblies to pole grounds using Burndy Clamps (UCG25RS) or equivalent. Do not bond to utility company grounding systems at signal and ITS equipment installations (i.e. Controller Cabinets, CCTV Cabinets, DMS Cabinets, etc.).

When installing messenger cable at locations other than signalized intersections, use the Department approved one-bolt attachment method for attachment of messenger cable and guy assemblies for the purpose of supporting communications cable. Use existing pole grounds when available. Should existing poles not have a grounding system, install a new grounding system for bonding the messenger cable. Provide grounding systems that comply with Article 1320-3 of the Standard Specifications.

Do not attach to existing guy assemblies unless specifically approved by the owner.

11.4. METHOD OF MEASUREMENT

Actual number of guy assemblies with anchors, guy cable, and guy guards furnished, installed, and accepted.

No measurement will be made of guy cable as this will be considered incidental to furnishing and installing guy assemblies.

11.5. BASIS OF PAYMENT

The quantity of guy assemblies, measured as provided above, will be paid for at the contract unit price each for "Guy Assembly."

Payment will be made under:

Guy Assembly.....Each

12. RISER ASSEMBLIES

12.1. DESCRIPTION

Furnish and install risers assemblies with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish riser assemblies with clamp-on, aluminum weatherheads or heat shrink tubing, galvanized pole attachment fittings, and all necessary hardware.

12.2. MATERIAL

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Provide metallic conduit for risers. Use metallic conduit and duct which is rigid hot-dipped galvanized steel and meets the requirements of UL Standard 6 "Rigid Metallic Conduit", with rigid full weight sherardized or galvanized threaded fittings.

Provide Tyco ™ (Raychem ™) part number 066193-000 or equal heat shrink tubing for the installation of fiber-optic cable. Obtain pre-approval for any heat shrink tubing retrofit or expansion kits.

12.3. CONSTRUCTION METHODS

A. New Installations

Install risers with required weatherheads or heat shrink tubing on poles using pole attachment fittings.

Use separate 1/2 inch riser with weatherhead for pedestrian pushbutton cable.

Use separate 1 inch riser with weatherhead for electrical service.

Use separate 2 inch risers with weatherheads for signal cables (bundled). Use separate 2 inch riser with weatherhead for the combination of all lead-in and twisted-pair communications cable.

Use separate 2 inch riser with heat shrink tubing for fiber-optic communications cable. Install risers with heat shrink tubing so that fiber-optic cable can be installed without violating the cable's minimum bending radius. Install fiber-optic cable so that it does not share a riser with any other cable. Install the heat shrink tubing in accordance with the manufacturer's recommendations. Provide tubing that is a minimum of 5 inches in length with a minimum of 2.5 inches extended over the fiber-optic cables and 2.5 inches extended over the riser after the heat has been applied. Use nylon

filler rods with UV protection or an equal and sealing spacer clips to separate the fiber-optic cables where multiple fiber-optic cables enter a riser. Ensure that sealing spacer clips have a sealing compound that is heat activated with the sealing compound fully encapsulating the space between the cables. Ensure that the heat shrink tubing provides a watertight fit around individual fiber-optic cables and the outer walls of the risers. Do not use cut sections of the fiber-optic cable or any other devices in lieu of filler rods. Use aluminum tape around fiber-optic cables to prevent damage to the cables from sealing chemicals. Use a heat source that will provide even heat distribution around the tubing. Ensure that no damage occurs to any cables.

B. Reuse Existing Risers

At locations shown in the plans, install fiber optic cable in existing riser assemblies. If required, replace existing weatherhead with heat shrink tubing using a method approved by the Engineer. Do not cut the fiber optic cable to replace the weatherhead.

12.4. METHOD OF MEASUREMENT

Actual number of risers of each type and size for signals and ITS equipment furnished, installed, and accepted.

No measurement will be made for replacing weatherhead of existing riser assemblies with heat shrink tubing as this will be considered incidental to the installation of the fiber optic cable.

12.5. BASIS OF PAYMENT

The quantity of risers, measured as provided above, will be paid for at the contract unit price each for "____-Inch Riser with _____."

Payment will be made under:

2" Riser with Weatherhead ..... Each

2" Riser with Heat Shrink Tubing ..... Each

13. INDUCTIVE DETECTION LOOPS

13.1. DESCRIPTION

Furnish and install inductive detection loops with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish inductive detection loops with loop slot sealant, loop wire, 1 inch conduit with fittings, and all necessary hardware.

13.2. MATERIAL

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

A. Loop Sealant

Provide loop slot sealant that will completely encapsulate loop wire when installed according to the manufacturer's instruction. Provide loop sealant that does not generate temperatures greater than 220 degrees F. Ensure that the sealant bonds with asphalt and concrete pavement saw slots so that the sealant and the encapsulated loop wire do not come out of the slot. Ensure that the sealant is self-leveling, but with sufficient viscosity to prevent exit from the saw slot when installed along a ten percent grade.

Provide sealant that protects loop wire by preventing the entrance of dirt, water, rocks, sticks, and other debris into the saw slot, and that is resistant to traffic, water, gasoline, chemical and chemical fumes, mild alkalis, oils, and mild acids. Ensure that the sealant will not be affected by water and the sealant does not chemically interact with the pavement and loop wire insulation.

Ensure that the loop sealant has sufficient flexibility to permit expected pavement expansion and contraction due to weather and to permit pavement movement due to traffic without cracking for a temperature range of -40 to 160 degrees F.

Provide sealant that has a usable life, once mixed, of at least ten minutes when the ambient temperature is 75 degrees F. Ensure that the sealant dries to a tack free state in no more than two hours, and does not flow within or out of the saw slot after the exposed surface has become tack free. Tack free time will be determined by testing with a cotton ball until no sealant adheres to the cotton ball and no cotton adheres to the sealant.

Ensure that two part sealant cures within 48 hours to attain 95 percent of the published properties for the cured material.

Ensure that one part sealant cures within 30 days to attain 95 percent of the published reports for the cured material.

B. Loop Wire

Provide loop wire composed of 19-strand conductor insulated by a cross-linked polyethylene compound. Ensure that insulated conductors are completely encased in tubes of low density polyethylene compound. Print the manufacturer's name, year of manufacture, and any applicable part number on the encasing tube at intervals of 2 feet or less.

Provide Number 14 AWG copper conductors fabricated from 19 strands and that comply with ASTM B-3 before insulating. Ensure that stranded conductors utilize either concentric or bunch stranding and comply with the circular mil area and physical requirements of ASTM Designation B-8 or ASTM Designation B-174 for bunch stranding.

Provide an insulating compound that is cross-linked thermosetting black polyethylene (ASTM D-2655-80). Ensure that insulation is applied concentrically about the conductor. Provide insulation thickness that is not less than 0.026 inches at any point and has a minimum average thickness of 0.030 inches as measured by Underwriters Laboratories, Incorporated Standard UL62 (ANSI C33.1).

Ensure that insulation of the finished conductor will withstand the application of a 60 Hertz or 3000 Hertz, 7500 volt (RMS) essentially sinusoidal spark test potential as specified in Underwriters Laboratory, Incorporated Standard UL83 (ANSI C33.8).

Provide insulated conductors that are factory-installed in a protective encasing tube that complies with the following:

- Have an encasing tube fabricated of a polyethylene compound conforming to ASTM D-1248 for Type I, Class C, Grade E5.
- Have an inside diameter of 0.150 inch minimum.
- Have a wall thickness of 0.040 inch + 0.010 inch.
- Have an outside diameter of 0.240 inch + 0.010 inch.

C. Conduit

Provide 1 inch non-metallic conduit. Comply with Article 1097-5 of the Standard Specifications except as noted herein:

Provide schedule 40 non-metallic conduit.

13.3. CONSTRUCTION METHODS

A. General

Notify the Engineer one week prior to installing inductive detection loops.

Coordinate sawcutting and loop placement with pavement markings. For new construction or for resurfacing, install inductive detection loops prior to placement of the final layer of surface course. On unmarked pavement, premark locations of stop lines and lane lines prior to locating inductive detection loops.

Prior to sawcutting, premark inductive detection loop locations and receive approval. Sawcut pavement at approved premarked locations. Do not allow vehicles to travel over unsealed loop slots.

Install 1 inch non-metallic conduit with bushings from edge of pavement to junction box. Do not sawcut through curb.

Remove all loose material and wash saw slots with a high-pressure method using an air and water mixture. Dry saw slots with compressed air. Clear saw slots of jagged edges and protrusions. Seat loop conductor at the bottom of the saw slot without damage.

Embed loop conductors in the saw slot with loop sealant. Seal saw slot and dispose of excess sealant in an environmentally safe manner. Provide the Engineer with the Material Safety Data Sheet and the manufacturer's test data. Upon request, demonstrate the integrity of sealant by trial applications.

Between corners of loops and junction boxes, twist loop conductor pairs a minimum of 5 turns per foot. Permanently label each twisted pair in the junction box with nylon cable tie using indelible ink. Indicate loop number and loop polarity on the tie.

B. Grounding Tests

Prior to sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megohms. Perform the grounding test and document the test results in a format similar to that shown on the following page.

Provide copy of test to Engineer and place copy of test in the signal cabinet.

Inductive Detection Loop & Grounding Test Results

Location: _____ Sig. Inv. #: _____

Inspected By: _____ _____\Contractor's Name Date Tested: _____

Loop No.	Sealant Type	Distance from Stop Bar	Megger Reading @ Pull Box (> 100 megohms)		Megger Reading @ Signal Cabinet (> 50 megohms)		Ohm Reading @ Signal Cabinet Length of Loop Wire & Lead-in Wire _____feet/meter (<0.00885 ohms/foot) (< 0.0295 ohms/meter)		
			Reading	Date	Reading	Date	Reading	Feet / Meter	Date

Grounding

Number of Ground rods? _____
(*3 Rod Minimum*)

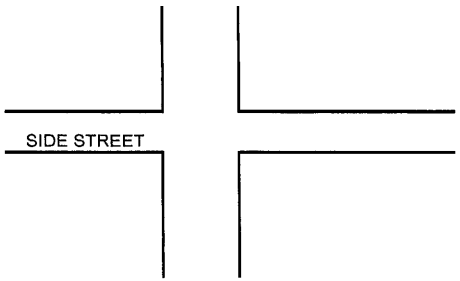
How are the ground rods installed? ☐ Individually ☐ Stacked

Ohm Reading? _____

Amount of ground wire? _____
(*From cabinet to closest ground rod*)

Ground Rod Location

(Draw in cabinet & locate ground rods)



NOTES:

ω Grounding of traffic signal controller cabinets should be in accordance to Section 1751 of the NCDOT Standard Specifications for Roads and Structures Manual and drawing number 1751.01 of the Highway Design Branch Roadway Standard Drawings manual

ω The installation and testing of inductive detection loop systems should be in accordance to Section 1725 and 1726 of the NCDOT Standard Specifications for Road and Structures manual.

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13.4. METHOD OF MEASUREMENT

The actual linear feet of inductive loop sawcut furnished, installed, and accepted.

No measurement will be made of loop slot sealant, loop wire, 1 inch conduit, and conduit fittings as this will be considered incidental to furnishing and installing inductive detection loops.

13.5. BASIS OF PAYMENT

The quantity of inductive loop sawcut, measured as provided above, will be paid for at the contract unit price per linear foot for "Inductive Loop Sawcut."

Payment will be made under:

Inductive Loop Sawcut ..... Linear Foot

14. LOOP LEAD-IN CABLE

14.1. DESCRIPTION

Furnish and install loop lead-in cable with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish loop lead-in cable and all necessary hardware.

14.2. MATERIALS

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Furnish lead-in cable with conductors of size 18 AWG that are fabricated from stranded copper, and that complies with IMSA Specification 50-2 except as follows:

- Provide the following two pair (4 conductor) conductor insulation pair colors: clear-yellow and red-green.
- Provide the following four pair (8 conductor) conductor insulation pair colors: clear-yellow, red-green, clear with black stripe tracer-yellow with black stripe tracer, and red with black stripe tracer-green with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern.
- Ensure each pair is completely covered with a spirally wrapped Aluminum Mylar tape with aluminum side out.
- Provide cable jacket formed from black polyethylene. Ensure the finished jacket provides environmental stress resistance, outdoor weatherability, toughness, low temperature performance, and ultraviolet resistance.
- Provide a ripcord to allow the cable jacket to be opened without using a cutter.
- Install all underground lead-in cable in non-metallic conduit.

14.3. CONSTRUCTION METHODS

Install lead-in cable.

For underground runs, install lead-in cable in 2 inch non-metallic conduit. For aerial installation, wrap lead-in cable to messenger cable with at least four turns of wrapping tape spaced at intervals less than 15 inches or lash lead-in cable to messenger cable with one 360 degree spiral of lashing wire per 12 inches.

Where railroad preemption is required and if called for on the Plans, install lead-in cable (type 1) from the signal controller cabinet to a railroad company furnished and installed lockable junction box.

Splicing of lead-in cable will be allowed only for runs in excess of 750 feet. Splice lead-in cable in junction boxes or condulets on poles.

Test each complete loop system installed by the Contractor from the controller cabinet by using a megger to verify that impedance from the loop system to the ground is at least 50 megohms. After successful completion of megger test, test the loop system resistance using an electronic ohmmeter to verify that loop system resistance is less than 0.00885 ohms per foot. Provide copy of test to the Engineer and place copy of test in the signal cabinet.

14.4. METHOD OF MEASUREMENT

Linear feet of lead-in cable shown on the plans as being necessary to complete the work. Where the signal plans have been revised, the quantity as shown on the revised signal plans. No measurement for payment will be made for this pay item, and no adjustment in the contract unit price or quantity will be made for any variation from the approximate quantity shown except in accordance with Article 1700-2(F) of the Standard Specifications. No measurement will be made between 2-pair and 4-pair lead-in cable as this will be considered incidental to furnishing and installing lead-in cable.

14.5. BASIS OF PAYMENT

The quantity of loop lead-in cable, measured as provided above, will be paid for at the contract unit price per linear foot as "Lead-In Cable."

Payment will be made under:

Lead-In Cable.....Linear Foot

15. FIBER OPTIC CABLE

15.1. DESCRIPTION

Furnish and install single mode fiber-optic (SMFO) communications cable, drop cable assemblies, and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish SMFO communications cable with grounding systems, fiber-optic cable storage racks (snow shoes), communications cable identification markers, lashing wire, and all necessary hardware.

15.2. MATERIALS

A. SMFO Communications Cable

Furnish loose tube fiber-optic cable with required fiber count that complies with RUS CFR 1755.900, single mode with a dielectric central member. Use single mode fiber in the cable that does not exceed 0.25 dB/km at 1550 nm and 0.35 dB/km at 1310 nm. Provide cable with all fibers that are useable and with a surface sufficiently free of imperfections and inclusions to meet optical, mechanical, and environmental requirements. Provide cable with a minimum of one ripcord under the sheath for easy sheath removal and with a shipping, storage, installation, and operating temperature of at least -40 to 160 degrees F.

Have a dual layered, UV cured acrylate fiber coating applied by the cable manufacturer that may be stripped mechanically or chemically without damaging the fiber.

Provide fibers inside a loose buffer tube. Use a doped silica core surrounded by concentric silica cladding for each fiber. Distinguish each fiber and buffer tube from others by means of color coding meeting the requirements of EIA/TIA-598, "Color Coding of Fiber-Optic Cables." In buffer tubes containing multiple fibers, ensure that the colors are stable during temperature cycling and not subject to fading, sticking, or smearing into each other or into the gel filling material. Use fillers in cable core if necessary to provide a symmetrical cross-section of cable. Fill buffer tubes with nonhygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. Ensure that gel is free from dirt and foreign matter, and is removable with conventional nontoxic solvents.

Provide a central member consisting of a dielectric glass reinforced plastic rod. Apply binders with sufficient tension to secure buffer tubes and binders to the central member without crushing buffer tubes. Ensure that binders are non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

Provide cable that has cable core interstices filled with super-absorbent, water-blocking compound that is non-conductive and homogenous. Ensure that compound is free from dirt and foreign matter, and is removable with conventional nontoxic solvents.

Provide cable with high tensile strength aramid yarns or fiberglass yarns that are helically stranded evenly around the cable core.

Provide cable jacket of consistent thickness that is free of holes, splits, and blisters, and containing no metal elements. Provide outer jacket of medium density polyethylene with minimum nominal sheath thickness of 0.050 inch. Ensure that polyethylene contains carbon black for ultraviolet light protection and does not promote the growth of fungus.

Provide length markings in sequential feet and within one percent of actual cable length. Ensure that character height of the markings is approximately 0.10 inch.

B. Drop Cable

Furnish drop cable assemblies to provide communications links between aerial splice enclosures and transceivers through interconnect centers. Furnish drop cable assemblies containing a minimum of six individual fibers.

Furnish drop cable assemblies that conform to the REA-PE-90 specifications. Ensure that drop cable assemblies have the same operating characteristics as the SMFO cable it is to be coupled with.

On one end of cable assemblies, furnish six ST-PC connectors for termination on the connector panel in the equipment cabinet. Provide either factory assembled drop cables with ST-PC connectors or field installed connectors.

Ensure that attenuation of drop cable at 1310 nm does not exceed 0.5 dB/km. The attenuation loss for the complete drop cable assembly must not exceed a mean value of 1.5 dB.

Provide length markings in sequential feet and within one percent of actual cable length. Ensure that character height of the markings is approximately 0.10 inch.

C. Communications Cable Identification Markers

Furnish yellow communications cable identification markers that are resistant to fading when exposed to UV sources and changes in weather. Use markers designed to coil around fiber-optic cable, and that do not slide or move along the surface of the cable once installed. Ensure that exposure to UV light and weather does not affect the markers natural coiling effect or deteriorate performance. Provide communications cable wraps that permit writing with an indelible marking pen.

For all fiber optic cables except those indicated on the Plans as City of Gastonia Electric Department, furnish cable wraps containing the following text in black:

WARNING

NCDOT FIBER OPTIC CABLE

CONTACT TELEPHONE NUMBER:

_____

WARNING

NCDOT FIBER OPTIC CABLE

Overall Marker Dimensions: 7(l) x 4 (w) inches

Lettering Height: 3/8 inch for "WARNING", 1/4 inch for all other lettering

For all fiber optic cables indicated in the Plans as City of Gastonia Electric Department cable, furnish cable wraps containing the following text in black:

WARNING

CITY OF GASTONIA ELECTRIC DEPARTMENT
FIBER OPTIC CABLE

CONTACT TELEPHONE NUMBER:

_____

WARNING

CITY OF GASTONIA ELECTRIC DEPARTMENT
FIBER OPTIC CABLE

Overall Marker Dimensions: 7(l) x 4 (w) inches

Lettering Height: 3/8 inch for "WARNING", 1/4 inch for all other lettering

Submit a sample of the proposed communications cable identification markers to the Engineer for approval before installation.

D. Fiber-Optic Cable Storage Guides

Furnish fiber-optic storage guides (snowshoes) that are non-conductive and resistant to fading when exposed to UV sources and changes in weather. Ensure that snowshoes have a captive design such that fiber-optic cable will be supported when installed in the rack and fiber-optic cable's minimum bending radius will not be violated. Provide stainless steel attachment hardware for securing snowshoes to messenger cable and black UV resistant tie-wraps for securing fiber-optic cable to snowshoe. Ensure that snowshoes are stackable so that multiple cable configurations are possible.

15.3. CONSTRUCTION METHODS

A. General

Provide cable manufacturer's attenuation and Optical Time Domain Reflectometer (OTDR) testing data for each reel of cable.

Install single mode fiber-optic (SMFO) communications cable with grounding systems, snow shoes, communications cable identification markers, lashing wire, and all necessary hardware.

Comply with NESC and manufacturer's recommendations. Install communications cable on signal poles, utility poles, on messenger cable, and in conduits as required to bring the fiber-optic cable into and, if necessary, out of each splice enclosure.

Take all precautions necessary to ensure that cable is not damaged during storage, handling, and installation. Do not violate the minimum bending radius of 20 times the radius of the cable diameter or the manufacturer's recommendation, whichever is greater. Do not step on cable nor run over cable with vehicles or equipment. Do not pull cable over or around obstructions, or along the ground.

Determine lengths of cable necessary to reach from termination-point to termination point. Install cable in continuous lengths between approved splicing facilities. Additionally, provide a sufficient amount of slack cable to allow for an additional 20 feet of cable to be present after removal of the outer sheath for termination. Measure slack cable by extending cable straight out of the cabinet door.

Keep cable ends sealed at all times during installation to effectively prevent the ingress of moisture. Use approved heat shrink cable end cap. Do not use tape to seal cable ends.

Before installing cable, provide three copies of the cable manufacturer's recommended and maximum pulling tension. Do not exceed the manufacturer's recommended pulling tension. Use pulling grips containing a rotating swivel. Coil cable in a "figure-8" configuration whenever cable is unreeled for subsequent pulling.

Install fiber-optic cable in separate 2 inch (50 mm) risers with heat shrink tubing. Do not share risers with other type cable.

B. Aerial Installation

Double lash fiber-optic cable to messenger cable with one 360 degree spiral per foot.

Use pole attachment hardware and roller guides with safety clips to install aerial run cable.

Maintain tension during the pulling process for aerial run cable by using an approved mechanical clutch (dynamometer) device. Do not allow cable to contact the ground or other obstructions between poles during installation. Do not use a motorized vehicle to generate cable pulling forces.

Use a cable suspension clamp when attaching cable tangent to a pole. Select and place cable blocks and corner blocks so as not to exceed the cable's minimum bending radius. Do not pull cable across J-hooks.

Store 100 feet of slack fiber-optic cable over-head on all cable runs that are continuous without splices and are greater than 2,500 feet and as shown on the plans. This shall be for each NCDOT fiber optic cable lashed to the messenger cable. Obtain approval for spare cable storage locations. Store spare fiber-optic cable on fiber-optic cable storage racks (snow shoes) that may be stackable. At aerial splice enclosures, store spare cable of each size. Do not mix Gastonia Electric Department and NCDOT fiber optic cables on same snowshoe. Locate spare cable storage in the middle of spans between termination points. Do not store spare fiber-optic cable over the roadway or driveways.

Install one communications cable identification marker within 36 inches of pole attachment points and at locations where more than one cable originates or terminates.

Maintain electrical continuity of messenger cable at all poles.

C. Underground Installation

Install fiber-optic cable underground in conduit using cable pulling lubricants approved by the fiber-optic cable manufacturer and the Engineer.

Obtain approval of cable pulling lubricant and method of pulling before installing underground fiber-optic cable.

Use a dynamometer (clutch device) so as not to exceed the maximum allowable pulling tension if the cable is pulled by mechanical means. Do not use a motorized vehicle to generate cable pulling forces.

Keep tension on the cable reel and pulling line at the start of each pull. Do not release tension if the pulling operation is halted. Restart the pulling operation by gradually increasing tension until the

cable is in motion.

For pulling cable through manholes, junction boxes, and vaults. Feed the cable by manually rotating the reel. Do not pull cable through intermediate junction boxes, handholds, or openings in conduit unless otherwise approved.

Install communications cable identification markers on each communications cable entering a junction box.

D. Installation of Drop Cable Assembly

Determine the length of drop cable needed, including slack, to reach from termination point to termination point.

At aerial splice enclosures, store 100 feet of slack cable on cable storage racks. At below ground splice enclosures, coil 100 feet of slack cable in the manhole or junction box where the enclosure is located.

At the equipment cabinet end of the drop cable assembly, terminate all fibers with STPC connectors to the connector panel. Label all connectors and the connector panel. At the aerial splice enclosure location, cap off all unused or designated fibers and label to correspond with the connector panel.

E. Storage at Future Traffic Signals

As shown on the plans, store cable at locations of future traffic signals. Coil drop cable from splice enclosure. Ensure there is sufficient length of cable to route cable from splice enclosure to proposed location of signal controller cabinet.

15.4. METHOD OF MEASUREMENT

Actual linear feet of fiber-optic cable of each fiber count furnished, installed, and accepted. Measurement will be made by calculating the difference in length markings located on the outer jacket of the fiber-optic cable from the start of the fiber run to the end of the fiber run for each fiber run. Terminate all fibers before determining the length of the cable run.

Measured linear feet of fiber optic drop cable assemblies furnished, installed, and accepted. Sag and vertical segments will not be paid for as these distances are considered incidental to the installation of drop cable assemblies.

No measurement will be made for terminating, splicing, and testing of the fiber-optic cable, for communications cable identification markers, for modifications to existing riser assemblies, or for fiber-optic cable storage racks, grounding of messenger cable, as this will be considered incidental to

the installation of the fiber optic cable.

15.5. BASIS OF PAYMENT

The quantity of optic cable, measured as provided above, will be paid for at the contract unit price per linear foot (linear meter) for "Communications Cable (___-Fiber)" in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed cable; 25% of the payment for the cable will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of fiber-optic cable for use by the City of Gastonia Electric Department, measured as provided above, will be paid for at the contract unit price per linear foot (linear meter) for "Gastonia Electric Department Communications Cable (___-Fiber)."

The quantity of drop cable assemblies, measured as provided above, will be paid for at the contract unit price per linear foot (linear meter) as "Drop Cable" in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed cable; 25% of the payment for the cable will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

Payment will be made under:

Communications Cable (12-Fiber) ..... Linear Foot

Communications Cable (24-Fiber) ..... Linear Foot

Communications Cable (36-Fiber) ..... Linear Foot

Communications Cable (48-Fiber) ..... Linear Foot

Communications Cable (72-Fiber) ..... Linear Foot

Communications Cable (144-Fiber) ..... Linear Foot

Gastonia Electric Department Communications Cable (144-Fiber) ..... Linear Foot

Drop Cable ..... Linear Foot

16. FIBER-OPTIC SPLICE CENTERS

16.1. DESCRIPTION

Furnish and install fiber-optic interconnect centers, fiber-optic aerial splice enclosures, and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish interconnect centers and aerial splice enclosures and all necessary hardware. Provide aerial splice enclosures that are suitable for aerial, pedestal, buried, junction box, and/or manhole installations.

16.2. MATERIALS

A. Interconnect Center

Furnish compact, modular interconnect centers designed to mount inside equipment cabinets. Furnish 6-position interconnect centers that are rack-mountable. Design and size interconnect centers to accommodate all fibers entering equipment cabinets with additional 50% spare capacity.

Inside buildings, furnish compact, modular interconnect centers designed to be rack mounted in a standard 19" rack cabinet. Furnish 144-position interconnect centers from the Corning LANscape line of equipment. Design and size interconnect centers to accommodate all fibers entering equipment cabinets with additional 50% spare capacity.

Provide splice trays that hold, protect, and organize optical fibers, and that secure fibers inside the splice tray. Design and size splice trays to be dielectric, to accommodate all fibers entering the splice tray, and to provide sufficient space to prevent microbending of optical fibers. Provide connector panels with ST-type connectors.

Furnish SMFO pigtails with each interconnect center. Provide pigtails containing connector panels and that are a maximum of 6 feet in length with a factory assembled PC-ST connector on one end. Ensure that the SMFO pigtails meet the operating characteristics of the SMFO cable with which it is to be coupled.

Furnish SMFO jumpers that are a minimum of 3 feet in length with factory assembled PC-ST connectors on each end. Ensure that SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

B. Aerial Splice Enclosure

Furnish aerial splice enclosures that are re-enterable using a mechanical dome-to-base seal with a

flash test valve, and that are impervious to the entry of foreign material (water, dust, etc.). Ensure that enclosures are manufactured in such a manner to be suitable for aerial, pedestal, buried, junction box, and manhole installation.

Provide enclosures with a minimum of one over-sized oval port that will accept two cables and with a minimum of four round ports (for single cables) which will accommodate all cables entering the enclosure. Provide heat shrink cable shields with the enclosure to ensure that a weather tight seal where each cable enters the enclosure.

Within enclosures, provide the minimum necessary number of hinged mountable splice trays to store the number of splices required, plus the capacity to house six additional splices. Provide a fiber containment basket for storage of loose buffer tubes that are expressed through the enclosure. Ensure that enclosures allow sufficient space to prevent microbending of the buffer tubes when coiled.

Provide splice trays that hold, protect, and organize optical fibers, and that secure fibers inside the splice tray.

Provide splice trays that are dielectric.

At locations where Gastonia Electric Department cable is spliced using a splice enclosure as shown on the Plans, furnish and install aerial splice enclosure as provided above.

16.3. CONSTRUCTION METHODS

A. General

Install interconnect centers with connector panels, splice trays, storage for slack cable or fibers, mounting and strain relief hardware, and all necessary hardware.

Install aerial splice enclosures with splice trays, basket containment assemblies, racking for slack cable or fibers, mounting and strain relief hardware, and all other necessary hardware.

Fusion splice and secure SMFO cable in splice trays inside the splice enclosure.

Do not exceed 0.05 dB of attenuation per splice.

Furnish strain relief so that no tensile force is on the SMFO cable when it is held within the interconnect center or aerial splice enclosure.

B. Termination and Splicing within Interconnect Center

Terminate and splice all fibers including unused fibers.

Label all fiber-optic connectors, whether on jumpers, connector panels, or other equipment, to prevent improper connection. Obtain approval of the fiber-optic connectors labeling method.

Ensure that all buffer tubes are contained within the splice tray so that no bare fibers are outside the tray.

For all fibers designated for termination to a connector panel within the interconnect center, fusion splice the fibers to the pigtails.

For all cut fibers designated to be expressed through the interconnect center, fusion splice the fibers.

For all buffer tubes designated to be expressed through the interconnect center, neatly coil the excess tubing inside the interconnect center. Do not damage the cable or violate the minimum bending radius of the cable.

C. Termination and Splicing within Aerial Splice Enclosure

Fusion splice all fibers including fibers designated to be coupled with fibers from a drop cable assembly and cut fibers designated to be expressed through the splice enclosure.

For all buffer tubes designated to be expressed through the splice enclosure, neatly coil the excess tubing inside the basket provided with the enclosure.

Ensure that all buffer tubes are contained within the splice tray so that no bare fibers are outside the tray.

Do not damage the fiber or exceed the minimum bending radius of the fiber.

Label all fiber-optic splices. Obtain approval of the method of labeling all fiber-optic connections.

Install heat shrink cable shields using methods recommend by the manufacturer of the enclosure. Perform a pressurization flash test on the enclosure in accordance with the manufacturer's recommend procedures at the conclusion of the splicing procedure and prior to the final placement of the enclosure.

For aerial installations, secure enclosures to messenger cable using the manufacturer supplied hardware. Secure SMFO cable and drop cable assemblies to snowshoes.

Install enclosures with a sufficient amount of slack cable to allow the enclosure to be lowered to ground level and extended into a splicing vehicle that is located within 10 feet of the equipment cabinet.

For underground, manhole, and junction box facility installations, place the enclosure along with required spare cables in the facility in a neat and workmanship like manner and insure that no

standing water remains in junction box. Do not place the splice enclosure in bottom of junction box. Do not damage cable or violate the minimum bending radius of the cable.

Never splice, cross connect, or share splice enclosure or interconnect centers between cables designated as Gastonia Electric Department cable and those cables without such designation.

D. Testing

Provide written notification a minimum of ten days before beginning fiber-optic cable testing.

After completion of splicing, perform the two patch cable test procedure and the OTDR test on each fiber, including unused fibers, to ensure that the following:

- fusion splice loss does not exceed 0.05 dB,
- terminations and connections have a loss of 0.5 dB or less,
- and reflection loss is 40 dB or greater for each connector.

If exceeded, remake splices until the loss falls below 0.05 dB. The Department will record each attempt for purposes of acceptance.

Furnish durable labeled plots and electronic copies on CD-ROM of test results for each fiber including engineering calculations demonstrating that OTDR test results meet or exceed the attenuation requirements and that optical properties of the cable have not been impaired. Label all test results (plots and diskettes) with the manufacturer and model number of the OTDR testing equipment. Provide engineering calculations and tests for fiber-optic cable that demonstrates the loss budget where the fiber originates and the point where the fiber meets an electronic device.

If any fiber exceeds the maximum allowable attenuation or if the fiber-optic properties of the cable have been impaired, take approved corrective action including replacement of complete segments of fiber-optic cable if required. Corrective action will be at no additional cost to the Department.

16.4. METHOD OF MEASUREMENT

Actual number of fiber-optic interconnect centers furnished, installed and accepted.

Actual number of fiber-optic splice enclosures furnished, installed and accepted. No measurement will be made between aerial, underground, manhole, or junction box installation of the fiber-optic splice enclosure.

No measurement will be made of splice trays, pigtails, jumpers, connector panels, and testing, as this will be considered incidental to furnishing and installing fiber optic interconnect centers and

aerial splice enclosures.

16.5. BASIS OF PAYMENT

The quantity of fiber-optic interconnect centers, measured as provided above, will be paid for at the contract unit price each for "Interconnect Center" in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment for the unit will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of splice enclosures, measured as provided above, will be paid for at the contract unit price each for "Aerial Splice Enclosure" in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment for the unit will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of splice enclosures for use with Gastonia Electric Department cables, measured as provided above, will be paid for at the contract unit price each for "Gastonia Electric Department Aerial Splice Enclosure."

Payment will be made under:

Interconnect Center ..... Each

Aerial Splice Enclosure ..... Each

Gastonia Electric Department Aerial Splice Enclosure ..... Each

17. FIBER-OPTIC TRANSCEIVERS

17.1. DESCRIPTION

Furnish and install fiber-optic transceivers with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish shelf-mounted, modular designed, single mode fiber-optic transceivers and all necessary hardware that are compatible with the system equipment and designed for RS-232 drop-and-repeat communications. Do not provide transceivers that are internal to the system equipment. Provide identical transceivers at all locations and that are capable of being interchanged throughout the system.

17.2. MATERIALS

A. General

Furnish transceivers that transmit and receive RS-232/optical pulse signals to and from the head-end and to each remote field cabinet. Ensure that transceivers are capable of operating at distances up to 10 miles without the need to boost the signal and without distortion of the signal.

Provide LED's on the front panel of transceivers for power, and transmitting and receiving indications. Comply with the following:

- Input Power: 115 VAC
- Minimum Loss Budget: 17 dB with corresponding receiver
- Operating Wavelength: 1310 or 1550 nm
- Optical Connector: ST
- Signal Connector: Female Plug Type
- Temperature Range: 0 to 150 degrees F

B. Shelf Mounted Transceivers

Stand-alone, shelf mountable, transceivers are to be provided in signal controller cabinets. Furnish stand-alone transceivers in an aluminum housing that has been treated to prevent corrosion. The transceivers shall conform to standard mounting and interconnection provisions within the cabinet. The mounting plate for the transceivers shall have mounting holes manufactured to tolerances to assure interchangeability of units within controller cabinets.

C. Rack Mounted Transceivers

Rack-mounted chassises shall be used to house the transceivers installed at the TOC. FOT rack-mounted chassises shall be provided and shall be incidental to the cost of the transceivers. The chassis shall be fabricated of anodized aluminum, designed for mounting in a 19 inch rack and not exceed three (3) standard mounting units in height (5.25 inch). The chassis shall contain a power converter compatible with the transceiver cards power requirements. The chassis shall include provisions for interconnecting cabling. The chassis shall be designed to accommodate a minimum of ten (10) transceiver cards that shall be easily mountable and removable from the chassis. When installed in the chassis, transceiver cards shall be securable. The front panel shall include functional identification markings in accordance with EIA 606. The transceiver cards shall be configured where they cannot be installed into a chassis in the wrong position (i.e., keyed).

17.3. CONSTRUCTION METHODS

Install fiber-optic transceivers in each signal controller equipment cabinet and comply with the manufacturer's installation instructions.

Install and integrate stand-alone transceiver units into signal cabinets at locations shown in the Plans.

Install transceiver rack mount chassis(es) as required into rack cabinet in TOC as shown in the Plans to accommodate all transceiver units. Integrate units with the communication server.

17.4. METHOD OF MEASUREMENT

Actual number of fiber-optic transceivers furnished, installed and accepted.

17.5. BASIS OF PAYMENT

The quantity of fiber-optic transceivers, measured as provided above, will be paid for at the contract unit price each for "Fiber-Optic Transceiver" in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment for the unit will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

Payment will be made under:

Fiber-Optic Transceiver.....Each

18. DELINEATOR MARKERS

18.1. DESCRIPTION

Furnish and install delineator markers with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish delineator markers and all necessary hardware.

18.2. MATERIALS

Furnish delineator markers that are a tubular design, approximately 6 feet long, and constructed of a Type III, high density polyethylene material. Provide delineator assemblies that are ultraviolet stabilized to help prevent components from color fading, warping, absorbing water and deterioration with prolonged exposure to the elements. Provide delineators designed to self-erect after being knocked down or pushed over. Provide delineators posts that are orange in color.

Provide text, including the division contact number, that is hot stamped in black on a yellow reflective background material that will not fade or deteriorate over time. Provide delineator markers with a nominal message height of 15 inches and that contain the following text visible from all directions approaching the assembly:

WARNING	**FIBER OPTIC CABLES**
BEFORE EXCAVATING OR IN AN EMERGENCY CALL (___) ___-____	
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION	

18.3. CONSTRUCTION METHODS

Submit a sample of the proposed delineator markers for approval prior to installation.

Install delineator markers using a method that firmly and securely anchors the delineator marker in the ground to prohibit twisting and easy removal.

18.4. METHOD OF MEASUREMENT

Actual number of delineator markers furnished, installed and accepted.

18.5. BASIS OF PAYMENT

The quantity of delineator markers, measured as provided above, will be paid for at the contract unit price each for "Delineator Marker."

Payment will be made under:

Delineator Marker ..... Each

19. CABLE TRANSFERS

19.1. DESCRIPTION

Remove and reinstall communications cable due to pole relocations. Comply with the provisions of Section 1700 of the 2002 Standard Specifications for Roads and Structures.

19.2. CONSTRUCTION METHODS

During the course of the project, transfers of existing communications cable to new poles may be required. Perform such transfers where directed by the Engineer. Remove the existing cables from the pole to be removed and reinstall these cables and any existing attachment hardware on the new pole. Furnish and install any new attachment hardware as required.

19.3. METHOD OF MEASUREMENT

Actual number of cable transfers with attachment hardware to new poles furnished, installed, and accepted.

19.4. BASIS OF PAYMENT

The quantity of cable transfers, measured as provided above, will be paid for at the contract unit price each for "Cable Transfer."

Payment will be made under:

Cable Transfer.....Each

20. REMOVE EXISTING COMMUNICATIONS CABLE

20.1. DESCRIPTION

Remove existing communications cable.

20.2. CONSTRUCTION METHODS

Removal of existing aerial communications cable also includes proper disposal of the communications cable, messenger cable and mounting hardware, including abandoned risers.

Removal of existing underground communications cable includes proper disposal of the communications cable and junction boxes, if required. Removal of junction boxes will be noted on the plans.

Do not reuse any removed communications cable, messenger cable, junction boxes, pole attachment hardware or abandoned risers on the project, unless otherwise identified by the plans. In the event that any of the removed communications cable, junction boxes or pole attachment hardware is to be returned to the Engineer, it will be so noted on the plans.

20.3. METHOD OF MEASUREMENT

Measured horizontal linear feet of existing communications cable removed and accepted. Sag, vertical segments, or spare segments of communications cable will not be paid for as these distances will be considered incidental to the removal of the existing communications cable.

No additional measurement will be made for multiple cables being removed from the same conduit or same pole. Where multiple adjacent conduits exist (each containing multiple cables), each conduit will be considered separately for purposes of payment. No payment will be made for cable that cannot be removed and is abandoned in place.

No measurement will be made of the removal of messenger cable, pole attachment hardware, and junction boxes, as these will be considered incidental to removing existing communications hardware.

20.4. BASIS OF PAYMENT

The quantity of removed existing communications cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Remove Existing Communications Cable."

Payment will be made under:

Remove Existing Communications Cable ..... Linear Feet

21. BUILDING MODIFICATIONS AND FIBER OPTIC CABLE TERMINATION

21.1. DESCRIPTION

At locations called for in the Plans, route fiber optic cable in new and/or existing conduit and install conduit into buildings as shown. Terminate fiber optic cable into fiber interconnect centers in building as shown in the Plans. Modify rooms and furnish and install cable and cable routing facilities as shown in the Plans.

21.2. MATERIALS

Use risers and conduit materials as called for in the Standard Specifications or these Project Special Provisions.

Use fiber interconnect centers as called for in the Standard Specifications or these Project Special Provisions.

Use caulking and sealing materials for sealing entrances into buildings as approved by the Engineer.

Use new cable raceways, electrical boxes, and metallic conduit as approved by the Engineer. Where called for in the Plans, use thin-walled EMT conduit that complies with the NEC and EIA/TIA Standard 569 and commercial building standards for telecommunications pathways.

21.3. CONSTRUCTION METHODS

A. General

Contact Engineer prior to entering any building. Coordinate and obtain approval from Engineer regarding allowable working time in buildings.

Prior to core drilling or otherwise creating new entrance into an existing building, obtain approval of methods and materials from the Engineer. In all cases create entrance that is weatherproof and water tight.

Whenever possible, use exiting cable raceways, ducts, raised floors, and drop ceilings to route fiber optic cable.

Perform all work called for in the plans to enter building, install cable conduits and cable raceways, and to route cabling in raised floors, drop ceilings, and new and existing conduits.

Terminate all optical fibers in interconnect centers unless otherwise shown on the Plans.

B. Municipal Operations Center

Install equipment and route cables as shown in the Plans.

Coordinate with Engineer and provide minimum of three (3) additional phone lines for service to dial-up controller cabinet locations and for remote dial-up access by remote users.

C. Garland Municipal Business Center

Install equipment and route cables as shown in the Plans.

D. City IT Building

Route and terminate cables as shown in the Plans.

E. MRTMC

Install equipment and route cables as shown in the Plans.

Integrate all signal system and CCTV system client applications on the existing workstation in the facility. Integrate client applications to properly communicate with T1 routers.

No activity at the MRTMC facility done under this project shall result in the MRTMC system operations being unavailable between the hours of 6:00 AM and 6:00 PM on weekdays.

F. Division 12 Office

Install equipment and route cables as shown in the Plans.

Integrate all signal system and CCTV system client applications on the existing workstation in the facility. Integrate client applications to properly communicate with existing dial-up telephone service.

21.4. METHOD OF MEASUREMENT

Each building modification shall be measured on a lump sum basis and shall include all work required to route and terminate the fiber optic cable into the buildings as shown as well as any other work not called for under other items but required to accomplish the building modifications.

No separate payment will be made for interconnect centers, patch panels, wall sockets and outlets, splicing, conduit, cable routing within building, and telephone service costs for permits and installation fees, as this will be considered incidental to building modifications.

21.5. BASIS OF PAYMENT

All payments for the building modification items will be made in accord with the following conditions: 75% of the payment will be made upon acceptance of the building modifications; 25%

of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

Payment will be made under:

Municipal Operations Center Building Modifications ..... Lump Sum

Garland Municipal Business Center Building Modifications ..... Lump Sum

City IT Building Modifications ..... Lump Sum

MRTMC Building Modifications ..... Lump Sum

Division 12 Office Building Modifications ..... Lump Sum

22. DIAL-UP COMMUNICATIONS

22.1. DESCRIPTION

As shown in the Plans, the signal controller located at Davidson Avenue and Hargrove Avenue will not be integrated with the fiber optic communications network, but will utilize dial-up communications over the public telephone network.

At this location procure telephone service and furnish, install, and fully integrate dial-up modem for controller communications.

22.2. MATERIALS

A. Modem

Controller dial-up modem shall be an external unit having a raw data-transfer speed of 56 kbps and shall conform to the Microcom Networking Protocol (MNP) classes 2 through 5, and the International Telecommunications Union (ITU) V.34, V.42, V.42bis, V.90, and V.92 standards. The modem shall be capable of communicating with 28,800, 14,400, 9600, 2400 and 1200 bps modems and shall automatically adjust the data rate and modulation to accomplish this. The modem shall have auto dial/auto answer features. Modem shall support the Hayes AT Command set and have at least the following function indicators for identifying modem operation:

- Carrier detect
- Auto answer on
- Modem ready
- Terminal ready
- Modem has taken phone off hook
- Received data is being sent to the computer or received transmission from phone line.
- Data sent from the computer was received by the modem or transmission made to phone line.

Modem shall be US Robotics Model 5686E or approved equivalent.

B. Telephone Demarcation

At locations shown in the Plans, provide a telephone demarcation assembly for dial-up modem communications. Each assembly shall consist of a 1" riser with weatherhead installed on a designated existing pole and a telephone demarcation box attached at the base of the riser

approximately 3 feet above ground level.

22.3. CONSTRUCTION METHODS

A. Modem

At locations shown in the Plans, furnish and install a dial-up modem for signal controller communications. Fully integrate with signal controller and telephone demarcation assembly.

Install identical dial-up modems at the TOC as shown in the Plans. Fully integrate with communications server.

B. Telephone Demarcation

Install a service pole in a location approved by the Engineer and deliver power and telephone service to it. Run power and telephone service to the controller cabinet through separate conduits.

22.4. METHOD OF MEASUREMENT

Actual number of dial-up modems furnished, installed, and accepted.

Actual number of telephone demarcation assemblies furnished, installed, and accepted.

22.5. BASIS OF PAYMENT

The quantity of dial-up modems, measured as provided above, will be paid for at the contract unit price each for "Dial-Up Modem."

The quantity of telephone demarcation assemblies, measured as provided above, will be paid for at the contract unit price each for "Telephone Demarcation Assembly."

Payment will be made under:

Dial-Up Modem ..... Each

Telephone Demarcation Assembly ..... Each

23. SIGNAL CABINET FOUNDATIONS

23.1. DESCRIPTION

Furnish and install signal cabinet foundations and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish either poured concrete foundations or preformed cabinet pad foundations and all necessary hardware. Selection of the type of foundation will be the contractor's option.

23.2. MATERIALS

Preformed cabinet pad foundation material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Provide pads with a minimum pad area that extends 24 inches from the front and back of the cabinet, and 3 inches from the sides of the cabinet.

Furnish poured cabinet foundations with chamfered top edges. Provide Class B concrete or better.

Comply with Article 1000-4 of the Standard Specifications regarding Portland Cement Concrete.

Where field conditions permit, preformed cabinet pad foundations may be furnished.

Ensure that preformed cabinet pad foundations provide chamfered top edges and a 7 (l) x 18 (w) inch minimum opening for the entrance of conduits. Ensure that no more than four 3/4 inch holes are cast or drilled in each pad for the purposes of handling or placing. Provide preformed cabinet pad foundations constructed of Class A concrete or better.

23.3. CONSTRUCTION METHODS

Comply with Section 825 of the Standard Specifications regarding Incidental Concrete Construction.

Obtain approval for final cabinet foundation locations before pouring the concrete base.

Do not install foundations over uncompacted fill or muck.

Use procedures, equipment, and hardware as follows:

- Hand tamp the soil on which the concrete is to be placed before placing the concrete.
- Maintain a minimum distance of 12 inches from the service pole to the closest point on the cabinet foundation unless approved.

- Use a minimum of four 1/2 inch diameter expanding type anchor bolts to secure the cabinet.
- Install foundations a minimum of 4 inches above the finished grade and 4 inches below the finished grade.
- Install conduits no more than 4 inches above the foundation. Locate external stubbed out conduit at the cabinet foundation so that the conduit is in the middle of the cabinet. Provide a service conduit as the rightmost conduit coming into the cabinet. Provide two spare conduits stubbed out; one pointed toward the service pole and the other toward the direction of the lead-in cable. Inscribe an identification arrow in the cabinet foundation indicating the direction of spare conduits.
- Give the cabinet foundation a broom finish.
- Seal the space between the base of the cabinet and the foundation with a permanent, flexible, waterproof sealing material.

23.4. METHOD OF MEASUREMENT

Actual number of signal cabinet foundations furnished, installed, and accepted.

23.5. BASIS OF PAYMENT

The quantity of signal cabinet foundations, measured as provided above, will be paid for at the contract unit price each for "Signal Cabinet Foundation."

Payment will be made under:

Signal Cabinet Foundation.....Each

24. MODIFY CABINET FOUNDATIONS

24.1. DESCRIPTION

Where approved by the Engineer, install conduit entrances into existing foundations in accordance with the plans and specifications. Comply with the provisions of Sections 1700 and 1750 of the Standard Specifications.

Modify existing foundations in accordance with the plans and specifications. Comply with the provisions of Sections 1700 and 1750.

24.2. MATERIALS

Comply with the provisions of section 1750-2 of the Standard Specifications.

24.3. CONSTRUCTION METHODS

A. Install Conduit Entrance into Existing Foundation

Install Conduit Entrances into existing cabinet foundations by core drilling foundations to install additional conduit.

Maintain a minimum of 3 inches of cover between new conduit and edge of foundation. Maintain minimum clearances of 1 inch from the flange of the base adapter and 2 inches from existing conduits. Avoid damaging existing conduit, conductors, and anchor bolts. Repair all such damages. Where approved by the Engineer, the foundation may be chipped instead of drilled for conduit entrance. When possible, maintain traffic signal operations while drilling is performed.

Bond new metallic conduit to the cabinet grounding system.

After installation of conduit, place grout to seal around conduit, and return the foundation to normal appearance.

B. Modify Foundation

Enlarge existing cabinet foundations to accommodate the new cabinet and/or to provide a maintenance technician pad(s).

Excavate the ground around the existing foundation to a depth sufficient to expose a minimum of 4 inches of the foundation below existing grade.

Rough the sides of the existing foundation from the top to a point 4 inches below grade by means of a chisel or other method approved by the Engineer.

Wash the sides of the foundation with water pressurized at 50 psi and thoroughly dry with

compressed air.

Drill holes approximately 12 inches deep on 12-inch centers into the existing foundation. Install #4 dowels and epoxy into place. Provide dowels of the following lengths:

Foundation Extension	Length of Dowel
>16"	24"
>6" and <16"	17"
=6"	14"

Use concrete to install the maintenance technician pad.

Form the sides of the modified foundation to a minimum depth of four inches below grade.

Position forms so that all existing exposed foundation surfaces at or above grade level will be matched.

Apply a coating of approved epoxy bonding agent to all exposed roughened concrete surfaces as recommended by the manufacturer.

On all four sides, enlarge the foundation to the distance specified for new cabinet foundations. Provide a 1-inch chamfer on all new outside edges.

Maintenance technician pads should be added to the foundation to provide a minimum work area of 24 inches (length) x 30 inches (width) from both the front and rear doors of the cabinet.

Extend foundation dimensions by the lengths shown in the table below. Location of extension (front, back, left, or right) shall be from the perspective facing the existing cabinet door. At certain locations indicated, rotate new cabinet front door to be 90^{o} from existing cabinet front door.

INTERSECTION REFERENCE INFORMATION			FOUNDATION MODIFICATION INFORMATION				
SIGNAL NUMBER	STREET 1	STREET 2	ROTATE NEW CABINET FRONT DOOR 90 DEGREES TO RIGHT FROM EXISTING CABINET FRONT DOOR	EXTEND LEFT (IN)	EXTEND RIGHT (IN)	EXTEND BACK (IN)	EXTEND FRONT (IN)
12-0017	CHESTER ST	DAVIDSON AV	1	15	17		
12-0030	FRANKLIN BLVD	GARRISON BLVD	1	7			
12-0032	FRANKLIN BLVD	LINWOOD RD	1				
12-0048	FRANKLIN BLVD	THOMAS ST	1				
12-0050	FRANKLIN BLVD	NEW HOPE RD	1	10	13		
12-0053	NEW HOPE RD	OZARK AV	1	9	9		
12-0069	CHESTER ST	GARRISON BLVD	1	14	4		
12-0080	WILKINSON BLVD	GROVE ST	1	16	13		
12-0097	MARIETTA ST	WALNUT AV	1	16	16		
12-0098	GARRISON BLVD	UNION RD	1	12	6		
12-0103	NEW HOPE RD	TITMAN RD/HUDSON BLVD	1	16	16		
12-0151	WILKINSON BLVD	REDBUD DR	1	12	16		
12-0152	NEW HOPE RD	BURTONWOOD DR					19
12-0154	NEW HOPE RD	ROBINWOOD RD	1	16	16		
12-0162	CHESTER ST	I-85 N RAMP	1	15	7		
12-0169	NEW HOPE RD	COURT DR	1	13	8		
12-0173	NEW HOPE RD	AUTEN RD	1	9	9		
12-0176	NEW HOPE RD	PEARL ST	1	11	11		
12-0181	HUDSON BLVD	LYNHAVEN DR	1	11	11		
12-0195	NEW HOPE RD	I-85 N RAMP	1	11	11		
12-0213	CHESTER ST	RANKIN AV	1	17	17		
12-0245	UNION RD	ROBINWOOD RD	1	8	12		
12-0331	LONG/OZARK AV	MODENA ST	1	15	15		
12-0609	ARMSTRONG PARK RD	GARDNER PARK DR	1	9	9		

INTERSECTION REFERENCE INFORMATION			FOUNDATION MODIFICATION INFORMATION				
SIGNAL NUMBER	STREET 1	STREET 2	ROTATE NEW CABINET FRONT DOOR 90 DEGREES TO RIGHT FROM EXISTING CABINET FRONT DOOR	EXTEND LEFT (IN)	EXTEND RIGHT (IN)	EXTEND BACK (IN)	EXTEND FRONT (IN)
12-0632	GARRISON BLVD	LINWOOD RD	1	17	17		
12-0633	GARRISON BLVD	MARIETTA ST					18
12-0902	COX RD	I-85 S RAMP	1	15	15		
12-0921	CHESTER ST	RANKIN LAKE RD	1	9	10		
12-0922	CHESTER ST	TULIP DR	1	11	11		
12-0923	LONG AV	BROAD ST	1	10	20		
12-0924	CHESTER ST	MAIN AV	1	9	9		
12-0929	LONG AV	MARIETTA ST	1	16	16		
12-0942	FRANKLIN BLVD	WEST CLUB CIR	1	16	16		
12-0986	NEW HOPE RD	ARMSTRONG PARK RD	1	9	9		
12-0990	ROBINWOOD RD	KENDRICK RD	1	9	9		
12-1086	COX RD	I-85 N RAMP					18
12-1105	FRANKLIN BLVD	FRANKLIN SQUARE I	1	9	9		
12-1124	FRANKLIN BLVD	SHANNON BRADLEY RD				18	
12-1231	NEW HOPE RD	PINEVIEW LANE				18	
12-1238	COX RD	GASTON MALL	1	12	16		
12-1282	COX RD	ABERDEEN BLVD	1	11	11		
12-1319	MAIN ST	I-85 N RAMP	1	12	8		
12-1320	MAIN ST	I-85 S RAMP	1	9	9		
12-1378	ROBINWOOD RD	HUDSON BLVD	1	12	7		
12-1401	FRANKLIN BLVD	FRANKLIN SQUARE II	1	14	14		
12-1410	HUDSON BLVD	NEAL HAWKINS RD				21	
12-1411	UNION RD	HUDSON BLVD	1	17	17		
12-1454	FRANKLIN BLVD	FRANKLIN CORNERS OR HOME DEPOT DRIVEWAY	1	9	9		
12-1459	HUDSON BLVD	BRADFORD HEIGHTS RD	1	9	9		

INTERSECTION REFERENCE INFORMATION			FOUNDATION MODIFICATION INFORMATION				
SIGNAL NUMBER	STREET 1	STREET 2	ROTATE NEW CABINET FRONT DOOR 90 DEGREES TO RIGHT FROM EXISTING CABINET FRONT DOOR	EXTEND LEFT (IN)	EXTEND RIGHT (IN)	EXTEND BACK (IN)	EXTEND FRONT (IN)
12-1535	NEW HOPE RD	REMOUNT RD	1	13	13		
12-1543	GARRISON BLVD	TRENTON ST/ATHENIAN DR	1	12	6		
12-1562	FRANKLIN BLVD	LINEBERGER RD	1	10	10		
12-1563	FRANKLIN BLVD	CHURCH ST (LOWELL)				9	9
12-1603	ARMSTRONG PARK RD	GARDNER PARK SCHOOL	1	9	9		
12-1604	GASTON DAY SCHOOL RD	HOFFMAN RD	1	9	9		
12-1605	HUDSON BLVD	ARMSTRONG PARK RD	1	9	9		
12-1623	CHESTER ST	RADIO ST				9	
CITY-09	ABERDEEN BLVD	WEST CLUB CIR	1	16	16		

24.4. METHOD OF MEASUREMENT

Actual number of conduit entrances drilled into existing cabinet foundations furnished, installed and accepted.

Actual number of existing cabinet foundations modified and accepted.

24.5. BASIS OF PAYMENT

The quantity of new conduit entrances, measured as provided above, will be paid for at the contract unit price each for "Conduit Entrance into Existing Foundation."

The quantity of modified foundations, measured as provided above, will be paid for at the contract unit price each for "Modify Foundation for Controller Cabinet."

Payment will be made under:

Conduit Entrance into Existing Foundation.....Each

Modify Foundation for Controller Cabinet.....Each

25. CABINET BASE EXTENDER

25.1. DESCRIPTION

Furnish and install cabinet base extenders in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the 2002 Standard Specifications

25.2. MATERIALS

Fabricate base extenders out of the same materials and with the same finish as the cabinet housing. Fabricate the base adapter and extender in the same manner as the controller cabinets, meeting all applicable specifications called for in Section 6.2.2 of the CALTRANS Traffic Signal Control Equipment Specifications (TSCES). Provide base extenders that are a minimum height of 12 inches.

25.3. CONSTRUCTION METHODS

Install a cabinet base extender at every location requiring a new base mounted cabinet on a new foundation. At locations shown, use a cabinet base extender of 18 inches or 24 inches as directed in the Plans.

Use a permanent, flexible waterproof sealing material to:

- Seal between the base of the cabinet and the cabinet base extender,
- Seal the seams of a two-piece cabinet base extender, and
- Seal the space between the cabinet base extender and the foundation.

25.4. METHOD OF MEASUREMENT

Actual number of cabinet base extenders furnished, installed, and accepted.

25.5. BASIS OF PAYMENT

The quantity of cabinet base extenders, measured as provided above, will be paid for at the contract unit price each for "Cabinet Base Extender."

Payment will be made under:

Cabinet Base Extender.....Each

26. CABINETS AND CONTROLLERS

26.1. DESCRIPTION

Furnish and install controllers with cabinets and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

As specified on the plans, furnish Type 2070L traffic signal controllers with Model 170 family controller cabinets. Furnish all pole or foundation mounting hardware, detector sensor cards, one Corbin Number 2 cabinet key, one police panel key, conflict monitors or malfunction management units, surge protection, grounding systems, AC/DC isolator cards, and all necessary hardware. Permanently inscribe cabinet identification information on the interior of the door.

Install and integrate Department furnished local intersection control software in all controllers. The Department will furnish software.

26.2. MATERIALS

A. General

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

The Department at any time prior to the approval of cabinets and controllers reserves the right to furnish themselves all or any portion of the controllers and cabinets required for this project. If the controllers and cabinets are furnished by the Department, the Contractor shall fully inspect, install, and integrate the equipment as specified in these Project Special Provisions. If the Department elects to furnish cabinets and controllers, payment for installation and integration of Department-furnished equipment would be negotiated with the Contractor at a later date after awarding the contract.

B. Type 2070L Controllers

Conform to CALTRANS Traffic Signal Control Equipment Specifications and all addenda in effect on the date of advertisement except as required herein. Where an item is no longer cited, the last applicable specification applies.

Furnish Model 2070L controllers. Ensure that removal of the program module from the controller will place the intersection into flash.

The Department will provide software at the beginning of the burning-in period. Contractor shall give 5 working days notice prior to needing software. Program software shall be provided by the

Department.

Provide model 2070L controllers with the latest version of OS9 operating software and device drivers approved by the Engineer and compatible with the Department's local intersection controller software, composed of the unit chassis and at a minimum the following modules and assemblies:

- MODEL 2070 1B, CPU Module, Single Board
- MODEL 2070-2A, Field I/O Module (FI/O)
- MODEL 2070-3B, Front Panel Module (FP), Display B (8x40)
- MODEL 2070-4A, Power Supply Module, 10 AMP
- MODEL 2070-7A, Async Serial Com Module (9-pin RS-232)

Furnish one removable data key with each 2070L controller unit.

C. Type 170E Cabinets

C.1. General

Conform to the CALTRANS Traffic Signal Control Equipment Specifications in effect on the date of advertisement except as required herein. Where an item is no longer cited, the last applicable specification will apply.

Furnish CALTRANS Model 336S pole mounted cabinets configured for eight vehicle phases with power distribution assemblies (PDAs) #2, and four pedestrian phases or overlaps.

Furnish CALTRANS Model 332A base mounted cabinets with Power Distribution Assembly (PDA) #2 and configured for eight vehicle phases, four pedestrian phases, and four overlaps. When overlaps are required, provide auxiliary output files for the overlaps. Do not reassign load switches to accommodate overlaps.

Provide a moisture resistant coating on all circuit boards.

C.2. Cabinet Electrical Requirements

Provide a cabinet assembly designed to ensure that upon leaving any cabinet switch or conflict monitor initiated flashing operation, the controller starts up in the programmed start up phases and start up interval.

Furnish two sets of non-fading cabinet wiring diagrams and schematics in a paper envelope or container and placed in the cabinet drawer.

Provide surge suppression in the cabinet for each type of cabinet device. Provide surge

protection for the full capacity of the cabinet input file.

Provide power line surge protectors that are two-stage devices which will allow connection of the radio frequency interference filter between the stages of the device. All AC+ power is subject to radio frequency signal suppression. Protect sensitive electronics with surge and spike suppression devices that comply with the following:

- Provides a maximum continuous current of at least 10 amperes at 120V.
- For an 8x20 microsecond waveform, withstands a minimum of 20 peak surge current occurrences at 20,000A.
- Provides maximum clamp voltage of 280V at 20,000A.
- Provides nominal series inductance of 200μH.
- Provides the following surge protection filtering:

Frequency (Hz)	Minimum Insertion Loss (dB)
60	0
10,000	30
50,000	55
100,000	50
500,000	50
2,000,000	60
5,000,000	40
10,000,000	20
20,000,000	25

Provide one V150LA20 MOV or equivalent protection between each load switch field terminal and earth ground.

Provide a terminal mounted loop surge suppresser device for each set of loop terminals in the cabinet. For a 10x700 microsecond waveform, ensure that the device can withstand a minimum of 25 peak surge current occurrences at 100A, in both differential and common modes. Ensure that the maximum breakover voltage is 170V and the maximum onstate clamping voltage is 40V. Provide a maximum response time less than 5 nanoseconds. Ensure that offstate leakage current is less than 10 μA. Provide a nominal capacitance less than 220 pf for both differential and common modes.

Provide surge suppression on each communications line entering or leaving a cabinet. Ensure

that the communications surge suppresser can withstand at least 80 occurrences of an 8x20 microsecond wave form at 2000A and a 10x700 microsecond waveform at 400A. Ensure that the maximum clamping voltage is suited to the protected equipment. Provide a maximum response time less than 1 nanosecond. Provide a nominal capacitance less than 1500 pf and a series resistance less than 15 W.

Provide protection for each preemption or 120 Vrms single phase signal input by an external stud mounted surge protector. Ensure that a minimum stud size of 1/3 inch, and Number 14 AWG minimum sized wire leads with 1 foot minimum lengths. Ensure that a peak surge trip point less than 890 volts nominal for a 600 volt rise per microsecond impulse, and 950 volts nominal for a 3000 volt per microsecond rise impulse. Provide a maximum surge response time less than 200 nanoseconds at 10 kV per microsecond. Ensure that the AC isolation channel surge suppresser can withstand at least 25 occurrences of a 8x20 waveform of 10,000 amperes and a peak single pulse 8x20 microsecond wave form of 20,000 amperes. Provide a maximum clamping voltage of 30V. Provide a maximum response time less than 1 nanosecond. Ensure that the discharge voltage is under 200 volts at 1000 amperes and the insulation resistance is 100 megaohms. Provide an absolute maximum operating line current of one ampere at 120 Vrms.

Provide conductors for surge protection wiring that are of sufficient size (ampacity) to withstand maximum overcurrents which could occur before protective device thresholds are attained and current flow is interrupted.

Furnish a fluorescent fixture in the rear across the top of the cabinet and another fluorescent fixture in the front across the top of the cabinet at a minimum. Ensure that the fixtures provide sufficient light to illuminate all terminals, labels, switches, and devices in the cabinet. Conveniently locate the fixtures so as not to interfere with a technician's ability to perform work on any devices or terminals in the cabinet. Provide a protective diffuser to cover exposed bulbs. Furnish all bulbs with the cabinet. Provide door switch actuation for the fixtures.

Furnish a police panel with a police panel door. Ensure that the police panel door permits access to the police panel when the main door is closed. Ensure that no rainwater can enter the cabinet even with the police panel door open. Provide a police panel door hinged on the right side as viewed from the front. Provide a police panel door lock that is keyed to a standard police/fire call box key. In addition to CALTRANS Specifications, provide the police panel with a toggle switch connected to switch the intersection operation between normal stop-and-go operation (AUTO) and manual operation (MANUAL). Ensure that manual control can be implemented using inputs and software such that the controller provides full programmed clearance times for the yellow clearance and red

clearance for each phase while under manual control.

Provide a 1/4 inch locking phone jack in the police panel for a hand control to manually control the intersection. Provide sufficient room in the police panel for storage of a hand control and its cord.

Provide detector call switches inside the cabinet on the door or other convenient location which may be used to place a call on each of eight phases based on standard CALTRANS input file designation for detector racks. Provide three positions for each switch: On (place call), Off (normal detector operation), and Momentary On (place momentary call and return to normal detector operation after switch is released). Ensure that the switches are located such that the technician can read the controller display and observe the intersection.

Provide a shorting jack inside the cabinet that functions exclusively to call the controller and cabinet assembly into the automatic diagnostics functions. Ensure that the shorting jack will mate with a Switchcraft Model 190 plug or equivalent. Place the jack in a convenient, unobstructed location inside the cabinet. When the mating plug is inserted into the jack, ensure that the controller enters the diagnostic test mode and a controller generated monitor reset signal is placed on Pin C1-102 (monitor external reset) of the model 210 conflict monitor which causes the monitor to automatically reset.

Equip the cabinet with a connector and terminal assembly designated as P20 (Magnum P/N 722120 or equivalent) for monitoring the absence of any valid AC+ signal display (defined here as red, yellow, or green) input on any channel of the conflict monitor. Connect the terminal through a 3 1/2 feet 20 wire ribbon cable which mates on the other end to a connector (3M-3428-5302 or equivalent) installed in the front of the Type 210 enhanced conflict monitor. Ensure that the female connector which mates with the connector on the conflict monitor has keys to ensure that proper connection. Ensure that the cabinet enters the flash mode if the ribbon cable is not properly connected. Provide a P20 connector and terminal assembly that conforms to Los Angeles City DOT "Traffic Signal Specification DOT 170 ATSAC Universal and Related Equipment #54-053-02" in effect on the date of advertisement.

Terminate the ribbon cable at the P20 connector and terminal assembly. Ensure that the P20 connector and mating ribbon cable connector is keyed to prevent the cable from being improperly installed. Wire the P20 connector to the traffic signal red displays to provide inputs to the conflict monitor as shown:

Pin #	Function	Pin #	Function
1	Channel 15 Red	11	Channel 9 Red
2	Channel 16 Red	12	Channel 8 Red
3	Channel 14 Red	13	Channel 7 Red
4	GND	14	Channel 6 Red
5	Channel 13 Red	15	Channel 5 Red
6	Special Function 2	16	Channel 4 Red
7	Channel 12 Red	17	Channel 3 Red
8	Special Function 1	18	Channel 2 Red
9	Channel 10 Red	19	Channel 1 Red
10	Channel 11 Red	20	Red Enable

Provide a convenient means to jumper 120 VAC from the signal load switch AC+ supply bus to any channel Red input to the P20 connector in order to tie unused red inputs high. Ensure that easy access is provided to the jumper connecting terminals on the back side of cabinet. Locate the jumper terminals connecting to all 16 channel Red inputs in the same terminal block. For each channel Red input terminal, provide a companion terminal supplying AC+ from the signal bus. Provide one of the following two methods for providing Signal AC+ to the channel red input:

- Place a commercially available jumper plug between the channel Red input and its companion Signal Bus AC+ terminal.
- Place a jumper wire between a channel red input screw terminal and its companion Signal Bus AC+ screw terminal.

Connection between channel Red input terminal and its companion Signal Bus AC+ terminal must not require a wire greater than 1/2 inch in length.

Conform to the following Department wiring requirements:

- Wire the Red Enable monitor input to the Signal Bus AC+ terminal TB01-1.
- Do not connect either the special function 1 or the special function 2 monitor input to the red monitor card.
- Ensure that removal of the P-20 ribbon cable will cause the monitor to recognize a latching fault condition and place the cabinet into flashing operation and that this is implemented in the conflict monitor software.

Ensure that removal of the conflict monitor from the cabinet will cause the cabinet to revert to flashing operation.

Provide Model 200 load switches, Model 204 flashers, and output files as required to fully operate traffic signal as called for in these Project Special Provisions.

If additional surge protected power outlets are needed to accommodate fiber transceivers, modems, etc.; install a UL listed, industrial, heavy-duty type power outlet strip with a maximum rating of 15 A / 125 VAC, 60 Hz. Provide a strip that has a minimum of 3 grounded outlets. Ensure the power outlet strip plugs into one of the controller unit receptacles located on the rear of the PDA. Ensure power outlet strip is mounted securely; provide strain relief if necessary.

C.3. Cabinet Physical Requirements

Provide a surge protection panel with 16 loop protection devices and designed to allow sufficient free space for wire connection/disconnection and surge protection device replacement. Provide an additional three slots protected with six AC+ interconnect surge devices and two protected by four DC surge protection devices. Provide no protection devices on slot 14. Attach flash sense and stop time to the upper and lower slot as required.

- For pole mounted cabinets, mount surge protection devices for the AC+ interconnect cable inputs, inductive loop detector inputs, and low voltage DC inputs on a fold down panel assembly on the rear side of the input files. Fabricate the surge protection devices from sturdy aluminum and incorporate a swing down back panel to which the surge protection devices are attached. Attach the swing down panel to the assembly using thumb screws. Have the surge protection devices mounted horizontally on the panel and soldered to the feed through terminals of four 14 position terminal blocks with #8 screws mounted on the other side.
- For base mounted cabinets, attach separate surge protection termination panels to each side of the cabinet rack assembly. Mount the surge protection termination panel for AC isolation devices on the same side of the cabinet as the AC service inputs. Install the surge protection termination panel for DC terminals and loop detector terminals on the opposite side of the cabinet from the AC service inputs. Attach each panel to the rack assembly using bolts and make it easily removable. Mount the surge protection devices in horizontal rows on each panel and solder to the feed through terminals of 14 position terminal blocks with #8 screws mounted on the other side. Wire the terminals to the rear of a standard input file using spade lugs for input file protection.

Provide permanent labels that indicate the slot and the pins connected to each terminal that may be viewed from the rear cabinet door. Label and orient the terminals so that each pair of inputs are next to each other. Ensure that the top row of terminals is connected to the upper slots and the bottom row of terminals is connected to the bottom slots. Indicate on the labeling the slot number (1-14) and the terminal pins of the input slots (either D &E for upper or J & K for lower). Terminate all grounds from the surge protection on a 15 position copper equipment ground bus attached to the rear swing down panel. Ensure that a Number 4 AWG green wire connects the surge protection panel assembly ground bus to the main cabinet equipment ground. Provide a standard input file and surge protection panel assembly that fits outside and behind the input file. Ensure that the fold down panel allows for easy removal of the input file without removing the surge protection panel assembly or its parts.

Provide a minimum 14 x 16 inch pull out, hinged top shelf located immediately below the controller mounting section of the cabinet. Ensure that the shelf is designed to fully expose the table surface outside the controller at a height approximately even with the bottom of the controller. Ensure that the shelf has a storage bin interior which is a minimum of 1 inch deep and approximately the same dimensions as the shelf. Provide an access to the storage area by lifting the hinged top of the shelf. Fabricate the shelf and slide from aluminum or stainless steel and ensure that the assembly can support the 2070L controller plus 15 pounds of additional weight. Ensure that the shelf has a locking mechanism to secure it in the fully extended position and that it does not inhibit the removal of the 2070L controller or removal of cards inside the controller when in the fully extended position. Provide a locking mechanism that is easily released when the shelf is to be returned to its non-use position directly under the controller.

C.4. Model 2010 Enhanced Conflict Monitor

Furnish Model 2010 Enhanced Conflict Monitors with 16 channels. In addition to CALTRANS requirements, ensure that the conflict monitor monitors for the absence of a valid voltage level on at least one channel output of each load switch. Ensure that the absence of the programming card will cause the conflict monitor to trigger, and remain in the triggered state until reset.

Provide a conflict monitor that recognizes the faults specified by CALTRANS and the following additional per channel faults that apply for monitor inputs to each channel:

- consider a Red input greater than 70 Vrms as an "on" condition;
- consider a Red input less than 50 Vrms as an "off" condition (no valid signal);
- consider a Red input between 50 Vrms and 70 Vrms to be undefined by these

specifications;

- consider a Yellow or Green input greater than 25 Vrms as an "on" condition;
- consider a Green or Yellow input less than 15 Vrms as an "off" condition; and
- consider a Green or Yellow input between 15 Vrms and 25 Vrms to be undefined by these specifications.

Ensure that the monitor will trigger upon detection of a fault and will remain in the triggered (failure detected) state until the unit is reset at the front panel or through the remote reset input for the following failures:

- **Red Monitoring or Absence of Any Indication (Red Failure)**: A condition in which no valid voltage signal is detected on any of the green, yellow, or red inputs to a given monitor channel. If a signal is not detected on at least one input (R, Y, or G) of a conflict monitor channel for a period greater than 1500 ms when used with a 2070L controller, ensure that the monitor will trigger and put the intersection into flash. If the absence of any indication condition lasts less than 1200 ms when used with a 2070L controller, ensure that the conflict monitor will not trigger. Have red monitoring occur when the P20 Connector is installed and both of the following input conditions are in effect: a) the Red Enable input to monitor is active (Red Enable voltages are "on" at greater than 70 Vrms, off at less than 50 Vrms, undefined between 50 Vrms and 70 Vrms), and b) and neither Special Function 1 nor Special Function 2 inputs are active.
- **Yellow Indication Sequence Error**: Yellow indication following a green is missing or shorter than 2.7 seconds (with ± 0.1-second accuracy). If a channel fails to detect an "on" signal at the Yellow input following the detection of an "on" signal at a Green input for that channel, ensure that the monitor triggers and generates a sequence error fault indication.
- **Dual Indications on the Same Channel**: In this condition, more than one indication (R, Y, G) is detected as "on" at the same time on the same channel. If dual indications are detected for a period greater than 500 ms, ensure that the conflict monitor triggers and displays the proper failure indication (Dual Ind fault). If this condition is detected for less than 250 ms, ensure that the monitor does not trigger.

Enable the monitor function for short/missing yellows and for dual indications on a per channel basis.

Provide Special Function 1 and Special Function 2 that comply with the Los Angeles City DOT

Traffic Signal Specification DOT 170 ATSAC Universal and Related Equipment #54-053-02 to eliminate red failure monitoring while allowing other additional enhanced fault monitoring functions to continue.

Ensure that the removal of the P-20 ribbon cable will cause the monitor to recognize a latching fault condition and place the cabinet into flashing operation.

Ensure that when the Conflict Monitor is triggered due to a fault, it provides an LED indication identifying the type of failure detected by the monitor except for the P20 ribbon cable removal fault. Ensure that the monitor indicates which channels were active during a conflict condition and which channels experienced a failure for all other per channel fault conditions detected, and that these indications and the status of each channel are retained until the Conflict Monitor is reset.

Ensure that the conflict monitor will store at least nine of the most recent malfunctions detected by the monitor in EEPROM memory. For each malfunction, record at a minimum the time, date, type of malfunction, relevant field signal indications, and specific channels involved with the malfunction.

Provide communications from the monitor to the 2070L controller via an RS-232C/D port on the monitor in order to upload all event log information from the monitor to the controller or to a system computer via the controller. Ensure that the controller can receive the data through a controller Async Serial Comm Module determined by the controller software. Provide software capable of communicating directly through the same monitor RS-232C/D to retrieve all event log information to a laptop computer.

In addition to the connectors required by the CALTRANS Specifications, provide the conflict monitor with a connector mounted on the front of the monitor (3M-3428-5302 with two polarizing keys or equal) which mates with a 20 pin ribbon cable connector that conducts the signals from the P20 connector on the cabinet assembly. Provide a P20 connector and terminal assembly that complies with the Los Angeles City DOT Traffic Signal Specification DOT 170 ATSAC Universal and Related Equipment #54-053-02 in effect on the date of advertisement. Provide connector pins on the monitor with the following functions:

Pin #	Function	Pin #	Function
1	Channel 15 Red	11	Channel 9 Red
2	Channel 16 Red	12	Channel 8 Red
3	Channel 14 Red	13	Channel 7 Red
4	Chassis Ground	14	Channel 6 Red

Pin #	Function	Pin #	Function
5	Channel 13 Red	15	Channel 5 Red
6	Special Function 2	16	Channel 4 Red
7	Channel 12 Red	17	Channel 3 Red
8	Special Function 1	18	Channel 2 Red
9	Channel 10 Red	19	Channel 1 Red
10	Channel 11 Red	20	Red Enable

Provide a DB-9 female connector for the purpose of data communication with the controller. Electrically isolate the port interface electronics from all monitor electronics, excluding Chassis Ground. Furnish a communications connecting cable with pin connections as follows:

2070L		Conflict Monitor DB-9
DCD pin 1	Connect to	DCD pin 1
RX pin 2	Connect to	TX pin 2
TX pin 3	Connect to	RX pin 3
GND pin 5	Connect to	GND pin 5
RTS pin 7	Connect to	CTS pin 7
CTS pin 8	Connect to	RTS pin 8

C.5. Type 170 Detector Sensor Units

Furnish detector sensor units that comply with Chapter 5, General Requirements for Detector Sensor Units," of the CALTRANS Specifications, and the requirements for Model 222 and Model 224 loop detector sensor units.

C.6. Cabinet Finish

Cabinet finish shall be an anodized silver aluminum finish, except at the following locations in the historic downtown area where a painted finish is required:

City 06	Main Avenue and Oakland Street
City 10	Main Avenue and Marietta Street
City 11	Main Avenue and South Street
12-0086	Main Avenue and York Street
12-0924	Main Avenue and Chester Street
12-0929	Long Avenue and Marietta Street

Painted finishes shall be applied prior to delivery and conform to the following specifications:

- All steel components (including nuts, bolts, screws, etc.) shall have s shop painted finish coat.
- The color shall be black semi gloss (# 27038) as defined by Federal Standard 595B-Color Used in Government Procurement.
- The finish coating shall be a six stage chemical treatment for an electrostatically applied fusion bonded polyester epoxy coating. The polyester protective coating shall be one coat, minimum 4 mls thick, heat curable, thermosetting powdered coating.

D. Terminal Splice Box

Furnish terminal splice boxes to splice and extend signal conductors and loop lead-in cables. Provide terminal splice boxes as described below. Furnish binder type terminal strips. Separate binder strips shall be furnished for signal wiring and loop lead-in.

No measurement will be made of additional signal conductors and loop lead-ins, as the splicing of all existing signal conductors and loop lead-ins in the splice box, extending them through new risers and conduits, and connecting them to the new controller cabinet shall be considered incidental to furnishing and installing terminal splice boxes. Additional signal conductors and loop lead-in shall be of the same size and type of the existing wires. Provide permanent labels prior to construction on all incoming and outgoing conductors using a naming convention such as Phase One Green, Phase Two Yellow, Loops 2A, etc.

Furnish terminal splice box that is fabricated of steel or aluminum and satisfies the requirements of environmentally sealed NEMA Type 4X enclosures.

Bond terminal splice box to equipment ground in cabinet using a 14 AWG stranded THHN. Do not put loop grounds and other grounds with neutral conductors.

Furnish terminal splice boxes with a minimum size of 12 inches wide by 20 inches high by 8 inches deep. Each terminal splice box shall have a terminal block having at least twenty (20) terminals with each terminal having two (2) terminal screws. The terminal screws shall be nickel-plated brass screws and have a minimum outside diameter of 4.3 mm. A removable sorting bar shall be provided between the screws of each terminal. The terminal block shall be of electrical grade thermoplastic or thermosetting plastic and shall have the terminals recessed between molded barriers. The terminal block shall be mounted on the back wall of the terminal splice box in such a manner that no mounting screws, nuts, etc. protrude through the box. The terminal block shall be centered on the back wall in line with the long dimension of the box. Install additional terminal blocks as necessary.

The terminal splice box shall have the following holes in the bottom. The box shall be furnished with weatherproof caps for all holes

- One (1) hole suitable for a 2 inch conduit, at the rear and centered.
- Two (2) holes which will accommodate 2 inch rigid metal conduits, one on either side of the hole described above. Each of these holes shall be provided with suitable cable entrance fittings which will both clamp the entering cables in place and protect their insulation from damage. These holes and their fittings shall be located so that the conduit hole between them can be fitted with a conduit hub without difficulty.

Furnish terminal splice box with brackets suitable for attaching the box to wood poles using nails or screws. The brackets shall facilitate a firm attachment to the pole. The design of the brackets shall be such that the conduit hubs and cable fittings shall not make mounting of the box difficult. At locations where the terminal splice box is to be attached externally to a metal strain pole, use banding method approved by the Engineer.

The terminal splice box shall have a hinged cover which shall open to the side.

26.3. CONSTRUCTION METHODS

A. General

Prior to any work being performed on cabinet, provide permanent labels on all incoming and outgoing conductors using a naming convention such as Phase One Green, Phase Two Yellow, Loops 2A, etc.

Remove existing controllers and cabinets where required. Prior to any work being performed on an existing cabinet, place permanent labels on all conductors using a naming convention such as Phase One Green, Phase Two Yellow, Loops 2A, etc. Remove the maintenance diary from the

cabinet and place it in the new cabinet or present it to the Engineer. Take existing equipment out of service only at the time directed.

Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.

Install controllers, cabinets, detector sensor units, and hardware that provide the required phasing, color sequence, flash sequence, interconnection, railroad clearance and preemption, and emergency vehicle clearance and preemption.

Stencil the signal inventory number on the side of the cabinet that faces the roadway. Use 3 inch black characters.

Provide an external electrical service disconnect at all new and existing cabinet locations unless otherwise shown on the plans.

Do not program controllers for late night flashing operation at railroad preemption installations. For all other installations, do not program the controller for late night flashing operation unless otherwise directed. Have all signal heads for the same approach flash concurrently during flashing operation.

Provide the serial number and cabinet model number for each new controller and controller cabinet installed.

Modify cabinet foundations where required.

Where pole mounted cabinets are required, install cabinets so that the height to the middle of the cabinet is 4 feet.

Activate controllers with the proposed phasing and timing, and modify proposed phasing and timing of existing controllers.

Ensure that maximum resistance between the grounding electrode and all points in the grounding system does not exceed 5 ohms.

In addition to the requirements of the NEC, test grounding electrode resistance at the connection point to the electrical service ground bus for a maximum of 20 ohms. Furnish and install additional ground rods to the grounding electrode system as necessary to meet test requirements. Submit copy of test results to the Engineer and place copy of test results in cabinet as described in **Section 13**.

B. Terminal Splice Box

At locations shown in the Plans, furnish and install a terminal splice box. Splice and extend signal conductors and loop lead-ins from the splice box to the cabinet. Furnish and install binder

type terminal strips.

C. School Flashers

At locations with existing school flasher assemblies, integrate school flasher output with new controller. Preserve all existing functionality and coordinate with Engineer for flashing schedule.

26.4. METHOD OF MEASUREMENT

Actual number of each type of controllers with cabinets furnished, installed, and accepted.

Actual number of each type of detector cards (2-channels) furnished, installed, and accepted.

Actual number of terminal splice boxes furnished, installed, and accepted. No measurement will be made of additional signal conductors and loop lead-ins, as the splicing of all existing signal conductors and loop lead-ins in the splice box, extending them through new risers and conduits, provision of those risers and conduits, and connecting them to the new controller cabinet shall be considered incidental to furnishing and installing terminal splice boxes.

No measurement will be made of conflict monitors, malfunction management units, required system interconnection, surge protection, grounding systems, and workshop for testing controllers and cabinets as this will be considered incidental to furnishing and installing controllers with cabinets.

No measurement will be made for school flasher integration and all associated equipment as this will be considered incidental to furnishing and installing controllers with cabinets.

26.5. BASIS OF PAYMENT

The quantity of controllers with cabinets, measured as provided above, will be paid for at the contract unit price each for "Controller with Cabinet (_____)" in accord with the following conditions: 90% of the payment will be made upon acceptance of the unit; 10% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of detector cards, measured as provided above, will be paid for at the contract unit price each for "Detector Card (_____)."

The quantity of terminal splice boxes, measured as provided above, will be paid for at the contract unit price each for "Terminal Splice Box."

Payment will be made under:

Controller with Cabinet (2070L Pole Mount).....Each

Controller with Cabinet (2070L Base Mount) ..... Each

Detector Card (Type 2070L) ..... Each

Terminal Splice Box ..... Each

27. ELECTRICAL SERVICE

27.1. DESCRIPTION

Comply with the Standard Specifications and these Special Provisions. At locations called out in the Plans, install new electrical service. All work involving electrical service shall be coordinated with the appropriate electrical utility company. Obtain all required local permits before beginning work.

27.2. MATERIAL

A. General

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of equipment installation.

Construct electrical service installations in accordance with the Standard Specifications. For locations shown on the Plans requiring new electrical service, provide a service that includes a new external service disconnect (breaker box) and a meter base. Run service cable(s) separately in 1" rigid metallic conduit (RMC). Do not allow the service conductors to share conduits with any other conductors or communications.

For pole mounted cabinets, mount the service on an existing pole as indicated in the Plans, and extend the service cables into the cabinet through a new 1" RMC.

Coordinate with utility company to ascertain the practicality of installing electrical service at each location before performing any work.

B. External Electrical Service Disconnect

Furnish external electrical service disconnects with a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure service disconnects are UL listed and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils (60 μm). Provide ground bus and neutral bus with a minimum of four terminals with a minimum wire capacity range of number 14 through number 4.

Furnish a NEMA Type 3R outdoor enclosure, 100 Ampere rated meter base. Furnish a 4 terminal, 600 volt, single phase, 3 wire meter base that complies with the following:

- Line, Load, and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire

- Ringless Type without bypass
- Made of galvanized steel
- Meet the UL-414 standard
- Overhead and underground service entrance

Provide meter bases in which the ampere rating of the meter sockets are based on the meter sockets being wired with a minimum of 167 degrees F insulated wire. Ensure that the meter bases have an electrostatically applied dry powder paint finish, light gray in color, with a minimum thickness of 2.4 mils (60 µm).

Furnish 1-inch watertight hub for threaded rigid conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is UL listed and marked as being suitable for use as service equipment.

27.3. CONSTRUCTION METHODS

A. Electrical Service

At locations where new electrical service is to be installed on wood or metal poles, furnish and install electrical service as called for in the Plans. After installation of the meter base, the utility company will transfer the existing meter or install a new meter if required and make any necessary connections to the power lines. Ground the new electrical service in accordance with the Standard Specifications and Standard Drawings.

Provide Engineer with a copy of all permits and final inspections if required.

B. Modify Existing Electrical Service

At locations shown in the Plans, modify electrical service to provide complete electrical service with external service disconnect that complies with the Standard Specifications and Drawings. After all required modifications are complete, each cabinet shall have its own power meter and electrical disconnect that are located on a pedestal or pole and not attached to the signal cabinet. Ensure that all connections between the power source, meter, disconnect, and signal cabinet are complete and grounded in accordance with these Project Special Provisions, the Standard Specifications, and the Plans.

27.4. METHOD OF MEASUREMENT

Actual number of new electrical services furnished, installed and tested. Riser assemblies (1-inch), meter bases, service disconnects, underground and exposed conduit runs to the cabinet,

acquisition of service fees, electrical service conductors, ground rod, ground wire and any remaining hardware and conduit to connect the electrical service to the cabinet are considered incidental to installing a new electrical service.

Actual number of existing electrical service locations modified, integrated and tested. Any electrical service conductors, remaining hardware and conduit to connect the electrical service to the cabinet or any other work to bring the electrical service into compliance with the Standard Specifications are considered incidental to the service modifications and will not be paid for separately. This includes, but is not limited to, furnishing new or relocating existing external service disconnects. No separate payment will be made for extending or replacing electrical service cable and conduits.

27.5. BASIS OF PAYMENT

The quantity of electrical service installations, measured as provided above, will be paid for at the contract unit price each for "New Electrical Service."

The quantity of existing electrical service modification sites, measured as provided above, will be paid for at the contract unit price each for "Modify Existing Electrical Service."

Payment will be made under:

New Electrical Service.....Each

Modify Existing Electrical Service.....Each

28. SPREAD SPECTRUM WIRELESS RADIO

28.1. DESCRIPTION

Furnish and install a spread spectrum wireless radio system with all necessary hardware in accordance with the plans and these Special Provisions to provide a data link between traffic signal controllers. Provide a radio system with a bi-directional, full duplex communications channel between two "line-of-sight" antennas using license free, spread spectrum technology operating in the 902-928 MHz frequency band. Comply with the provisions of Section 1700 of the Standard Specifications.

28.2. MATERIALS

A. 900 MHz Wireless Radio Systems

Furnish license free 902 – 928 MHz radio modems with antennas, coaxial cable and mounting hardware, and configuration software. Design radio modems to work in "point-to-point", "point-to-multipoint", "multipoint-to-point", "multipoint-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

- License free (ISM) Spread Spectrum radio band (902 – 928 MHz)
- Frequency Hopping Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
- Bi-Directional, Full Duplex
- Programmable Radio Frequency (RF) output levels of 1 mW, 10 mW, 100 mW, or 1 Watt
- A minimum of 139 user-selectable radio frequency channels, with 62 available hopping sequences (2 non-overlapping)
- RS-232 interface capable of operating from 1200 bps to 115.2 Kbps, with 8 or 9 bit format or 1200 bps Bell 202 and supports FSK (2 or 4-wire) systems configurations (provide appropriate FSK module as needed when working with copper backbone systems)
- DB9-F connector for RS-232 port
- RJ 22 connector for FSK port
- Maximum of 8 mSec. end-to-end latency

- 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- Built-in store-and-forward (single radio repeater – back to back radio set-ups are not allowed to accomplish this function)
- 32 Bit encryption
- Receiver Sensitivity of –110 dBm @ 10^-6 BER
- Antenna port: Reverse Polarity - Threaded Normalized Connector-Female (RP TNC-F) antenna connector
- Front panel LED indicators:
    - Power
    - Transmit Data
    - Receive Data
    - Data Port Indicator
- Operating temperature of –40 to +176 degrees F at 0 to 95% Humidity
- Power supply requirements:
    - Wall Adapter: 120 VAC UL/CSA wall cube plug-in module with 12 VDC, 1 Amp, nominal output.
    - Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
    - Radio Sleep mode with a maximum current draw of <1μA.
- Shelf mounted design not to exceed 9" long x 2" wide x 5" high

Furnish a Radio Frequency Signal Jumper constructed of an RG-58 Coaxial Cable with Reverse Polarity - Threaded Normalized Connector-Male (RP TNC-M) on one end for connection to a radio unit and a Standard N-Type Male Connector on the other end for connection to the lightning arrestor. Provide the jumper in 6 foot lengths.

Furnish an RS-232 data interface cable to be installed between the radio modem and the field device's RS-232 interface. Ensure cable is a minimum of 6 feet long.

Ensure that installing the wireless radio system with a fully functional traffic signal controller does not require any field device modifications with regards to hardware or software.

Furnish an ENCOM Model # EP-5100 Spread Spectrum Wireless Radio or an approved equivalent.

B. Software

Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide "remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer" features. Provide software that runs on the notebook computers supplied under this project. For compatibility with the ENCOM wireless radio or an approved equivalent wireless radio, provide ENCOM ControlPAK software or an approved equivalent software that is designed to function with the approved wireless radio. Provide configuration software that can be upgraded in the future at no additional charge.

Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with 2070 controllers containing custom software written specifically for the North Carolina Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

C. Directional Antenna (Yagi)

Furnish a directional antenna that will allow the system to function as designed. Furnish Cushcraft Model # PC906N (8.5 dB Gain) or Cushcraft Model # PC9013N (13 dB Gain) antenna or an approved equivalent antenna that meets the following minimum specifications:

Cushcraft Model # PC906N (8.5 dB Gain)

Frequency Range	896 – 940 MHz
Nominal Gain	8.5 dB
Front to Back Ratio	18 dB
Horizontal Beamwidth (at half power points)	65 degree
Vertical Beamwidth (at half power points)	55 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Length	24" (612 mm)
Rated Wind Velocity	125 mph (200 kph)

Rated Wind Velocity (with 0.5 inch radial ice)	100 mph (161 kph)
Projected Wind Surface Area (flat plane equivalent)	0.26 ftsq. (0.024 msq)
Number Elements	6
Allows for Vertical or Horizontal polarization	
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
Minimum separation distance from persons installing and using an active device	9" (230 mm)
Minimum separation distance from other RF sources including radios and antennas	6.5' (2 m)
Welded construction	

Cushcraft Model # PC9013N (13 dB Gain)

Frequency Range	902 – 928 MHz
Nominal Gain	13 dB
Front to Back Ratio	20 dB
Horizontal Beamwidth (at half power points)	40 degree
Vertical Beamwidth (at half power points)	35 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Length	53" (1346 mm)
Rated Wind Velocity	125 mph (200 kph)
Rated Wind Velocity (with 0.5 inch radial ice)	100 mph (161 kph)
Projected Wind Surface Area (flat plane equivalent)	0.46 ftsq. (0.043 msq)
Number Elements	13
Allows for Vertical or Horizontal polarization	
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
Minimum separation distance from persons	9" (230 mm)

installing and using an active device	
Minimum separation distance from other RF sources including radios and antennas	6.5' (2 m)
Welded construction	

Furnish mounting hardware to secure the antenna to the metal pole or wood pole, as recommended by the manufacturer of the antenna and as approved by the Engineer.

D. Omni Directional Antenna

Furnish an omni directional antenna that will allow the system to function as designed. Furnish 3 dB Antenex Model # FG9023 or 6 dB Antenex Model # FG9026 antenna or approved equivalent antennas that meet the following minimum specifications:

Frequency Range	902 – 928 MHz
Nominal Gain	Typical gains of 3 or 6 dB (dependent upon gain needed for application)
Termination	Standard N-Type Female Connector
Impedance	50 ohms
VSWR	1.5:1
Vertical Beam Width	3 dB – 33 degrees; 6 dB – 17 degrees
Lightening Protection	DC Ground
Power Rating, UHF Frequency	100 Watts
Length	3 dB – 25" (635 mm) 6 dB – 65" (1.65 m)
Rated Wind Velocity	125 mph (200 kph)
Solid, single piece construction	
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
Minimum separation distance from persons installing and using an active device	9" (23 cm)
Minimum separation distance from other RF sources including radios and antennas	6.5' (2 meters)
Mount in a vertical direction and limit to vertically polarized RF systems	

Furnish mounting hardware to secure the antenna to the metal pole or wood pole, as recommended by the manufacturer of the antenna and as approved by the Engineer.

E. Coaxial Cable

Furnish a Times Microwave Systems ™ LMR 400 Cable or ANDREW CNT-400 Cinta Braided Cable, or equivalent antenna coaxial cable to provide a link between the antenna and the lightning arrestor that meets the following minimum specifications:

Attenuation (dB per 100 feet) @ 900 MHz	3.9 dB
Power Rating @ 900 MHz	0.58 kW
Center Conductor	0.109" Copper Clad Aluminum
Dielectric: Cellular PE	0.285"
Shield	Aluminum Tape – 0.291" Tinned Copper Braid – 0.320"
Jacket	Black UV protected polyethylene
Bend Radius	1" with less than 1 ohm impedance change at bend
Impedance	50 ohms
Capacitance per foot	23.9 pf/ft
Wrap all connections with self sealing tape for weatherproofing and moisture seal	
End Connectors	Standard N-Type Male Connectors on both ends

F. Lightning Arrestor

Furnish a lightning arrestor installed in line between each antenna and its designated radio modem inside the equipment cabinet. Furnish a Polyphaser Model # IS-B50LN-C2 lightning arrestor or an approved equivalent that meets the following minimum specifications:

- Surge: 50 kA IEC 1000-4-5 8/20 us waveform 500 Joules
- Turn-on: 600 VDC ±20% 2.5 ns for 2 kV/ns
- Insertion Loss: ≤ 0.1 dB over frequency range
- Temperature: -49 to 185^0 F Storage/Operating 122^0 F
- Vibration: 1G up to 100 Hz

- Utilizes UL497B listed gas tube
- Throughput energy: ≤ 200 µJ for 3 kA @ 8/20 µs Waveform
- Throughput voltage: ≤ 150 Vpk
- VSWR: 1.1:1
- Frequency Range: 125 MHz to 1000 MHz
- Max Power: VHF 375W, UHF (low) 250W, 800 MHz to 1 GHz, 125W
- Multistrike capability
- Low strike throughput energy
- Flange mount and bulkhead mount options
- Standard N-Type Female Connector on both the surge side and protected side connectors

28.3. CONSTRUCTION METHOD

A. General

Perform a radio path Site Survey test before installing any equipment. Ensure the test evaluates the Signal Strength (dBm), Fade Margin (dB), Signal-to-Noise Ratio, Data Integrity (poll test), and a complete frequency spectrum scan. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. During the initial radio path signal strength test it may be determined that a repeater station may be necessary to complete the intended link. Provide the test results to the Engineer for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. The Engineer will approve final locations of antennas and any necessary repeater stations. Install an antenna splitter cable at locations where it is determined that a dual antenna configuration is necessary to accommodate communications in multiple directions.

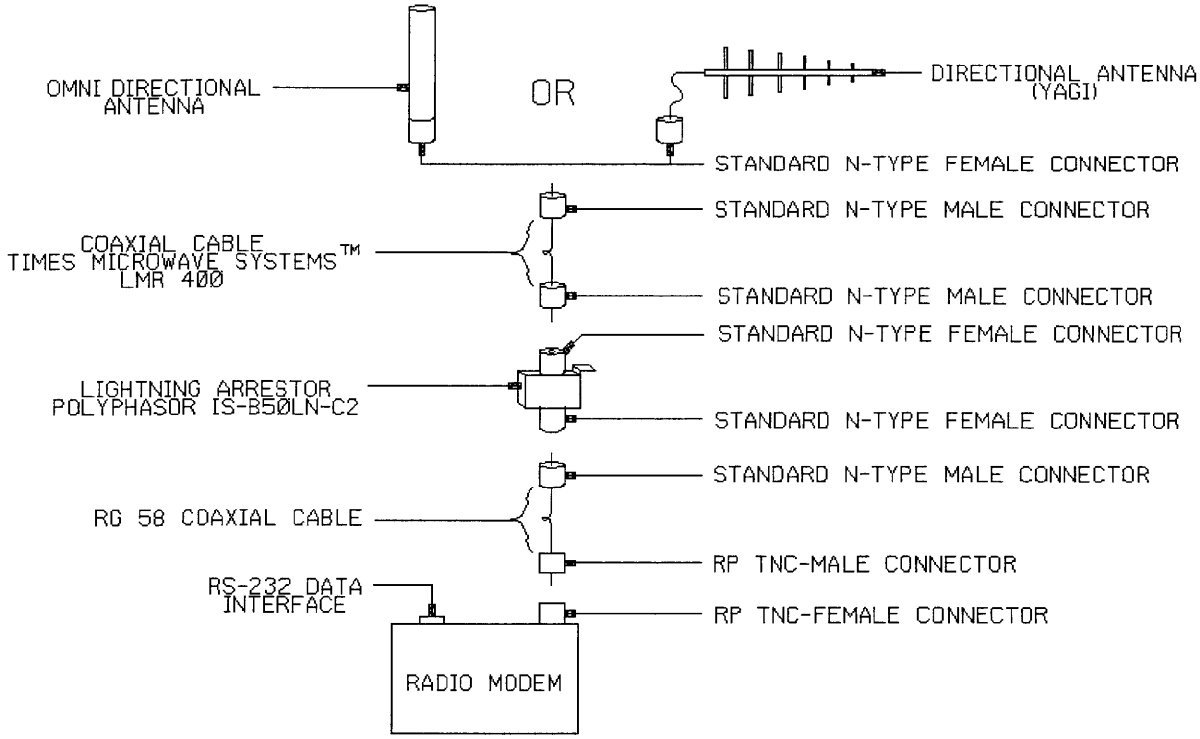
Install the antenna in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the National Electrical Safety Code) and as specified in the antenna manufacturer's recommendations. Secure the antenna mounting hardware to the pole and route the coaxial cable such that no strain is placed on the coaxial connectors. On wood pole installations, bond the antenna mounting hardware to the pole ground using # 6 AWG bare copper wire using split bolt or compression type fitting.

Do not exceed the 1-inch bend radius of the coaxial cable as it transverses from the cabinet to the antenna assembly. Connect the lightning arrestor to the coaxial cable in the equipment cabinet.

Properly ground and secure the arrestor in the cabinet. Permanently label all cables entering the cabinet. Ensure that the power supply for the radio system is NOT connected to the GFCI receptacle circuitry located in the cabinet. Place a copy of all manufacturer equipment specifications and instruction and maintenance manuals in the equipment cabinet.

At certain locations it may be necessary to integrate the radio system with a fiber optic system. Follow the details shown in the fiber optic splice plans.

B. Antenna and Coaxial Cable Schematic



28.4. WARRANTY

Provide a minimum two-year warranty with each radio and antenna assembly to ensure that the products are free of manufacturing defects in material and workmanship. The warranty commences on the date that the radio system is accepted by the Engineer.

28.5. METHOD OF MEASUREMENT

Actual number of 900 MHz wireless radio systems and antenna(s) furnished, installed and accepted at a single intersection location. This item includes the appropriate antenna, coaxial cable, lightning arrestor, labeling and any integration between the wireless radio system and a fiber optic

network if necessary. All individual location, link, and system testing and integration related to the wireless radio system shall be considered incident and not paid for separately.

All power supplies, power cords, adapters, antenna mounting hardware, connectors, serial cables, installation materials and configuration software necessary to complete this work, including the radio path Site Survey test and warranties, will be incidental. Final payment will be made when work is accepted by the Engineer.

New electrical services including riser assemblies (1-inch), meter bases, service disconnects, underground and exposed conduit runs to the cabinet, acquisition of service fees, electrical service conductors, ground rod, ground wire, and any remaining hardware and conduit to connect the electrical service to the cabinet are considered incidental to installing 900 MHz wireless radio systems.

28.6. BASIS OF PAYMENT

The quantity of 900 MHz wireless radio systems, measured as provided above, will be paid for at the contract unit price each for "900 MHz Wireless Radio System" in accord with the following conditions: 75% of the payment will be made upon acceptance of each system; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

Payment will be made under:

900 MHz Wireless Radio System ..... Each

29. CCTV FIELD EQUIPMENT

29.1. DESCRIPTION

Furnish and install new CCTV cameras, cabinets, poles, and camera control equipment at locations shown in the Plans. The camera assembly shall be fully compatible with the CCTV video server and video matrix switch.

29.2. MATERIALS

A. General

Furnish and install, at the locations shown on the Plans, new CCTV camera assemblies. CCTV camera assembly includes camera, lens, housing, pan and tilt unit, pole mounting adapter, camera controller receiver/driver, and camera cabling.

Furnish Pelco Spectra II/Spectra III high performance dome equipment or approved equivalent.

B. Camera and Lens

B.1. Cameras

Furnish new charged coupled device (CCD) color cameras. The cameras shall provide automatic gain control (AGC) for clear images in varying light levels. The cameras shall meet the following minimum requirements:

- Video signal format: NTSC composite color video output, 1 volt peak to peak
- Automatic Gain Control (AGC): 0-20 dB, peak-average adjustable
- Automatic focus: Automatic with manual override
- White balance: Automatic through the lens and manual adjustable from remote controller.
- Electronic-Shutter: dip-switch selectable electronic shutter with speed range from 1/60 of a second (off) to 1/30,000 of a second
- Overexposure protection: The camera shall have built-in circuitry or a protection device to prevent any damage to the camera when pointed at strong light sources, including the sun
- Sensitivity: 1.5 lux at 90% scene reflectance
- Signal to noise ratio: Greater than 48-dB

- Video output Connection: 1-volt peak to peak, 75 ohms terminated, BNC connector
- Power: 24 VAC or less

B.2. Zoom Lens

Furnish each camera with a motorized zoom lens with automatic iris control with manual override and neutral density spot filter. Furnish lenses that meet the following optical specifications:

- Focal length: 0.16" – 3.45", 22X optical zoom, 8X electronic zoom
- Preset positioning: 64 Presets

The lens shall be capable of both automatic and remote manual control iris and focus override operation. The lens shall be equipped for remote control of zoom and focus, including automatic movement to any of the preset zoom and focus positions. Mechanical or electrical means shall be provided to protect the motors from overrunning in extreme positions. The operating voltages of the lens shall be compatible with the outputs of the camera control.

C. Camera Housing

Furnish new dome style enclosure for the CCTV assemblies. Equip each housing with mounting assembly for attachment to the CCTV camera pole. The enclosures shall be equipped with a sunshield and be fabricated from corrosion resistant aluminum and finished in a neutral color of weather resistant enamel. The enclosure shall meet or exceed NEMA 4X ratings. The viewing area of the enclosure shall be tempered glass.

D. Pan and Tilt Unit

Each new dome style assembly shall be equipped with a pan and tilt unit. The pan and tilt unit shall be rated for outdoor operation, provide dynamic braking for instantaneous stopping, prevent drift, and have minimum backlash. The pan and tilt units shall meet or exceed the following specifications:

- Pan: continuous 360 Degrees
- Tilt: up/down 180 degrees minimum
- Input voltage: 24 VAC 50/60 Hz
- Motors: Two phase induction type, continuous duty, instantaneous reversing
- Preset Positioning: 64 PTZ presets per camera

E. Control Receiver/Driver

Each new camera unit shall contain control receiver/driver that are integral to the CCTV dome

assembly. The control receiver/driver shall receive serial asynchronous data initiated from a camera control unit, decode the command data, perform error checking, and drive the pan/tilt unit, camera controls, and motorized lens. As a minimum, the control receiver/drivers shall provide the following functions:

- Zoom in/out
- Automatic focus with manual override
- Tilt up/down
- Automatic iris with manual override
- Pan right/left
- Minimum 64 preset positions for pan, tilt, and zoom

In addition, each control receiver/driver shall accept status information from pan/tilt unit and motorized lens for preset positioning of those components. The control receiver/driver shall relay pan, tilt, zoom, and focus positions from the field to remote camera control units. The control receiver/driver shall accept "goto" preset commands from the camera control unit, decode the command data, perform error checking, and drive the pan/tilt and motorized zoom lens to the correct preset position. The preset commands from the camera control unit will consist of unique values for the desired pan, tilt, zoom, and focus positions.

F. Coaxial Cable

Coaxial communications cable shall comply with the following:

- Belden 8281 or approved equivalent Number 20 AWG, solid bare copper conductor with BNC connectors from the CCTV camera to the controller cabinet.
- Belden 9259 or approved equivalent Number 22 AWG, stranded bare copper conductor with BNC connectors from the CCTV camera to the junction box, and within the controller cabinet.

G. CCTV Camera Attachment to Pole

At locations shown in the Plans where new CCTV cameras are to be installed on new CCTV poles, design, fabricate, and furnish an attachment assembly for the CCTV camera unit. Use stainless steel banding approved by the Engineer for attachment.

Furnish CCTV attachment to pole via the stainless steel banding that allows for the removal and replacement of the CCTV enclosure as well as providing a weatherproof, weather tight, seal that

does not allow moisture to enter the enclosure.

Furnish CCTV Camera Attachment Assembly that is able to withstand a wind load of 80 miles per hour (mph) with a 30 percent gust factor and can support a minimum camera unit dead load of 45 pounds.

H. Surge Suppression

All equipment at the top of the pole shall be protected by grounded metal oxide varistors connecting each power conductor to ground.

Coaxial cable from each camera shall be protected by a surge protector equal to Vicon V15LP, at each end of the cable.

I. Pole Mounted CCTV Cabinet

Furnish pole mounted 336 stretch cabinet as initially described in **Section 26** of these Project Special Provisions. Furnish and install only those accessories related to PDA and grounding system. Do not furnish any other cabinet accessories listed in **Section 26**.

29.3. CONSTRUCTION METHODS

A. General

Install CCTV assemblies at locations as shown in the Plans and in the diagrams on the following pages.

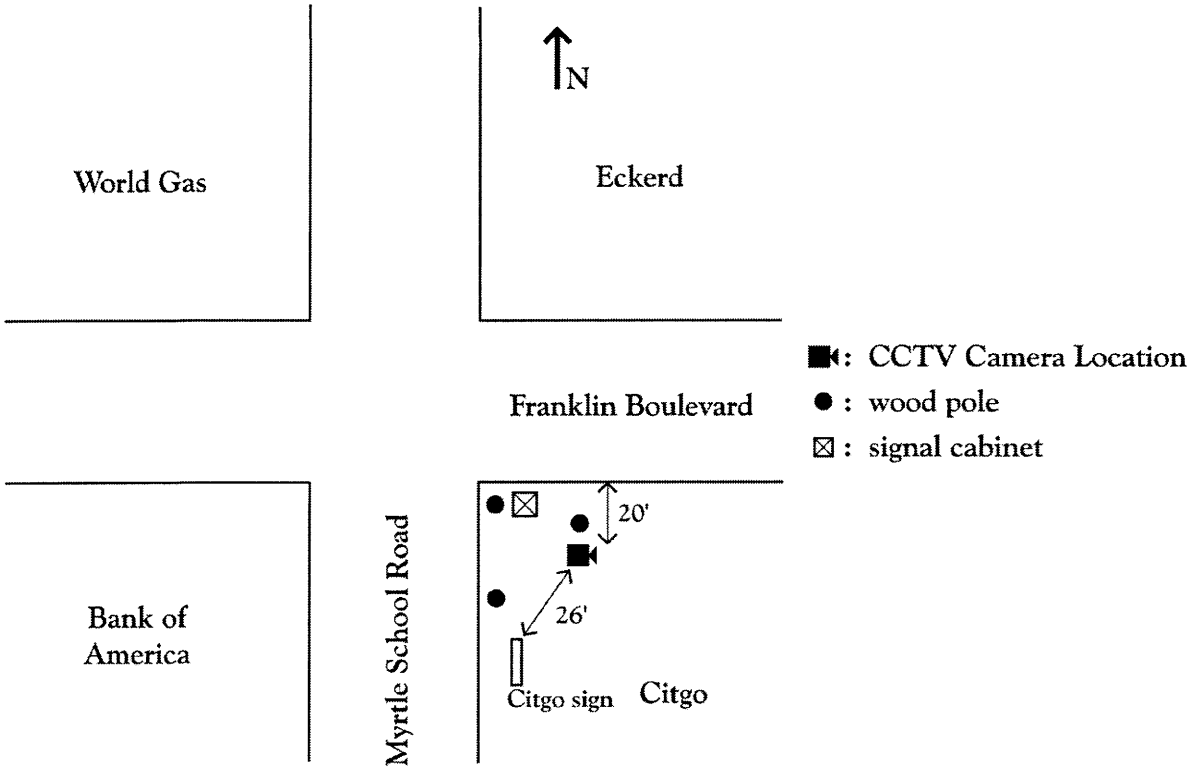
Mount CCTV camera units at the attachment heights listed in the Summary of Work detail in the Plans or as approved by the Engineer. The minimum height shall be 25 feet above ground level and the maximum height shall be 40 feet above ground level.

Mount CCTV camera on side of pole nearest intended field of view and avoids occluding the view with the pole. Use banding or other method approved by the Engineer to fasten CCTV camera to pole.

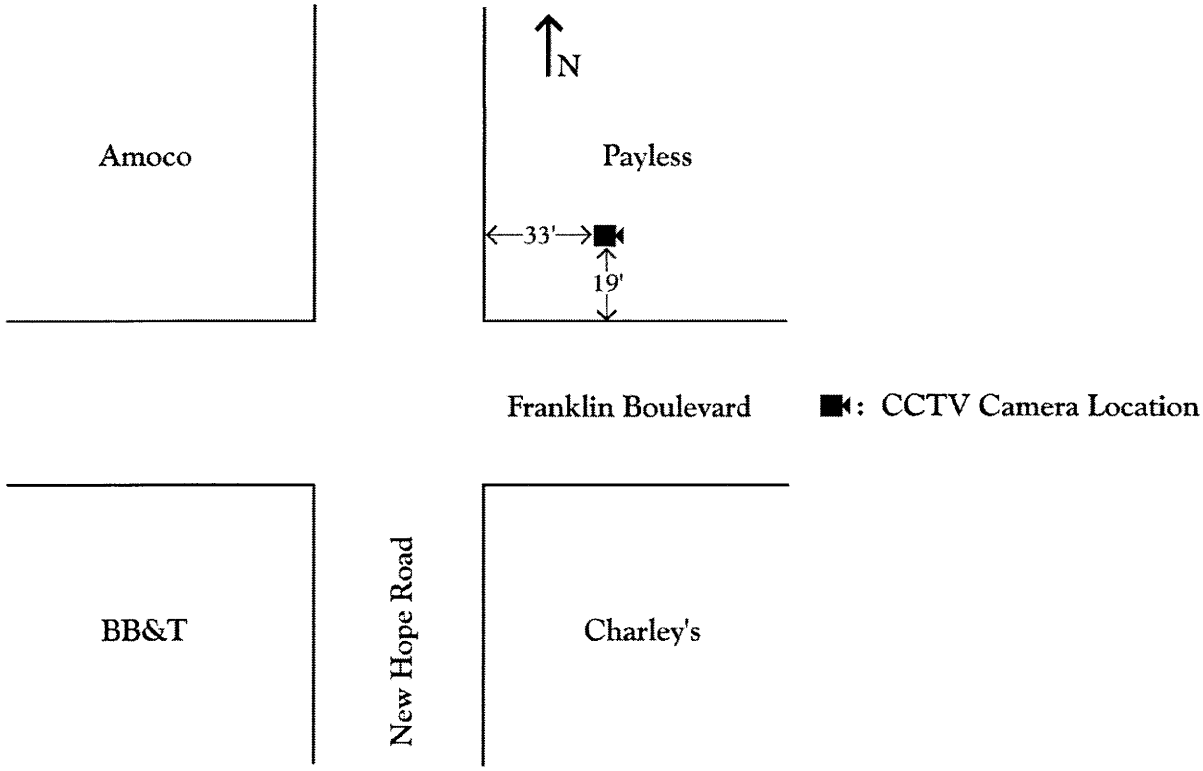
Electrically bond each camera and pan/tilt/zoom mechanism and its housing to the CCTV camera attachment assembly using a number 6 AWG braided copper conductor.

Integrate CCTV camera unit with fiber optic transmission equipment, equipment cabinet, and equipment cabinet power supply.

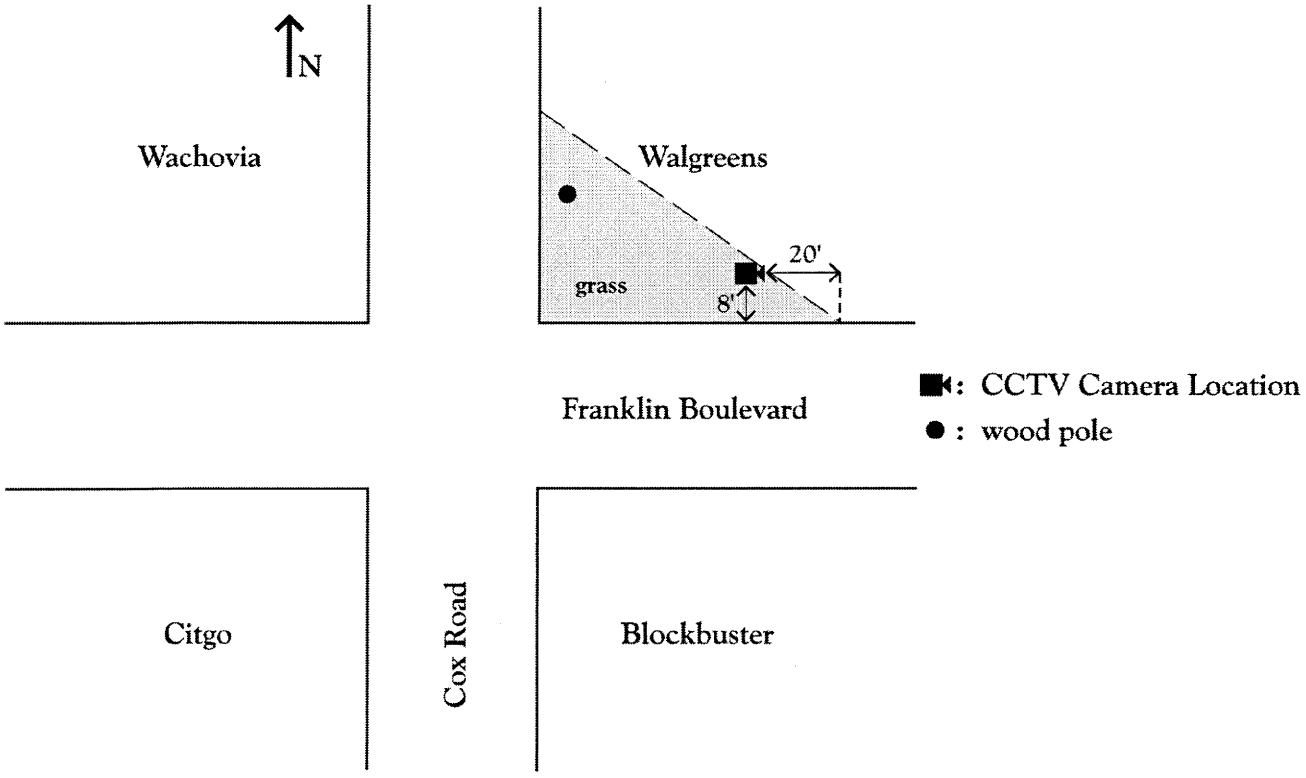
CCTV 1. Franklin Boulevard & Myrtle School Road



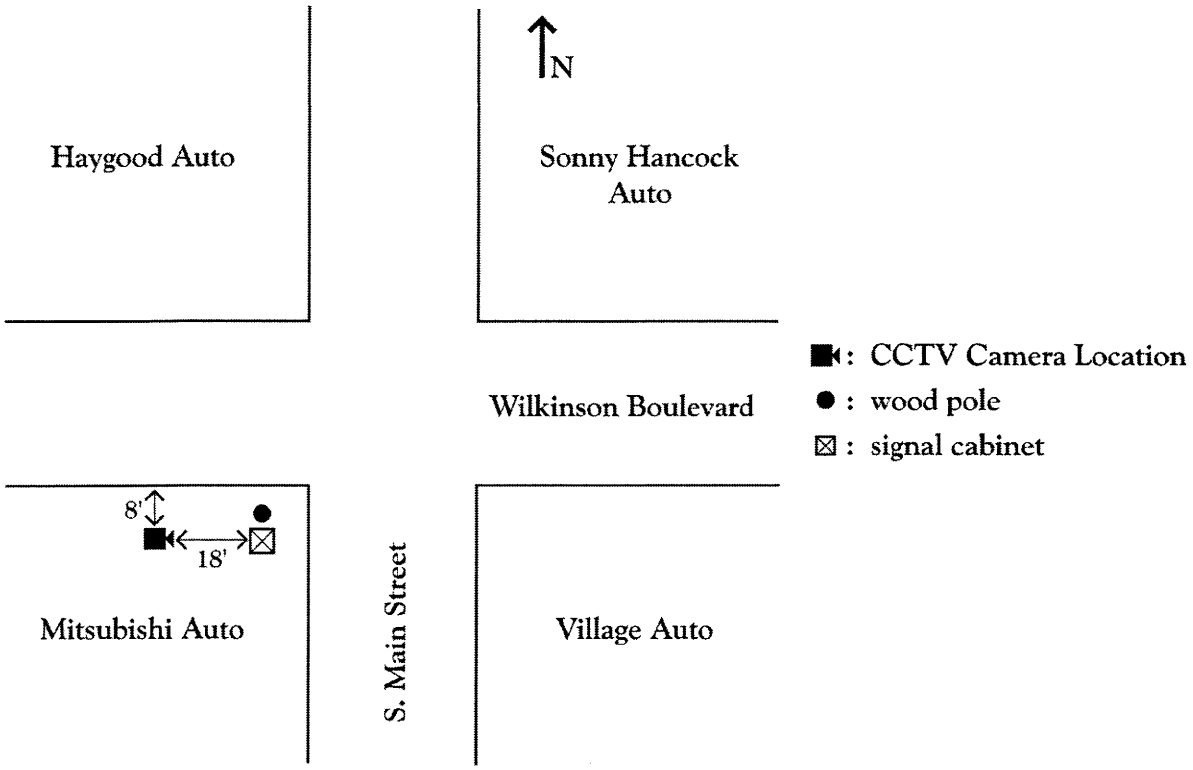
CCTV 2. Franklin Boulevard & New Hope Road



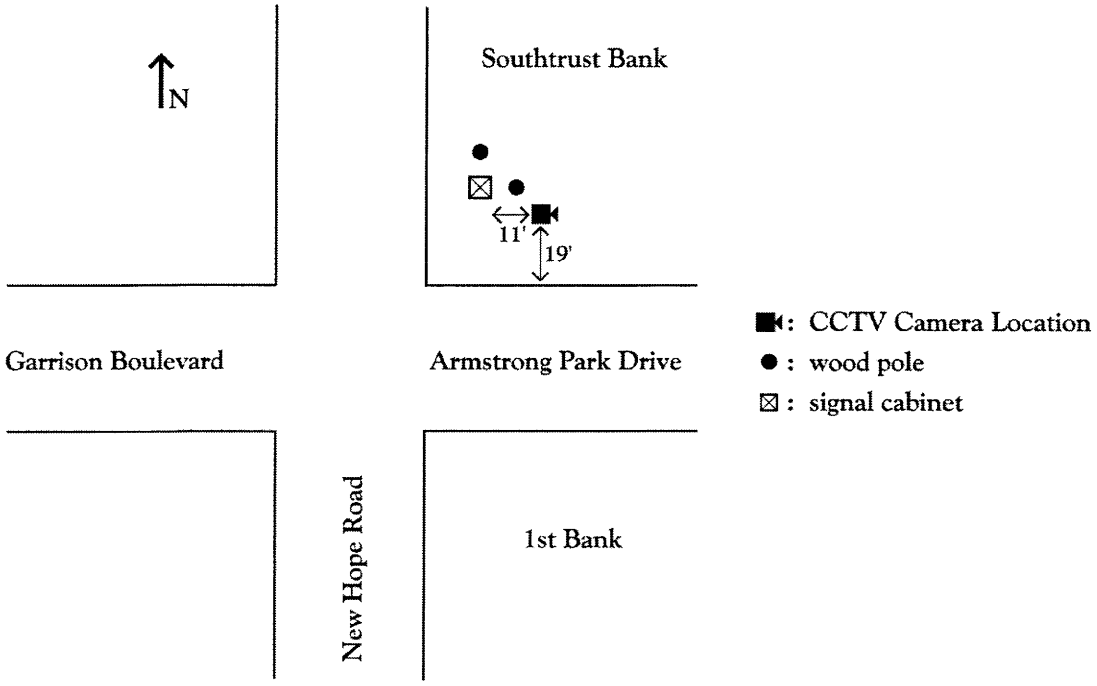
CCTV 3. Franklin Boulevard & Cox Road



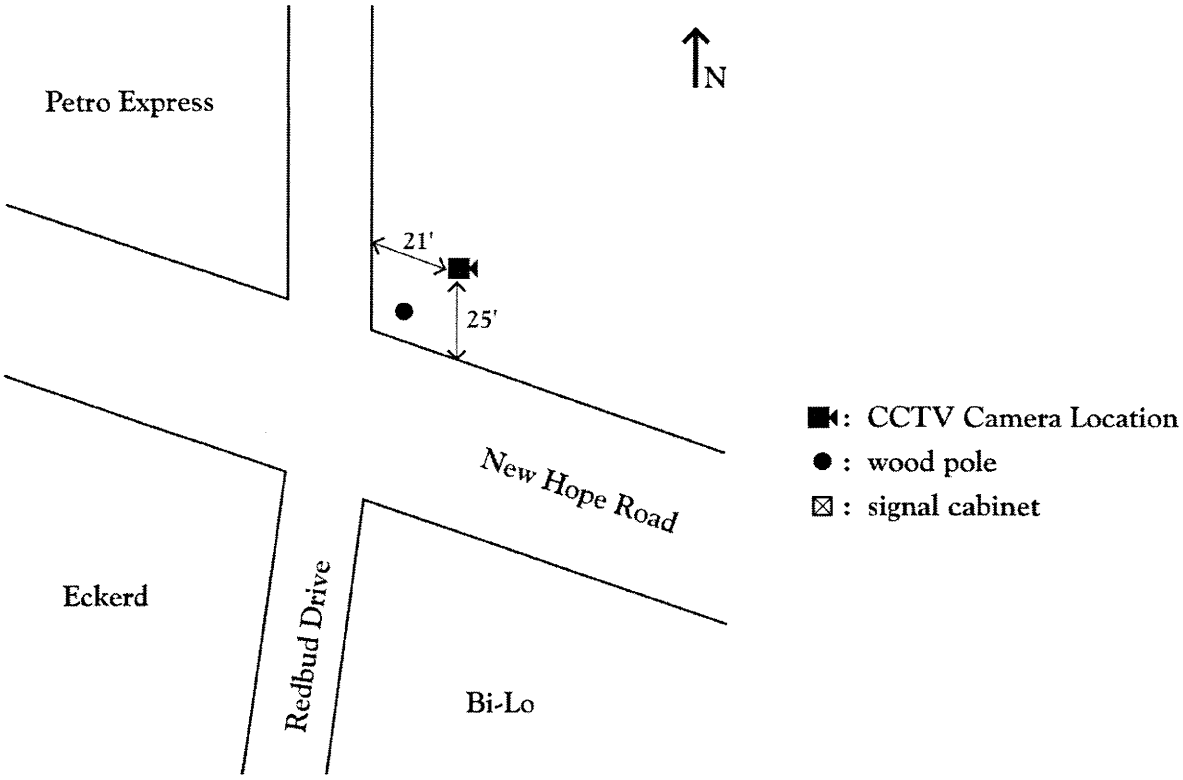
CCTV 4. Wilkinson Road & S. Main Street



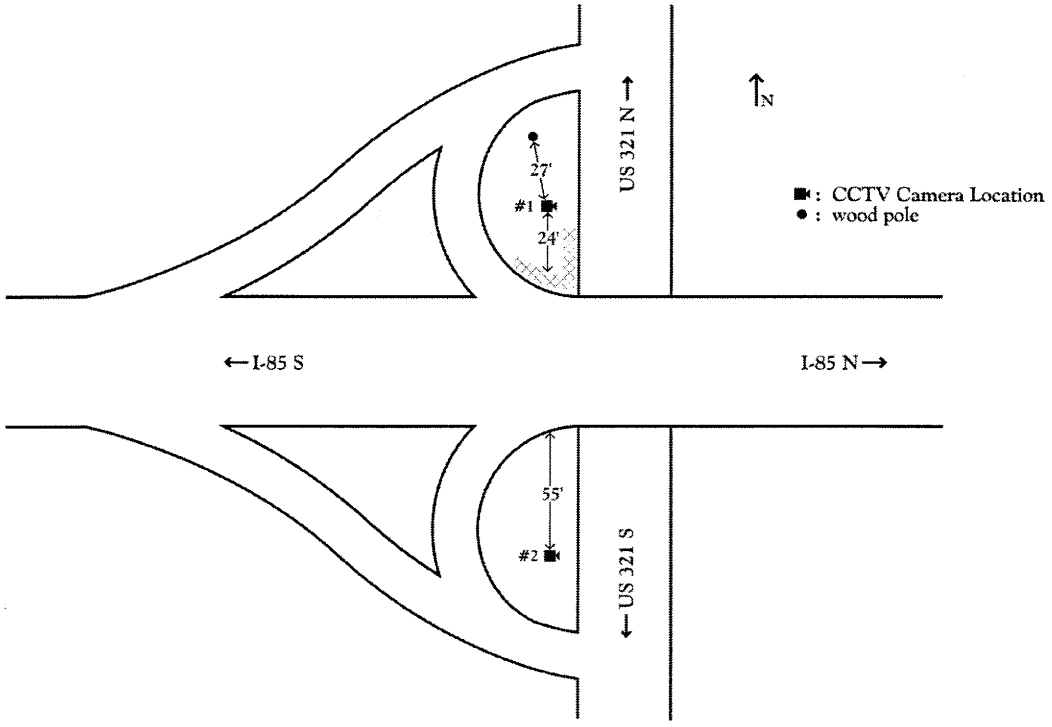
CCTV 5. New Hope Road & Garrison Boulevard/Armstrong Park Drive



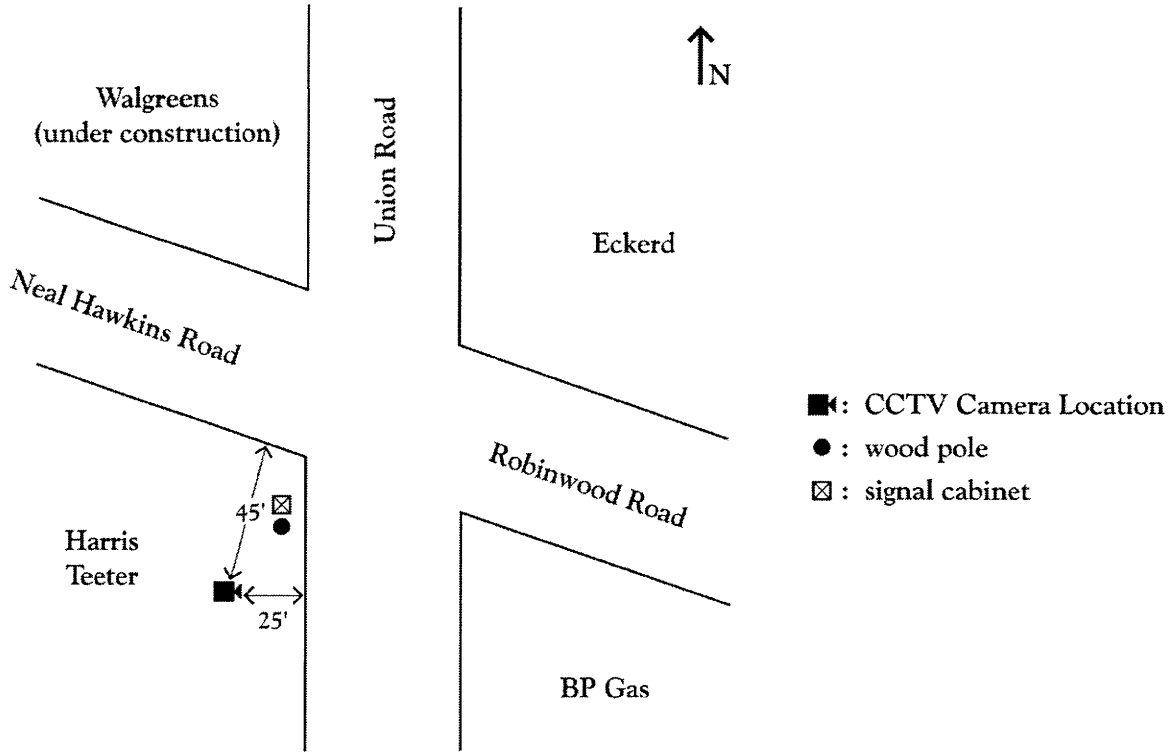
CCTV 6. New Hope Road & Redbud Drive



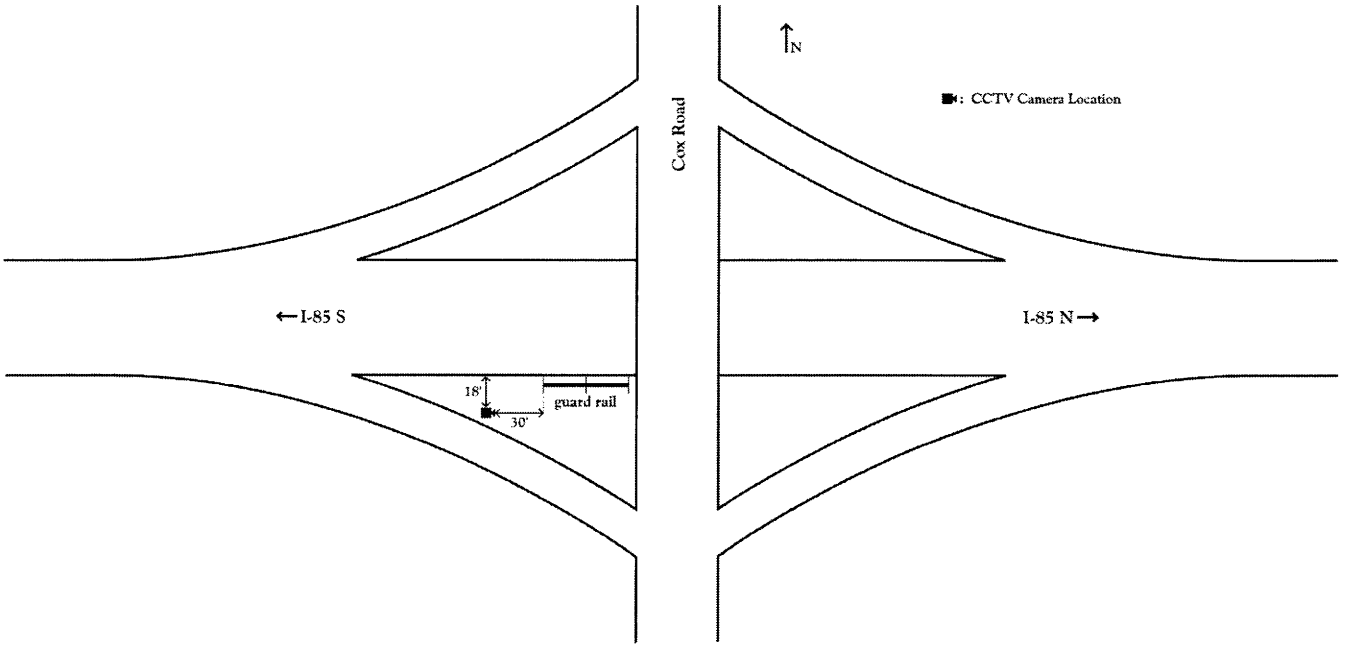
CCTV 7. I-85 & US 321



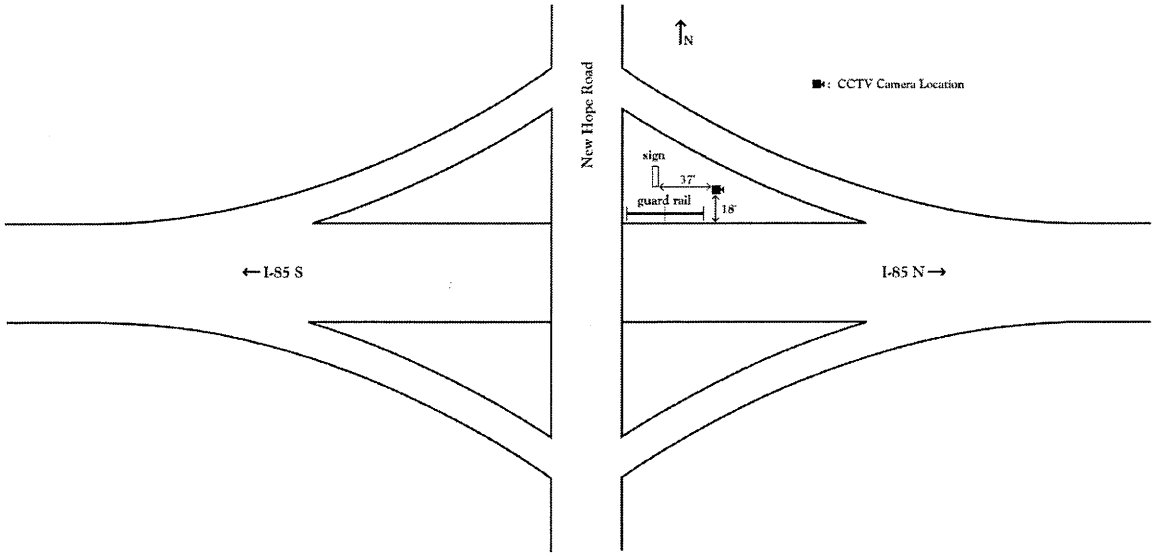
CCTV 8. Union Road & Robinwood Road/Neal Hawkins Road



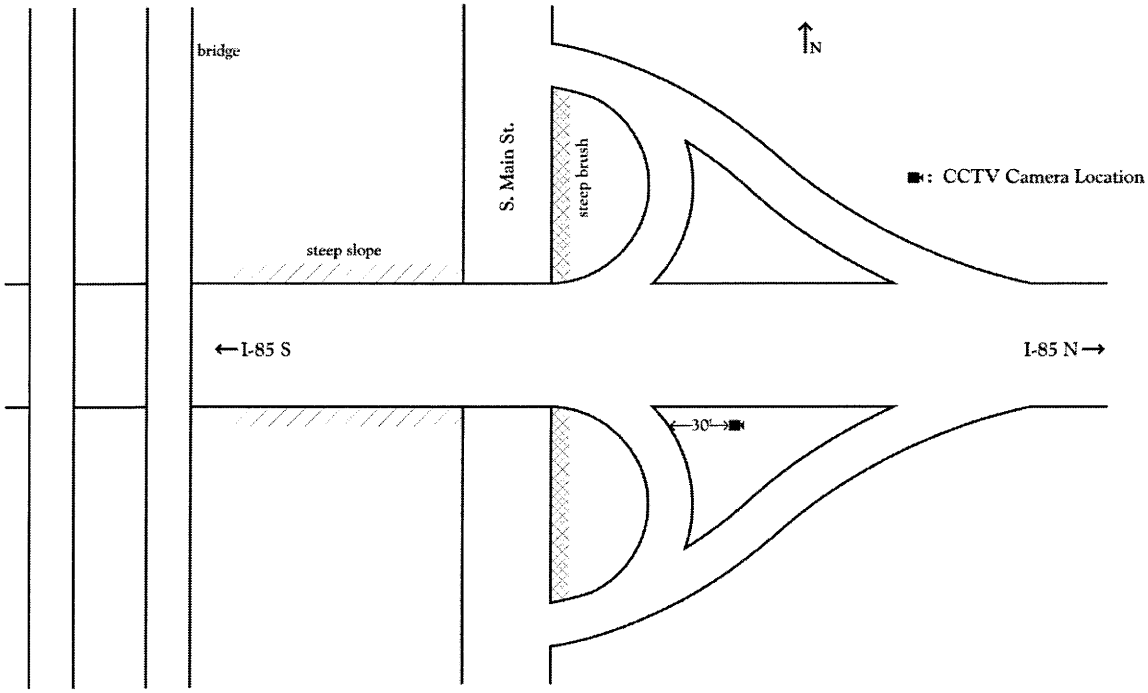
CCTV 9. I-85 & Cox Road



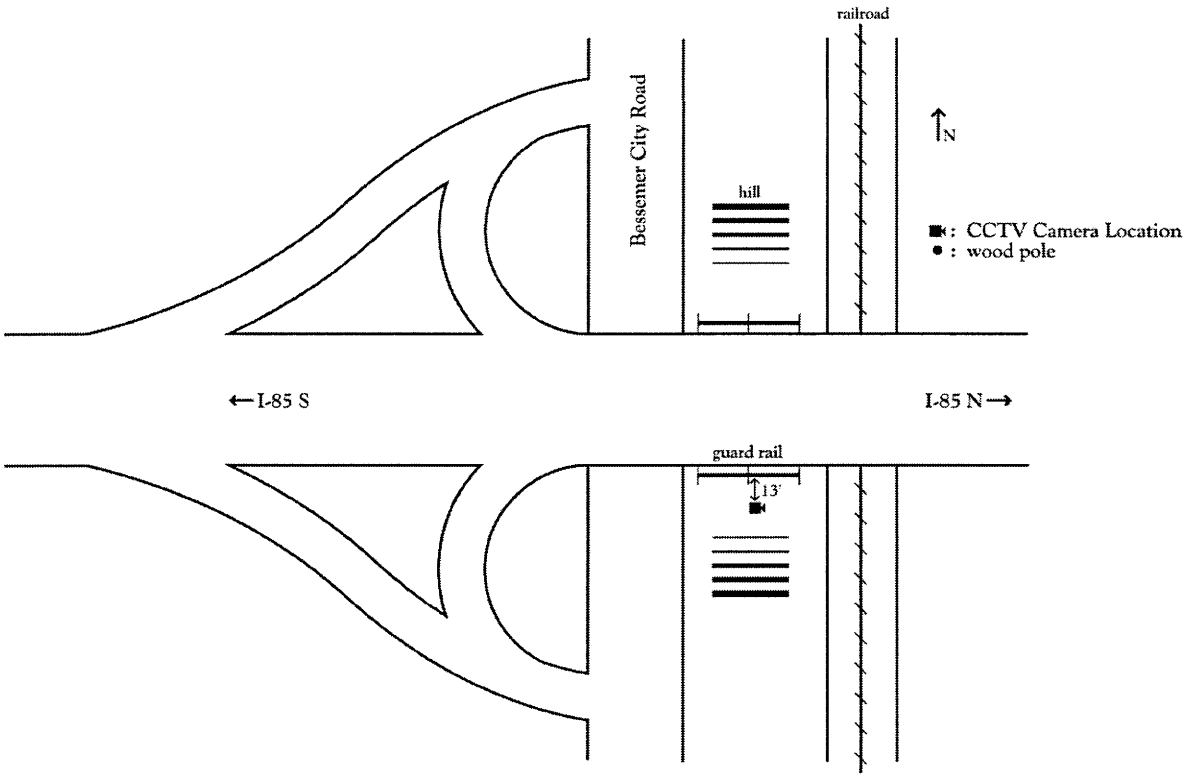
CCTV 10. I-85 & New Hope Road



CCTV 11. I-85 & S. Main Street



CCTV 12. I-85 & Bessemer City Road



B. Electrical and Mechanical Requirements

Ground all equipment as called for in the Standard Specifications, these Project Special Provisions, and the Plans.

Install surge protectors on all ungrounded conductors entering the CCTV enclosure. House the protectors in a small, ventilated weatherproof cabinet attached near the CCTV attachment point in a manner approved by the Engineer. The air terminal ground wire shall not pass through this cabinet.

Install coaxial cable as required to interconnect fiber optic video transceivers with the CCTV units. Insure that all connections are tight and fully secure.

C. Pole Mounted CCTV Cabinet

Use banding or other method approved by the Engineer to fasten CCTV cabinet to pole.

Install all conduit, condulets, and attachments to equipment cabinets in a manner that preserves the minimum bending radius of the fiber optic cable and creates water proof connections and seals.

At each new CCTV cabinet where fiber optic cable is routed, coil a minimum of 20 feet of fiber optic cable in the cable as shown in the Plans.

29.4. METHOD OF MEASUREMENT

Actual number of CCTV assemblies furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, CCTV camera attachment assemblies, conduit, condulets, grounding equipment, CCTV camera enclosures, surge protectors, or any other equipment or labor required to install the CCTV assembly and integrate it with the fiber optic communications equipment. No separate measurement will be made for integration of CCTV unit with Central CCTV Control Software.

No separate payment will be made for coaxial cable. Coaxial cable, furnished and installed in the quantities required, will be incidental to the "CCTV Assembly" pay item.

Actual number of pole mounted CCTV cabinets furnished, installed, integrated, and accepted. No measurement will be made of external electrical service disconnect, required system interconnection, surge protection, and grounding systems as this will be considered incidental to furnishing and installing CCTV cabinet.

CCTV wood poles will be paid for under **Section 10** of these Project Special Provisions.

29.5. BASIS OF PAYMENT

The quantity of CCTV assemblies, measured as provided above, will be paid for at the contract unit price each for "CCTV Assembly" in accord with the following conditions: 75% of the payment will be made upon acceptance of each CCTV Assembly; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of pole mounted CCTV equipment cabinets, measured as provided above, will be paid for at the contract unit price each for "Pole Mounted CCTV Equipment Cabinet" in accord with the following conditions: 75% of the payment will be made upon acceptance of each Pole Mounted CCTV Equipment Cabinet; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

Payment will be made under:

CCTV Assembly.....Each

Pole Mounted CCTV Equipment Cabinet.....Each

30. SYSTEM SOFTWARE

30.1. DESCRIPTION

Furnish and install traffic control system software for the following applications

- Distributed Processing System Software
- CCTV Control Software
- System Support Software

Install the following software as furnished by the Engineer.

- Local Controller Software

30.2. FUNCTIONAL REQUIREMENTS

A. General

Unless otherwise called for, furnish software whose architecture is based on distributed open architecture concepts. Processing shall be distributed, and "open" communications protocols shall be used for all interfaces. Client workstations shall access networked file servers that perform application operations, system communications, database management, and system graphics.

All system software shall be implemented using the standard, commercially available computer hardware required in **Section 31** of these Project Special Provisions. Windowing graphical user interfaces (GUI) using object oriented design and geographically coded database components shall be an integral part of the system design. These elements shall form the basis of all user interactions with the system. They shall be integrated using industry standard Application Programming Interfaces (API) and protocols.

The software shall be portable across multiple hardware platforms and designed to integrate with off-the-shelf PC software. For example, the system shall provide the ability to exchange files with common Geographic Information Systems (GIS), databases, Computer Aided Design (CAD), and the Microsoft Office Suite of products.

The system shall be coded in JAVA, C++ programming language, or other object oriented programming language approved by the Engineer. C++ ; C# or JAVA tools and multi-platform commercial graphics libraries shall be used to support system configurability and portability.

All software and firmware furnished under this project (both for individual field equipment locations and for central software) that maintain internal clocks and utilize those clocks for display

of time, reporting of time back to system users, reporting of time on reports and event logs, and/or use of internal time clock to coordinate actions and activities with other software or devices shall be able to adjust to leap-year, current day light savings time dates, and new daylight savings time extensions that will occur in 2007 automatically with out user intervention or adjustment.

A.1. Local Area Network Requirements

A 10/100 Base-T Ethernet, local area network (LAN) shall support the distributed client/server architecture. The requirements for the LAN are in **Section 32** of these Project Special Provisions.

All system software shall allow for a minimum of sixteen (16) simultaneous LAN users connected locally over the City of Gastonia Signal System LAN or via the MRTMC remote LAN connection. Inclusive of the sixteen simultaneous users, a minimum of eight (8) users shall be able to access all system software applications via remote dial-up, remote broadband, or via a secure, encrypted, virtual private network connection (VPN). Depending on security level an operator may have up to full access for system control, database entry/examination, malfunction diagnosis, system operation evaluation, and measures of effectiveness analysis. Access by a particular user to a particular command shall be allowed or disallowed based upon that user's assigned security level.

The requirements for the network management software are discussed in **Section 32** of these Project Special Provisions.

A.2. Software License

Provide a perpetual, irrevocable software license to the Department and the City of Gastonia that gives them the right to copy and use the distributed processing and CCTV software furnished with this project at any facility within the City of Gastonia signal system limits.

Furnish software modifications necessary for system operation as per this Project Special Provision to the agency at no additional cost during the warranty period.

Furnish software that may be used at the City of Gastonia's Traffic Services Office, the Traffic Engineer's Office, City Hall, or at any other offices in the State of North Carolina that the City and State, or their authorized agent, may establish for the purpose of traffic signal monitoring and control in the Gastonia signal system jurisdictional area.

For any software functionality that is specifically developed for this project, the software developer shall provide hardcopy and digital copies of the un-compiled source code of the software. This source code must be fully documented and commented, so that an experienced programmer/developer (3 plus years) in the language(s) that the software is written may interpret, modify, and debug the code. The required software compilers shall be specifically and clearly

identified and include the operator system platform, the version number, release number and date, and brand.

For copy written COTS software, a copy of the source code (both hardcopy and un-compiled digital commented as described in the preceding paragraph) shall be held in an escrow account by an independent agent agreed to prior to final acceptance of the system by the Department. The version of the source code in the escrow account shall be updated as modifications, fixes, enhancements, and improvements are made to the software and implemented on the software products used by the Department. In the event the provider of COTS software product(s) defaults, discontinues support of the software product(s) furnished under this project, goes out of business, or otherwise is unavailable to support the software product(s), the software source code contained in the escrow account shall immediately become the property of the Department.

Provide any third party software licenses to the Department and the City of Gastonia for software that may be used. Example: report-configuring, diagnostic, or monitoring software.

A.3. Operating System

The operating system for all software provided under this project shall be Microsoft Windows Server 2003 and Microsoft Windows Server 2003 Client or Microsoft Windows XP compatible with the Microsoft Windows Server 2003 software. The release used shall be the latest revision available as recommended by the supplier of the system software.

The network operating system (NOS) shall be Microsoft Windows Server 2003 or approved equal and must be compatible with the traffic signal system software.

The NOS and software operating system shall be compatible and work seamlessly with the traffic signal system software.

B. Distributed Processing Signal System Software

B.1. General

Furnish signal system software that is not a prototype or software custom-developed for this project. The software shall have been successfully integrated, tested, and accepted in at least two cities of comparable size (a minimum of 100 intersections). This deployment shall be with 2070 controllers utilizing the local controller software to be deployed under this project.

The system software shall communicate directly with all of the 2070 controllers that will be utilized under this project. The use of remote communication units (RCUs) is not permitted. The system software shall be compatible and compliant with emerging industry standards for system interconnectivity, interoperability, and expandability. The system shall use a client/server design

based on distributed, open architecture concepts.

The new system shall be designed to operate 24 hours per day, unattended, with operator attention required only periodically. Operator intervention requirements shall be limited to defining system components, modifying system timing, responding to malfunction alarms or indicators, diagnosing component failures, and manually "fine-tuning" new timing plans.

The system software shall initially provide central monitoring of approximately 150 intelligent controllers with the capacity to expand to 300 controllers without additional central computer equipment.

The system design shall accommodate future expansion. The addition of new intersections and detectors in the field, up to the specified minimum expandability, shall not require additional software or central hardware and shall require only modification of the controlling database. The software design shall facilitate the easy, future incorporation of additional control strategy, software logic, and additional system features.

B.2. System Expansion Requirements

The following minimum sizing criteria shall be used relative to the design of the distributed signal system software:

Intersections	Control Sections	System Detectors	Local Detectors
300	60	1000	5000

B.3. Traffic Signal Controller Communications

Within the City of Gastonia computerized signal system, traffic signal controllers will be arranged in multi-drop communications channels capable of supporting a minimum (10) traffic signal controllers on a dedicated communications channel at a minimum data baud rate of 19,200 kilobytes per second. Each controller is connected to the system via a pair of optical fibers and repeating fiber optical transceivers. A channel consists of two fibers: one transmitting and the other receiving. Each repeating channel is configured to receive or transmit a message from any transceiver on the channel and repeat the message at each device on the channel.

Each multi-drop communications channel with its boundaries and the controllers contained within it are depicted on the cable schematic diagram shown in the Plans.

B.4. Database Preparation

Complete all data entry necessary to implement the operation of the system software. The

Engineer will furnish coordination parameters (cycle, split, offset) only. Prepare coding sheet and input the parameters into the system and local controller database.

B.5. System Paging

The software shall provide auto-dial, alphanumeric paging. The alarm conditions that initiate a page shall be user-programmable, as shall be the telephone numbers to be auto-dialed in response to a particular type of alarm. The system shall include pager management software that pages a defined sequence of numbers until a response to the page is acknowledged. The pager shall provide an alphanumeric message that informs the user of the type of error and its location. Specifically, the paging system shall operate as follows:

- The paging system shall be capable of storing at least 20 pager numbers
- The paging system shall have a 24 hour day, 7 day week, 365 day scheduler/calendar that accounts for leap years and contains all Federal, State of North Carolina, and City of Gastonia Holidays.
- The user shall be able to assign hours of the day for each day where the system software is required issue a page when an alarm occurs when there is no operator scheduled to man the TOC. The user shall define the alarms that will trigger a system page.
- In addition to a primary pager number, the user shall be able to assign a secondary and tertiary pager number to rollover to in the event a page is not responded to.
- The paging system shall make one, two, or three attempts (as defined by the user) on intervals defined by the user (5 minute, 10 minute, 15 minute, 30 minute, or 60 minute). If the primary pager number does not respond to the page, the system will then page the secondary number (if one has been assigned) the number of times and at the intervals defined as described herein. Similarly, if the secondary number does not respond to the page, then the tertiary number will be paged. Non-responses include the paged party not calling back, the system paging a number that is busy, and the system paging a number that is not in service.
- The paging system shall maintain a report of all system pages made, all calls made during each page, and the time the page was ultimately responded to.
- In addition to the paged party responding to the page by placing a phone call to the system and entering the appropriate response sequence, the users shall also be allowed to respond to the page by logging into the distributed system software. And also entering the paging sub-system, and acknowledging the page to discontinue the page sequence.

The paging system shall not require an internet service provider (ISP) to be operational. The Paging system shall use the dial-up modem called for on the Signal System server computer.

B.6. Start-up and Shutdown

B.6.1. Initial Start-up

The traffic control system shall provide for the initial start-up of the system by initializing all operational and failure arrays within the software. The initialization routines shall be used not only at the true initial start-up of the system, but whenever it is desired to reinitialize the system without prior status information.

B.6.2. Automatic System Restart

The software shall automatically re-boot itself upon the restoration of primary power.

The process of automatically restarting the system after a power failure differs from initial system start-up in that certain previously accumulated operational and failure data will have been maintained in the applicable data arrays. Accordingly, following a power failure the automatic system restart shall make use of these data arrays rather than performing initialization on them.

B.6.3. Planned Shutdown

The traffic control system shall accommodate a planned shutdown of the monitoring functions of the traffic control software.

B.6.4. Emergency Shutdown

Two types of emergencies shall be accommodated by the traffic control system:

- Unplanned stopping of program execution
- Operator observation of improper operation

B.7. Power failure

Interface system software with the uninterruptible power supply. Upon detection of a loss of power, the system software shall initiate a planned system shut down. Provide the operator with the capability to override the shut down. Upon restoration of power, the automatic restart circuit shall initiate the restart of the traffic control system hardware and software.

The traffic control program may suddenly stop execution for various hardware or software reasons. In such event, alarms shall alert the operator as to the problem and circuitry shall ensure against the transmission of erroneous data by the field communications subsystem.

In the event that the operator determines that the operation of the system is improper, he/she

shall be able to immediately force all system intersections to an off-line, or a time-based coordination timing plan stored in the local controller (depending on the local day plan) from any system workstation.

B.8. Backup Operation

Provide for backup operation in case of failure of the distributed system file server, communications server, or the communication system. This backup shall be accomplished by means of time-based coordination (TBC) provided by the local controller software. The local controllers shall automatically implement TBC according to the day plan programmed into the controller whenever communication is absent.

B.9. Monitoring of System Functions

Verification of on-street system operation shall be incorporated in the new traffic control system. Operation of all controller equipment shall be monitored on a once-per-second basis, with current displays and malfunctions reported in real-time. Real-time shall be defined as within one second of the occurrence of the event or change in display status. Continuous, once-per-second polled communication between the communications server and all remote control components of the traffic control system shall be provided, and a minimum of ten (10) controllers shall be able to be connected to a single communications channel and maintain data update requirements described herein.

B.9.1. Intersection Monitoring

The status of each controller shall be monitored, and any detected error condition shall be logged. Error conditions shall be stored in a form that specifies the type, date, and time of the error. Error processing shall be performed during both coordinated and free operations.

When the software identifies a communications or controller failure, an error message shall be logged and the intersection shall be dropped from system monitoring. The software shall, at a user-defined interval, attempt to re-establish monitoring of the intersection. When the fault has been corrected and the pick-up has been completed, the controller shall be returned to coordinated status and transitioned to the current timing plan.

The software shall monitor for the following on-line error conditions:

- Communication Error - If communication between the communications server and local intersection is lost for a user specified number of consecutive seconds, a failure shall be identified.
- Conflict Error – If the signal monitor reports a conflict status (absence of any indication,

yellow indication sequence error, or dual indications on the same channel), an error shall be reported.

In the free (or off-line) operation, the software shall use the same error checking and error processing procedures for communication error testing, and conflict error checking as for the coordinated mode. Communication of detector data and other status information shall continue even when the local controller is in free (or off-line) operation. An error condition detected while a controller is in free operation shall be immediately reported and logged by the system software.

Monitoring of the following shall also be provided:

B.9.1.1 Monitoring of Local Preemption

The system shall monitor and recognize the occurrence of preemption at each local intersection.

A local preempt shall cause the local software to suspend coordinated operation. Accordingly, a preempted intersection shall not be erroneously diagnosed as having experienced a coordination failure. When the local preempt status has been removed, the local software shall initiate the transition back to coordinated operation. System log messages shall be recorded to note the beginning and ending times of local preemption and the type of preemption (e.g., emergency vehicle, railroad, etc.).

As programmed on an individual intersection basis by the user, an option for immediate return to coordination following preemption shall be provided.

B.9.1.2 Monitoring of Local Manual Control

Local manual control shall be initiated and controlled by hardware at the intersection. The software shall identify any intersection that is in local manual control by means of a status message. Local manual control shall cause the local software to suspend coordination. Accordingly, an intersection being operated under manual control shall not be erroneously diagnosed as having experienced a coordination failure. When the local manual control status has been removed, the local software shall initiate the transition back to coordinated operation. System log messages shall be recorded at the start and end of local manual control condition.

B.9.1.3 Communications Status

The system software shall report the present status of the communication system at the controller. Changes in status of the communication system shall be recorded in the system log.

B.9.2. Detector Monitoring

B.9.2.1 Detector Data Validity Checks

The local controller software shall continuously monitor the detectors for undercounting, overcounting, minimum/maximum presence, and communication errors. Parameters for determining undercounting, overcounting, minimum/maximum presence shall be adjustable by the user. Local controllers shall report detector errors, which shall be logged by the system software.

A detector shall be automatically suspended from use if it is determined to have failed one of the threshold tests. A change in classification to "failed" and the reason for the change shall be reported to the operator and automatically entered in the system log. A reclassification to "acceptable" shall also be logged.

Regardless of the classification status of any detector, detector status reporting shall continue unless inhibited by an operator command. A detector that has been suspended from use due to a failure shall remain suspended until its operation has been reclassified as acceptable or until the operator enters a command that releases it from suspension.

B.9.2.2 Detector Data Smoothing

Detector data smoothing shall be provided to prevent short-term fluctuations from incorrectly influencing traffic responsive control algorithms.

B.9.2.3 Detector Data Logging

For proper generation of new timing plans, a user shall be able to accumulate and properly analyze detector data. In order to accommodate this analysis, historical detector data shall be stored in the signal system software database on the signal system server hard drive online and on recordable optical media off-line. The system will facilitate one calendar year's worth of data to be stored on-line on the signal system server's hard drive. The system detector data archive module will store the data online, sorted in archives arranged by calendar months. After twelve months of data are stored, for the 13th month, the user will be prompted to save or move the previous twelve months of system detector data to a recordable optical media. Once moved and verified, each new month of system detector data will over write the oldest month of detector data still present on the signal system server hard drive.

The location where the data is stored shall be user selectable. All archived data shall be time stamped. For analysis purposes a user shall be able to select a number of system detectors, a start time, a period length (from 1 to 216 hours), and a logging interval (from 5 to 60 minutes) for which data will be recorded. Upon completion of the data collection period, the system software shall

automatically convert the collection data to a Microsoft Access database table or format approved by the Engineer. The table shall include column identifiers for the system detectors and row identifiers for the logging intervals.

B.9.2.4 Detector Data Update Threshold

System detector data shall be polled and updated from the local controllers at user selectable intervals of 1 minute, 2 minutes, or 5 minutes. This threshold will be set on a system-wide basis.

B.9.3. Signal Monitor

The system software shall monitor the signal monitor and record all detected conflicts in the system log. The system software shall daily (or upon another user-selectable interval), automatically upload the event log from each signal monitor and archive this data on the distributed system file server. The system software shall include a software module that allows these events to be reviewed, sorted, and queried and for reports to be generated.

All status information recorded by the conflict monitor, malfunction management unit, or enhanced signal monitor, shall be uploaded and logged on the signal system server in the native format of the monitor unit central software.

Third party software may be used to collect and query signal monitor logs. Third party software shall be compatible with local controller software and signal system central software. If provided, install third part software on all workstations and notebook computers furnished under this project.

B.10. Detector Features

B.10.1. Local Detectors

The software shall be able to recognize and report failures of local intersection detectors (e.g., constant call, constant maximum presence, etc.). All set-up and monitoring parameters available to a technician at the cabinet in the field shall be accessible via the system software.

B.10.2. System Detectors

The software shall allow remote set-up, retrieval of internal loop diagnostic records, and status information.

The software shall provide the following selectable logging parameters:

- Loop description (up to nine [9] characters)
- Loop type

The system software shall provide the following channel selectable parameters:

- Sensitivity thresholds
- Detection mode
- Delay time
- Extend time
- Automatically upload update of detector data at user selectable thresholds.

B.11. Timing Plans

B.11.1. Number of Timing Plans

An intersection timing plan is defined as a unique combination of cycle length, split, and offset at an intersection. The distributed processing system software shall accommodate a minimum of thirty-two (32) timing plans. In addition, the software shall enable selection of both flashing and free operation of any intersection.

B.11.2. Functions Related to Timing Plans

The following functions shall be related to the specific intersection timing plans and shall be implemented in the correct state as part of the associated timing plan. It shall not be necessary to use a special function to implement any of these functions. The timing plan shall implement these functions. The functions are:

- Phase set (sequence)
- Maximum recall by phase
- Primary coordinated phases
- Pedestrian recall by phase
- Secondary coordinated phases
- Phase omit by phase
- Minimum recall by phase

B.11.3. Timing Plan and Scheduler Resolution

Cycle lengths, offsets, and splits shall be adjustable in one-second increments. Events in the scheduler (both turn-on and turn-off) shall be adjustable in increments of one minute or less.

B.11.4. Local Zero Reference for Timing Plans

The software shall enable the user to enter actual offset from a control section's zero reference to the planned beginning or end of the primary coordinated phase green as required by the software. It

shall not be necessary to calculate adjustments in the yield points for varying amounts of pedestrian clearance times. Similarly, the software shall enable the user to enter the actual phase (green plus yellow plus red clearance) splits. It shall not be necessary to calculate fictitious splits. All required adjustments shall be automatically calculated and implemented by the software.

B.11.5. Coordination across Control Section Boundaries

The software shall achieve coordinated operation across control section boundaries operating on the same cycle length or on multiples of the same cycle length by ensuring that all such control sections are synchronized to a common reference.

B.11.6. Cross-Street Coordination

The software shall provide coordination of traffic on crossing streets. It shall be possible for the operator to select a secondary coordinated phase (phase pair in dual-ring controllers) for each intersection. When so selected, the software shall not permit termination of the secondary coordinated phase or phase pair until the planned (yield point) point in the cycle, even if traffic on the secondary coordinated phase is light.

B.11.7. Double-Cycling

The software shall permit the operation of some signals in a control section at one-half the cycle length of other signals in the group. The intersections operating on both cycle lengths shall share a common reference point so that coordination can be maintained.

B.11.8. Actuated Coordination

The controller shall allow the following fully actuated, coordinated operation:

- A guaranteed minimum period of service for the coordinated phases which shall be less than the split allotted to the coordinated phase shall be provided. The period of service may be extended by vehicle actuations to the full period of the split.
- The non-coordinated phases shall be served at any point after the end of the minimum period of service if the coordinated phases terminate due to expiration of the gap timer. The simultaneous gap-out settings currently in effect shall be used.
- Any phase may be served in the standard sequence after the end of the coordinated phase, provided that the permissive period for that phase has not expired. Any phase may be re-serviced in the standard sequence during its permissive period. The controller shall follow the recall settings currently in effect.
- Extension of the coordinated phases shall not result in any loss of coordination or

reduction of the time allowed for service of the non-coordinated phases. The coordinated phases shall be allowed to be re-serviced in the standard sequence during the permissive period of the non-coordinated phases in response to vehicle demand or recall settings.

The end of the permissive period for each phase and the force off point for each phase shall remain relative to the system zero point.

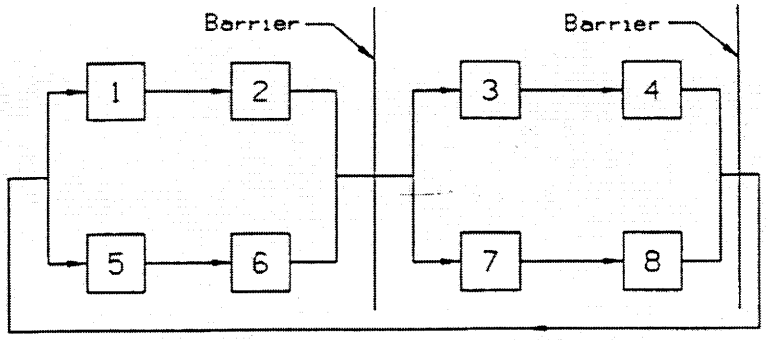
B.12. Control of Local Intersections and Other Devices

B.12.1. Full Control of Dual-Ring Controllers

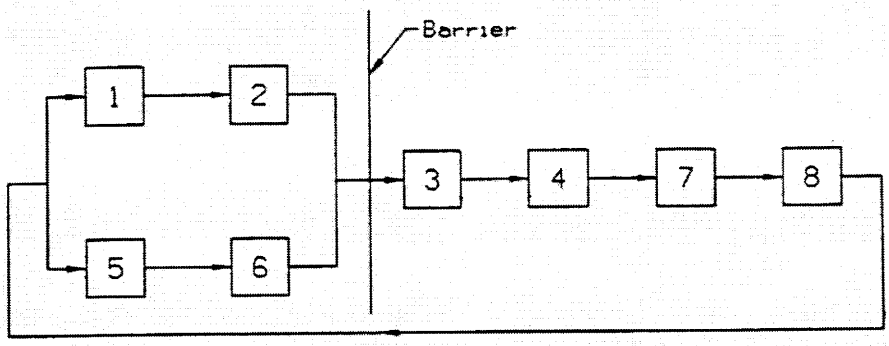
The system shall monitor each independent movement of an eight- (8)-phase, dual-ring controller. This shall include separate yield points and permissive periods for each ring. The system shall provide coordination for each of the signal sequences depicted in Figures 1 and 2 below.

Figure 1 – Ring Diagrams of Required Sequences for Dual-Ring Controllers (Type 8)

Dual-Quad Sequence



Quad-Sequential Sequence



8-Phase Sequential

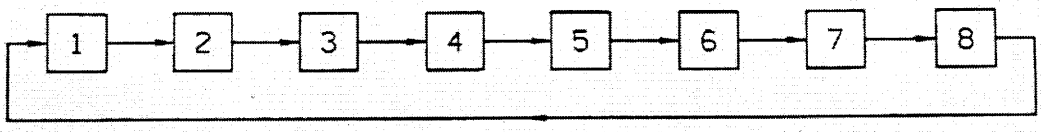
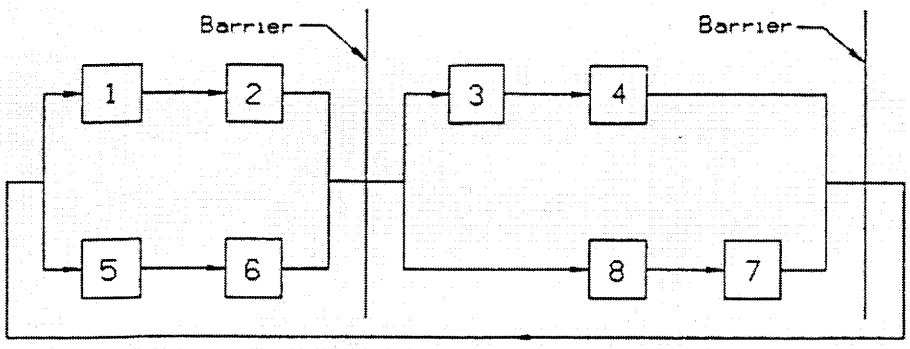


Figure 2 – Leading-Lagging Left Turn Sequence



NOTE: Phases 3 and 7 are incompatible and shall not be displayed concurrently.

B.12.2. Clock Updates

The software loaded on the signal system server shall allow for automatic updating of the universal time at least once per day, or at a user programmable interval. This update shall be carried out by means of a connection to the GPS antenna housed on the Municipal Operations building or other approved network clock update means as approved by the Engineer. Following each update of the clock on the distributed signal system server, the system shall update the clocks on all servers on the LAN, and all workstations logged into the signal system server. For workstations and laptop computers not logged onto the signal system server, upon next log-in, their clock shall be automatically updated to the current time of the distributed system server clock.

B.13. Signal Operation and Timing Plan Selection

The signal system shall report and log the timing plan that has been implemented in each controller that is online and shall maintain in its database the coordination plan and controller operating status (coordinated, free, flash, conflict flash, etc.). This information shall be stored online for a minimum of one year in the signal system's database.

Timing plans, at the discretion of the system operator, shall be allowed to be implemented for a single intersection. The timing plan shall be selectable by the operator (Manual mode), by a time clock schedule (Time-of-Day/Day-of-Week mode) in the controller, or by the system, when operating in the Traffic Responsive mode or other threshold trigger mode.

B.13.1. Orderly Timing Plan Transition

The system, in conjunction with the local controller software, shall provide for orderly, smooth transition from one timing plan to another. Whenever a new timing plan is implemented, each controller shall achieve the new offset by implementing a transition with respect to the new cycle clock. For each intersection the system software shall recognize and display a message that local transition is in effect.

A workstation user shall have the ability to modify the mode of offset correction implemented at any system intersection.

B.13.2. Manual Operating Mode

The manual mode of system operation shall provide a pattern to be implemented from any workstation. From the perspective of the local controller, this mode shall be identical to traffic responsive.

B.13.3. Time-of-Day Operating Mode

The Time-of-Day/Day-of-Week/Day-of-Year (TOD/DOW/DOY) mode of operation shall allow the advance scheduling of the signal plan and timing plan to be implemented in each section. TOD/DOW/DOY scheduling shall be performed based on the schedule data stored locally at the controller and updated by upload/download operations. The TOD/DOW/DOY schedules stored and implemented by the local controllers shall be able to be manually overridden from operators logged into the signal system server. Also, events may be implemented from the signal system server's event scheduler that would override the locally scheduled timing plan.

B.13.4. Traffic Responsive Operation

In traffic responsive operations, the system software shall select the timing plan whose defined coordination parameters most closely match the detected pattern of traffic.

System detectors shall provide volume and occupancy data that shall be used by the system software as the basis for traffic responsive plan selection.

The system database shall identify the system detectors that are assigned to each controlled section for traffic responsive operation. System detectors may be assigned to more than one controlled section.

The process that shall be used for plan selection in traffic responsive operation is summarized as follows:

- Process the vehicle volumes and occupancies from all detectors assigned to the controlled

section.

- Using user-definable weighting factors, calculate weighted volume and weighted occupancy by multiplying the sampled volume and the weighting factor.
- Compare the weighted volumes and occupancies with the stored detector plan thresholds.
- Perform the calculation for all eligible plans.

Select the plan with the closest match to the calculated value. The selected timing plan shall be transmitted to the controllers, provided that the selected timing plan is available for all controllers in the applicable section or system. If all the controllers do not have the selected timing plan, the timing plan will not be transmitted and the controllers shall return to their time-of-day schedules. An appropriate error message shall be displayed to the user.

In traffic responsive operation, the software shall use weighted volume and occupancy from the historical lists for failed detectors until the percentage failed exceeds an operator-specified threshold for the selection table being used. The section shall then automatically switch to the TOD/DOW/DOY timing plan. This plan shall remain in effect until the percentage of failed detectors falls below a different operator specified threshold. At this time traffic responsive operation shall automatically resume.

The operator shall be allowed to establish minimum time and minimum threshold criteria to prevent excessive switching between timing plans. The minimum time between timing plan changes for any given section shall be measured in one-minute increments (this value shall be separately defined for each section). The traffic responsive operation shall use algorithms developed by the U.S. Department of Transportation or other algorithms as approved by the Engineer. If the Contractor desires to use an alternate algorithm, the algorithms proposed for use shall be demonstrated to the satisfaction of the Engineer during the system demonstration test. If the Engineer is not satisfied with the algorithm's performance it may not be used.

The traffic responsive algorithm shall also have the following features:

- Allow the user-definition of time-of-day signature values
- Include a user-defined lock-out period to prevent frequent timing plan changes
- Allow the substitution of historical data for failed detector data

The software shall fully provide for traffic responsive operations to be locked out by time-of-day. Also, the software shall enable the operator to limit the specific timing plans that are eligible for traffic responsive implementation at specific times of the day. (For example, the operator shall be

able to define a specific "family" of "AM plans" that shall be the only plans eligible for implementation during an operator-defined AM peak. Similarly, the operator shall be able to define a specific family of "PM plans" that are the only plans eligible for implementation during an operator-defined PM peak. Any stored plan shall be assignable by the operator to one or all such families.)

Upon operator command, the system shall automatically calculate the values needed for traffic responsive operation. This calculation shall use historical data, collected by the system detectors. The software shall permit the operator to review and approve the calculated values prior to their implementation.

B.13.5. Flashing Operations

The system shall have the following flash mode capabilities:

- Central Flash: individual intersections and controlled sections shall be capable of being placed on flash by operator command or schedule entry.
- Cabinet Flash: cabinet flash mode shall be indicated when a controller enters flash via manual selection at the cabinet.
- Conflict Flash: conflict flash shall result from a tripped malfunction management unit/conflict monitor at the local intersection. Conflict flash shall be logged as a failure by the software system.

The type of flash mode (Central, Cabinet, or Conflict), the intersection name, date, and time shall be logged for each entry or exit from flash. Except in the case of Conflict Flash, controllers shall be brought back on-line upon termination of the flash mode. The return to normal operation shall occur only when the controller begins to time the major street walk interval (the initial interval if the WALK interval is not used). This shall be accomplished via the activation of the external start input.

B.14. Event Scheduling

The software shall include a user-friendly TOD/DOW/DOY event scheduler, which shall allow certain operator commands to be scheduled in addition to mode and timing plan changes. Some specific requirements are as follows:

- Event scheduling from any logged in party (either via operator workstation, laptop connected to the network, or via virtual private network (VPN), provided that the user has an appropriate security clearance level.
- A minimum of 100,000 unique events may be stored.
- Event scheduling shall have a resolution of one minute or less.

- Flash and special function implementation shall be accommodated.

The scheduler shall include two types of schedules: permanent schedules and temporary schedules.

- Permanent schedules. Permanent schedules shall contain the schedule of events for each day of the week and for recurring holidays. Functions stored in the permanent schedule shall remain unchanged after they have been executed.
- Temporary schedules. Temporary schedules shall provide the capability of scheduling one-time events in addition to the events scheduled for the current day. Functions stored in the temporary schedule shall be deleted following their execution.

The scheduler shall provide a minimum of ten (10) independent day schedules for each controller. Each day schedule for each controller shall provide a minimum of thirty-two (32) event (state-change) times with each event time programmable for all possible function changes that are supported by the local controller firmware. The event times for each day schedule at an intersection shall be independent of the event times for the other day schedules.

All system functions executed by the system shall be recorded on the system log. The system log shall identify the source of the executed function as being the scheduler or interactive user, including identification of whether it represents a permanent or temporarily scheduled function.

The software shall provide for the programming of a minimum of seven (7) days in advance to implement any of up to a minimum of three (3) temporary schedules to accommodate special circumstances. The temporary schedules shall override the normal daily plans.

The scheduler shall accommodate automatic adjustment for both the beginning and the end of leap year up to one (1) year in advance. Alternatively, this adjustment shall not require programming but shall be inherent in the system design.

The system shall provide the ability to incorporate all user-definable special functions available at an intersection (up to a maximum of 16) on the system into an event.

B.15. Database Management

The system shall be built around a Microsoft's SQL Server database software product unless otherwise approved by the Engineer.

The database shall be used to store, retrieve, and maintain system data and parameter files and shall be available for common computer hardware platforms.

All timing parameters (cycle, split, offset) in all the databases shall be stored in seconds.

The database system shall use structured query language (SQL) and conform to Microsoft's open database standards.

The software shall provide user-friendly database facilities that allow changes to be put into effect while the system remains fully operational. The system shall provide the following database management features.

B.15.1. General Principles on Database Entry/Edit

The following principles shall apply to the data entry/editing process provided by the database software:

- The database management software shall allow programming of the intersection controller databases. Each intersection controller shall have separate database programming pages. These pages shall contain all the programming options unique to each intersection.
- All data shall fit on one page when possible. Scroll bars may be used to view and edit the information on the page if all the data cannot be displayed on the screen. Formatted screens with cursor positioning shall be used.
- All programming entries shall primarily consist of numerical values and YES/NO or ON/OFF entries. During program entry, the new data shall overwrite the old data. If the data is in error, changes shall not be permitted and an error message on the display or a warning tone shall alert the user.
- All data items entered from any workstation shall be tested for data type (numeric or text) and allowed range. All string data items shall be tested to ensure that they do not exceed the allowed length. The program shall not terminate because any data item is incorrectly entered. When errors or potential errors are detected, the program shall either display a specific diagnostic message on the screen or shall give an audible alarm and shall place the cursor in the proper field. In either case, the system shall allow the operator to re-enter the item. Prior to or simultaneously with re-entry, the diagnostic message, if any, shall be erased.
- All numeric data items shall be tested to ensure that they are within the ranges allowed by the software. A specific warning message shall be printed or an audible alarm shall be sounded whenever a data item falls outside the reasonable benchmarks, and the operator shall be allowed to change the data item if desired.
- The same screen formats shall be used for initial data entry and for editing.

- Whenever a logical grouping of data (such as a full screen or the complete database file) has been entered or edited satisfactorily, that data shall be written to the proper file. This may take place upon return to the main menu or, alternatively, it may take place as the entry or editing of each distinct file is ended.
- The screen organization and data entry/edit method shall enable the operator to use all functions without the need to use reference manuals or cards.
- Simple English Required -- All field descriptions and inputs shall be simple and all text shall be in simple English and common traffic engineering terminology. It shall not be necessary to perform any decoding to read the information. All necessary field descriptions shall be specifically and discretely provided on the same display screen as they are needed.

B.15.2. Copy Facility

It shall be possible to copy from within the database software individual database entry form cells or entire database entry form sheets to like cells and like sheets for the database of another controller if the database forms for both controllers are open. Copied data shall be treated like manually entered data and all field error checks and resultant flags and dialog boxes shall appear if out of range or improper type data are enter into a field. This may be done using standard MS Windows edit-copy-paste menu commands and mouse-right-click edit-copy-paste commands. Typically grouped datasheet forms may be:

- Phase split and timings
- Detector minimums and maximums
- Timing plan entries
- Preemption sequences

B.15.3. Upload/Download of Database

The system software shall provide for uploading (copying) the database from any controller to the central signal system software server via user prompting from an operator workstation while all equipment is performing its traffic control functions. Likewise, the software shall provide for downloading (copying) the database for a controller from the central signal system software server via user prompting from an operator workstation to the controller.

The upload/download feature shall use block transfer techniques with verification. Non-verified data shall cause termination of the upload or download operation with no transfer of the corrupted

block taking place. It shall not be possible to download erroneous interval and configuration information to the controller. An error message shall be displayed when improper termination of the upload or download operation occurs.

The software shall provide for the upload and download of all controller parameters.

B.15.4. Data Entry Aggregation

The software shall allow data to be entered in logical traffic engineering groupings; that is, all data for an intersection shall be entered together and in logical groupings, all system data shall be entered together and in logical groupings, etc. Any codes needed for data entry or editing shall be displayed on the same screen or display, together with the data to be entered or edited.

B.15.5. Data Entry/Edit by Table Fill-In

Data entry screens and editing screens shall be the same for functionally identical data groups. Entry and editing shall be by means of filling-in formatted tables. It shall not be necessary to enter data in sequence. Use of the cursor control keys and/or other pointing device(s) shall allow the cursor to be moved right, left, up, and down among the fields of data.

B.15.6. Error/Reasonableness Checking

The software shall perform automatic error checking of the data entered. No data shall be downloaded to a local controller if any value is found to be incompatible with the local controller settings. When an error is detected, the incorrect value shall be highlighted, the operator notified of the range violation, and a prompt for action provided.

B.15.7. Database Comparison

Following an upload, the system shall automatically compare the database of any intersection controller to the database stored for that intersection on the file server. This comparison shall identify any differences between the uploaded and stored file data. The system operator shall be able to correct, use, or substitute data values and proceed with further comparison.

B.15.8. Use of Mnemonics

The software shall minimize the use of mnemonics to interface with the user on the screen, in printed reports, and in the system's documentation or worksheets. Only mnemonics consisting of Engineer-approved traffic engineering abbreviations and other straightforward abbreviations shall be acceptable.

B.15.9. Security

In addition to the network security features provided by the Windows Operating System, the

software shall provide a minimum of three (3) levels of access security:

- The top level (or system manager) shall provide for total access (i.e., permit the operator to view and change all information in the system). Only users with this authorization shall be permitted to view or change access security codes.
- A second level shall provide all view and editing rights to all aspects of the system, but shall not permit the user to change access codes.
- A bottom level shall permit viewing of all information (except access security codes) but shall not permit the operator to make any changes to the database.

Other intermediate levels of access may be provided. The system shall require a password before allowing a user to change, from any workstation, data stored in a local controller or in the central database.

B.15.10. Labeling

All reports and screens associated with specific intersections shall, as a minimum, be labeled with the intersection's signal inventory number (as shown in the plans) and full name (including street name suffix).

B.15.11. Database Backup and Restoration

The software shall provide the following database backup and restoration features:

- The system shall include simple means of copying the database files from the hard disk to CD, DVD, or to a magnetic tape storage device. All files required to restore the system to operation without the need to manually re-enter data shall be included on the backup CD, DVD, and magnetic tape.
- Files containing records of logged events and detector data shall be saved on hard disk. The system shall enable an operator to copy all logged events, within a user-specified date range, to either the recordable CD system, the recordable DVD system, or the DAT drive (as selected by the user). The system shall enable an operator to copy all selected detector data, within a user-specified date range, to either the recordable CD system, the recordable DVD system, or the DAT drive (as selected by the operator). The system shall analyze data from such stored files using the same programs and producing the same reports as are possible when the files are on the hard disk. Recopying the files to the hard disk to accomplish this shall be permitted.
- The software shall provide simple, straightforward means for restoring system operation

from the backup database files.

B.15.12. Data Entry/Edit through On-Street Equipment

In addition to the data entry and editing at any workstation, it shall be possible to enter and edit all data stored at the intersection using the keyboards and displays on the controllers.

B.16. Graphic User Interface

An object-oriented, graphical user interface (GUI) shall be provided to control and access all systems displays, reports, and dialogue boxes. All workstation user interface functions shall be implemented using GUI concepts conforming to Microsoft Windows' standards.

Graphical icons shall be used on the graphical displays to represent system devices. The icons shall provide easy access to traffic control data (signal timing, geometrics, etc.), real-time data (intersection, link status, etc.), the database, and graphical image files.

The raster based graphic map shall act as a system selection palate enabling the operator to make a selection by pointing to a particular system object (i.e., controller, CCTV camera, etc.). When that system object is selected, a more detailed status window shall be capable of being displayed.

The GUI shall include an intersection/link base map with windowed table reports and management input windows. The workstations shall also have access to CCTV images.

The GUI shall provide access to all signal system monitoring and control options from a single screen. As a result, all operator actions shall be immediately visible as a change in the system graphic.

The GUI shall use the multiple document interface (MDI) standard to manage the Windows work space environment. The various windows within the work space area shall be managed as a group using the MDI scheme. At user log-off time, the session work space shall remember the size, position, and state of its document windows and shall restore this state when the user logs back onto the system.

The work space session window shall display a toolbar near one of the window borders. The toolbar shall contain buttons and other controls for creating document windows, importing and exporting data, setting session parameters, or invoking any other action or activity that affects the entire session. Actions supported by and pertaining to a single window shall be invoked through that window's action bar menu or controls internal to the window itself.

All action bar menus shall support a set of keyboard equivalent accelerators, arrow key navigation of the menu bar, and individual pull-down menus.

Menu and dialogue box options that are not appropriate in a particular context or not available to a given user shall be "grayed-out" and unavailable for selection.

Traffic engineering terminology shall be used throughout the programming displays. Display organization and data entry approach shall allow system operators to operate the distributed signal system software without using reference cards or manuals.

User definable accelerator buttons shall be able to be placed on a toolbar. These buttons shall allow a user to quickly access user-selected portions of the software. The software shall allow the user to record a series of menu selections and/or keyboard entries. The recorded selections or entries shall then be able to be assigned to a user-defined icon on a toolbar.

The user interface shall include an object library that contains dynamic icon objects for system control and monitoring devices. The basic system shall include, at a minimum, objects for traffic signals and CCTV. The library shall also include an interactive editor for placing these objects within dynamic graphic screens. The system shall allow the user to link dynamic graphical objects directly to system database elements without programming or recompilation. The library shall also include dynamic objects, allowing the user to define directional roadway links using a simple vector drawing facility. Proper representation of directional status attributes shall be available at all zoom levels.

B.17. System Graphics

Graphical displays shall be provided for the entire system, individual control sections, and individual intersection levels. The graphics for the entire system and control sections shall be developed in the ESRI map objects embedded environment, or approved equal.

All graphics for system maps, control section maps, and intersection displays shall be submitted to the Engineer for approval before being integrated with the software.

B.17.1. System Map

The raster based system-wide map shall provide a dynamic display of the entire surveillance area, including interstate highways, major arterial roads, railroads, jurisdiction boundaries, and bodies of water. Labels for these items shall also be displayed at user selectable scales. All labeling shall be approved by the Engineer. Intersections and roadway links shall change color dynamically based on user definable status functions. It shall be possible to "zoom in" to any specific area of the map using the pointing device to select one corner of an area to view, and then select the opposite corner of the area to view. (Zoom out capability shall also be provided.) The window containing the system-wide map shall be capable of being dynamically sized by a workstation user. Resizing the

window shall not reduce the amount of data displayed on a workstation monitor and the same aspect ratio shall be maintained as before the resizing.

B.17.2. Control Section Map

Control section maps shall provide a more detailed display of selected zones or areas of the system. Control section shall be able to be called from the system map display via a double mouse click. A minimum of fifteen (15) control section displays shall be capable of being simultaneously displayed while the system map is open and the maximum number intersection display windows are open. The control section map interface shall be an integrated portion of the distributed processing system software and shall not be a stand-alone package.

The control section map shall provide a dynamic display of the signal system, including landmarks, streets, signalized intersections, interstate highways (if applicable), railroads (if applicable), system detectors, system detector actuation. Labels for these items shall also be displayed. All labeling shall be approved by the Engineer. The graphic shall also dynamically display the status of the controllers in the sub-area (e.g., coordination, emergency vehicle preemption, railroad preemption transition, free operation, flashing, failed, intersection phase status). Volume and occupancy level shall be displayed as color bars on the map. Intersection phase status (green, yellow, and red) shall be displayed in real-time using arrow icons. Link status shall be shown as green for free flow or near free flow conditions. Yellow shall be shown for moderate congestion or transition conditions. Red shall be shown for congested conditions, and flashing red shall be used to indicate severe congestion or major delays. The control section display shall be capable of being dynamically sized by a workstation user. Resizing the window shall not reduce the amount of data displayed on a workstation monitor, and the same aspect ratio shall be monitored as before the resizing. The control section map graphic shall include a user-definable control section map title. North shall either be at the top or right side of the monitor when displaying a control sub-area. Vertical and horizontal scroll bars may be provided if the size of the sub-area is such that it cannot be displayed on a monitor at a scale (as determined by the Engineer) that is adequate for viewing by the operator. The Engineer will provide to the Contractor the final control sections boundaries for each control section display to be developed by the Contractor. There will be a maximum of 30 Control Section Map displays.

B.17.3. Intersection Display

The intersection graphic shall display both static and dynamic information. The static information shall include the geometrics of the intersection (including a graphic display of the number of lanes and their associated use), adjacent land use, approaching and departing intersection

leg road names, the location of the controller, and a layout of the intersection with the intersections signal inventory number and name. The dynamic information to be displayed shall include:

- All vehicle signal indications for each active phase and up to four (4) overlaps with red, yellow, and green indicators.
- All pedestrian signal indications for a minimum of four (4) active phases. WALK, flashing DON'T WALK, and steady DON'T WALK shall be shown.
- Vehicle and pedestrian detector actuations for each active phase.
- Cycle countdown.
- Timing plan in effect (with cycle length and offset).
- Split timer.
- Status of up to four (4) special functions.
- Operational status of the intersection (in coordination [TOD or TR], in transition, free operation, flash, preemption [railroad or emergency vehicle], local manual control, or failed).
- The actuation status of up to sixteen (16) local intersection detector inputs.
- The actuation status of a minimum of eight (8) system detector inputs.
- Status information from the signal monitor.

The intersection display shall accurately reflect real-world conditions at the intersection including actual intersection geometry, actual number and arrangement of lanes, actual number and location of loop detectors, actual number and location of signal heads, and other intersection features.

The intersection display shall accommodate all standard NEMA phasings as well as those that can be produced by the phase sequences shown in Figures 1, 2, and 3 in this section

The dynamic information shall be updated in real-time in accordance with the once-per-second monitor messages. By means of a window box or similar technique, the operator shall be able to select to return to the previous displays.

The intersection display shall provide a user the same information (in a similar format) that is available at the front panel of the controller. The intersection display shall be capable of being dynamically sized by a workstation user. Resizing the window shall not reduce the amount of data displayed on a workstation monitor, and the same aspect ratio shall be maintained as before the

resizing.

All text data shall be displayed in traffic engineering terms. Mnemonics, as defined in **Section 30.2.B.15.8** will be acceptable; however, the need for reference guides and manuals shall not be acceptable. All information shall be shown simultaneously and continuously displayed until canceled by the operator. Displays shall not affect system operation. All displays shall have a maximum one-second resolution.

The GUI shall provide interactive mechanisms to assist in creating, editing, and modifying dynamic graphic screens that are linked to system dynamic elements.

Intersection graphics screens created for one intersection may be copied to serve as the starting point for creating a new intersection graphics screen.

These dynamic condition maps shall provide a simple mechanism for system navigation, presentation of status, and selections within the user interface. Multiple, dynamic traffic condition views shall be supported simultaneously on the desktop.

The user shall be able to create a new window by clicking the appropriate button in the toolbar. Traffic condition graphical displays shall contain multiple levels of background images.

Backgrounds for the system-wide graphic control sections, and intersections shall be capable of containing commercial vector images of geographically accurate maps or scanned images. These images shall be compatible with BMP or images developed in AutoCAD (DXF), common paint/drawing programs, common GIS packages such as ArcGIS and MAPINFO, and other packages that allow export of drawings in vector and/or bitmap form. These images shall be used as the display layers of real-time graphics displays.

Zooming, scrolling, and automatic control layers of graphic presentations shall be included with the system.

B.18. Reports

Submit examples of all reports to the Engineer for approval prior to implementation.

The system shall generate each of the following reports. In all reports that include phase numbers at a specific intersection, the phase numbers shall be accompanied by an abbreviation (e.g., NB LT, WB TH, etc.) to indicate the directional orientation of that phase. In addition to the reports described in the following sections, the database software shall permit the operator to use structured query language (SQL) to retrieve data and develop custom reports. The user shall be able to define the format of those reports. Provide any third party software license to the Department and the City of

Gastonia for any software that may be used. Example: report-configuring, diagnostic, or monitoring software. License should be provided for all workstations and laptops.

B.18.1. Computation of Measures of Effectiveness

Measures of Effectiveness (MOE) reports shall permit the operator to gauge the effectiveness of the system's operation. The MOEs that shall be included in this system are as follows:

- Smoothed volume (VPH)
- Smoothed occupancy (%)
- Smoothed queue estimates
- Smoothed stops
- Smoothed delay

B.18.2. Detector History Report

Each detector shall have its historical volume and occupancy data stored at the central computer for specific periods of time for usage during times that the detector is failed. These data may be manually inputted during the initial implementation of the system and shall be dynamically updated by the traffic signal system software on an on-going basis through the use of an appropriate data smoothing algorithm. The detector history files shall be comprised of data points stored in 15-minute increments. The software shall allow the user to generate user-defined custom reports by querying the stored information.

B.18.3. Detector Analysis Report

Past detector performance shall be summarized in this report. The operator shall be able to specify the period of time over which the summarization is to take place. The operator may specify a detector, all the detectors at a location, all the detectors in a section, or all of the detectors in the system. Volume, occupancy, speed, queue, stops, and delay shall be included in the report.

B.18.4. Traffic Performance Summary Report

Current detector performance shall be summarized in this report. The time period over which the summarization is to take place shall be user-defined. The operator may specify a detector, all the detectors at a location, all the detectors in a section, or all of the detectors in the system. Volume, occupancy, speed, queue, stops, and delay shall be included in the report.

B.18.5. Split Monitor Report

The split monitor report shall record, in real-time, the time allocated to each controller phase or

interval. The controller or controllers to be monitored and the period of time over which the monitoring is to take place shall be user-defined. The report shall take the form of a table, graph, or time-space diagram.

It shall also be possible to generate this report based upon data stored in the database.

B.18.6. System Status Report

The system status report shall list the desired and actual modes of operation, the timing plan number in effect, the number of controllers and detectors declared failed, and the time and date of the report, as a minimum. A system status report shall be callable by control section or by total system. A system status report shall be scheduled by time-of-day and may be requested by the operator.

B.18.7. Intersection Operation Report

The operator shall request this report by system intersection number. The report shall include the intersecting street names, as well as the pertinent intersection data such as: timing plan and associated TOD/DOW/DOY, the control section number to which the intersection has been assigned, the intersection offset, cycle length, on-line or off-line status, interval data such as phase designations, fixed or variable interval, and nominal and minimal time durations. Intersection-assignable detector data, including phase, direction, volume, occupancy, speed, queue, stops, and delay shall also be included as appropriate to the system design and intention.

B.18.8. Time-of-Day Plan Schedule Report

The time-of-day plan schedule report shall record the current time-of-day, day-of-week command assignments for each section within the system.

B.18.9. Intersection Status Report

The software shall provide for a user-defined intersection status report for an individual intersection, all of the intersections within a section, or all of the intersections in the system. This report shall indicate the intersection status (on-line, off-line, critical intersection control, failed), control mode (time-of-day, traffic responsive, free operation) cycle length, timing plan number imposed, controller type (pre-timed, actuated), etc.

B.18.10. Detector Status Report

The detector status report shall record the status of all detectors in the system. The following criteria shall be user assignable to the evaluation of detector performance: acceptable detector data, software-determined marginal detector data, software-test-determined failed detectors, and operator-declared off-line detector status.

B.18.11. Failure Status Report

The failure status report shall record the frequency and number of controller, detector, and communication failures. Such a report shall list the status change in the individual equipment by time and condition, as well as by the number of failures and the mean time between failures.

B.18.12. System Operations Summary Reports

Summary reports shall present historical records of system operations. These reports shall be "end-of-day" reports programmed to be outputted at midnight. To minimize paper wastage, an option shall be included to selectively omit any or all of these reports and/or to direct them to hard disk.

The summary reports shall include the following:

- Equipment failure listings ordered by equipment type, equipment serial number, and time of failure.
- Vehicular flow reports by section number and detector number within the section. The contents of these reports shall include volume, occupancy, and speed and may include estimated stops and delays.
- System activity logs containing listings, by time-of-day, of all operator and system scheduled events. Nonscheduled events such as power failures and resultant system recoveries, preemption events, cabinet intrusions, etc. shall also be recorded.

B.19. System Detector Count Files

The system shall provide the following functions for collecting and processing system detector count data:

Upon request from the operator, the system shall record in disk files raw traffic volume data from the system detectors. In building the system detector count file(s), the system shall allow the operator to select the complement of system detectors to be logged. This selection shall also be possible by means of the scheduler. The method of polling and storing the count data shall ensure that no data is duplicated in the file and that no data is lost.

Software shall be provided that will enable the operator to process the system detector count files into ASCII files with the format as approved by the Engineer. The software to create these files shall allow the user to assign file names to the files created.

B.20. Approval of Report Formats

The formats of all reports shall be submitted to the Engineer for approval.

B.21. Screen Development

There shall be, either internal or external to the distributed processing software, a means to develop new, modify existing, and copy screen displays.

The city map to be shown on the system-wide display shall be a raster based image that is a total and complete representation of the City of Gastonia and surrounding areas included in the Plans. This map shall be subject to review and approval by the Engineer.

B.22. Software for Intersection Graphics Development

The system or stand-alone software furnished as part of the system but operating off-line shall permit the operator to draw the intersections and control sections using a mouse or a digitizer and to scan and then modify both drawings and aerial photographs. Additionally, preprogrammed graphics shall be provided that can easily be adapted to the intersections by the operator. Such software shall enable the operator to import files in the following formats: DXF, DGN, BMP, PIF, PIC, PCX, CDR, CGM, WMF, and DWG. Such preprogrammed graphics shall accommodate a minimum of cross-type intersections and T-type intersections with user adjustment of number of lanes per direction.

B.23. Display of Timing Plans in Graphic Format (Network)

Splits and offsets shall be displayed in a graphical format to facilitate the fine tuning of timing plans.

The software shall also include a program that shall run in stand-alone or background mode to access the system database and output time-space diagrams of stored timing plans for selected intersections. Provisions shall be included in the program to output these diagrams to a networked printer.

B.24. Object Linking and Embedding

The system software shall support Microsoft Object Linking and Embedding (OLE) capabilities. The ability to "drag and drop" and "cut and paste" operations between various window applications running on the workstation shall be provided.

B.25. Help Screens

The signal system software shall have comprehensive, on-line help screens. The help screens shall be specific to the screen displayed. Hypertext links shall be used to allow a user to obtain help on related information.

C. CCTV Control Software

Furnish a network-ready, client-server CCTV control software package that operates over the LAN. The software shall be integrated into the signal systems software.

Furnish CCTV central control software that allows the user to:

- Select CCTV field units
- Control selected CCTV units via software based graphical controls and, for workstations so equipped, a fully functional CCTV control keypad
- Assign field CCTV images and component device output (e.g. DVR) to monitors, workstation video capture cards, and component device inputs

At the user's discretion, either a control panel (joystick) or graphical user interface may be used for CCTV control functions.

C.1. Operator Access Privileges

Provide up to 36 unique operator identification passwords. Operator privileges shall be definable by the system administrator. At a minimum, the following privileges shall be definable (yes/no) for each operator:

- Video switch control
- Pan, tilt, zoom camera control
- Programming control
- DVR control

In addition, the software shall allow these privileges to be assigned by TOD/DOW/DOY.

C.2. Programming Control

Provide user-defined programming of up to 100 timed events. Provide the user with the option to associate an alphanumeric name with each event. Provide 7-day, 24-hour programming ability. At a minimum, programmed events shall include:

- Video switch, and camera to any monitor (including remote monitors)
- Command pan/tilt unit to a defined pre-set
- Initiate a video tour
- Activate (or deactivate) a relay to turn the DVR on or off

The software shall allow for up to four (4) events to be initiated per timed event.

The software shall permit the manual override of the scheduled events.

C.3. Graphical User Interface

The graphical user interface (GUI) shall provide a graphic of the overall project area with icons representing camera locations. This graphic shall be identical to the map used for the signal system software. Selecting an icon will provide the user with camera control, unless the camera is in use by another user. If the selected camera is in use by another user, a message identifying the current user shall be displayed. In addition, a display showing the camera's current user defined preset position will be shown. At the operator's discretion, the GUI or the camera control panel (joystick) may be used to control all camera functions.

C.4. Video Switch

Clicking on an icon in the CCTV control software shall produce a scrollable, drop-down list that contains the name of all video outputs (such as monitors, DVR, CODEC, etc.) that are connected to the video switch. A subsequent click on the appropriate video output name shall select the device on which the video is to be displayed or transmitted. Output devices presently in use shall not be available for use until they have been de-selected.

D. Local Controller Software

Local controller software shall be the latest version of the NCDOT approved controller software or approved equivalent. The Engineer will furnish the latest version of the software at the time of installation.

Local controller software provided by the Engineer, or furnished from other sources, shall be compatible with all cabinet and controller equipment furnished under this project.

E. Other Software

E.1. Signal Timing Software

Furnish Synchro Plus SimTraffic, version 6 (or latest version that is compatible with the computer operating system provided on the computer workstations furnished under this project) as offered by Trafficware Corporation.

Furnish TS/PP-Draft, version 6.0 (or latest version that is compatible with the computer operating system provided on the computer workstations furnished under this project) as offered by any authorized distributor.

Furnish two (2) Garmin eTrex Legend GPS Receivers, or approved equivalent, with Cigarette

Lighter Adapters (#010-10203-00) for each receiver. The GPS receivers shall be considered necessary accessories and incidental to furnishing the TS/PP-Draft software.

Furnish all signal timing software that is installed on all workstation and notebook computers. Include a complete user's manual and original installation disks or CD-ROMs for each software package. Provide full technical and maintenance support for all software.

E.2. Productivity Software

Furnish a network version of the latest release of the Microsoft Office Suite, Professional Edition, including Excel, Access, Word, and PowerPoint. A license shall be provided for each workstation and notebook furnished with the project. Furnish and install a copy of the latest release of Microsoft Office Suite, Professional Edition, on each workstation and notebook computer furnished.

E.3. Utility Software

Furnish utility software for uploading and downloading timing plans locally at the signal cabinet. Furnish software that is compatible with local controller software and signal system central software. Furnish software with printing functionality.

30.3. INSTALLATION AND TESTING

A. General

Install and fully integrate distributed processing signal system software on Distributed Processing Signal System server called for in **Section 31** of these Project Special Provisions. Install and fully integrate distributed processing signal system software on each workstation and notebook computer in the City of Gastonia signal system.

Install and fully integrate distributed processing signal system software on Distributed Processing Signal System Communications server called for in **Section 31** of these Project Special Provisions as required.

Install and fully integrate CCTV central software on CCTV server called for in **Section 31** of these Project Special Provisions as required.

Install all software furnished for the system in accordance with the procedures recommended by the software supplier.

Install a copy of the distributed processing traffic signal system software and all communications software necessary to achieve dial-up, remote operations on the notebook computers.

Register all software products furnished with this project with the software supplier. The City of

Gastonia Traffic Services and the NCDOT shall be identified as the registered owner of all software.

A.1. Operating System

Install and integrate the operating system and all necessary utilities.

B. Distributed Processing Signal System Software

Install and integrate the distributed processing traffic control applications software and all other software with the communications system and local controllers to provide a traffic signal system that provides the functionality required by these Project Special Provisions. A Windows Server 2003 based installation program shall be provided for installing the software on the file server. Provide a separate Windows XP based installation program for installing the client software on workstations.

Load all parameters necessary to implement coordinated signal operations. The Engineer will furnish the timing parameters in standard traffic engineering format (cycle, split, and offset) prior to the initiation of the 90-day observation period. Make any modifications to the cycle, split, and offset information furnished by the Engineer that are necessary to implement the timing plans into the system database. The test period may not begin until the timing parameters have been loaded. The Engineer may, at his/her option, observe the loading of the timing plans.

As directed by the Engineer, make modifications to the coordinated signal timing parameters (cycle, split and offset) prior to system acceptance to improve system coordination and efficiency. The Engineer will furnish the parameters to be modified by the Contractor. Make these modifications at no additional cost. No timing plan changes will be required after the successful completion of the system operational test (as approved by the Engineer).

Prepare comprehensive, detailed graphic displays for the system display, for all control section displays, and for all intersection displays.

Submit specific landmarks and features to be displayed in the section and intersection displays to the Engineer for approval. Develop each screen upon approval of the areas to be displayed by each screen and make revisions as required from review.

Provide training to City and Department personnel relative to the creation and editing of the sub-area and intersection displays as required in these Project Special Provisions.

C. CCTV Control Software

Install and integrate the CCTV control software with the field hardware. Install CCTV control software onto CCTV server. Install CCTV client software onto workstations and notebook computers at the TOC, ROC, MRTMC, and Division 12 Office.

D. Local Controller Software

Install NCDOT approved local controller software on all new controllers. Use the latest version available at the time of installation as directed by the Engineer.

At locations where 2070 controllers are existing, and will not be replaced under this project, upgrade the local controller software to the current version of the NCDOT approved software being installed in new controllers under this project. All controllers in the final Gastonia Signal System shall have identical local software.

E. Other Software

Install the signal timing software, productivity software, and utility software on all workstations and notebook computers provided with the project.

F. Testing

F.1. General

Provide the following tests and demonstration of the system software:

- System Demonstration Test
- System Operational Test (as called for in **Section 39**)
- 90-Day Observation Period (as called for in **Section 1** and **Section 39**)

F.2. System Demonstration

Within one-hundred (100) calendar days after award of the contract, demonstrate ability to provide a working traffic control system that will be in general accordance with these Project Special Provisions. This shall be accomplished by conducting a demonstration of the major elements of the traffic control software at an existing, operational traffic signal system somewhere within the United States or Canada, excluding Alaska and Hawaii.

The demonstration shall take place at an actual, operating traffic signal system that features software developed and furnished by the same vendor proposed by the Contractor for this project. The candidate demonstration system shall have actual functional performance that is similar to, or better than the system required by these Project Special Provisions. A minimum of thirty (30) days prior to this demonstration, the Contractor shall submit to the Engineer a detailed description of the features provided by the candidate demonstration system and a narrative discussion of how that system differs from the functionality required by these Project Special Provisions. The Engineer shall be the sole judge as to whether or not the candidate demonstration system is sufficiently similar to the one required for the Gastonia System. All transportation, lodging and per diem costs for

NCDOT and City personnel to witness the system demonstration will be borne by NCDOT or the City.

30.4. METHOD OF MEASUREMENT

Lump sum for the distributed processing signal system software. This shall include the furnishing, installation, testing, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to install the software, complete system integration, and provide a complete operating system. Partial payment for this item will be made as follows: 50% of the lump sum price upon delivery and installation of the software and 50% of the lump sum price upon successful completion of the Observation Period. No payment will be made for providing software license and source code as required in these Project Special Provisions.

Lump sum for the software required for the CCTV camera control. This shall include the furnishing, installation, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to install the software, complete system integration, and provide a complete operating system. Partial payment for this item will be made as follows: 50% of the lump sum price upon delivery and installation of the software and 50% of the lump sum price upon successful completion of the Observation Period. No payment will be made for providing software license and source code as required in these Project Special Provisions.

Lump sum for the signal timing and productivity software. This shall include the furnishing, installation, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to install and configure the software and provide a complete operating system. Payment for this item will be made as follows: 100% of the lump sum price upon delivery, installation and testing of the software into the appropriate hardware. GPS receivers for the TS/PP-Draft software will not be paid for separately but will be considered incidental. No payment will be made for providing software license and source code as required in these Project Special Provisions.

All other software and hardware otherwise required to accomplish the functionality required by the Project Special Provisions will not be paid for separately but will be considered incidental. No payment will be made for providing software license and source code as required in these Project Special Provisions.

Testing will not be paid for separately but will be considered incidental to equipment installation.

30.5. BASIS OF PAYMENT

The software for the distributed processing signal system, measured as provided above, will be paid for at the contract lump sum price for "Signal System Software."

The software required for CCTV camera control, measured as provided above, will be paid for at the contract lump sum price for "CCTV Central Software."

The signal timing and productivity software, measured as provided above, will be paid for at the contract lump sum price for "System Support Software."

Payment will be made under:

Signal System Software ..... Lump Sum

CCTV Central Software ..... Lump Sum

System Support Software ..... Lump Sum

31. COMPUTER HARDWARE AND PERIPHERALS

31.1. DESCRIPTION

Furnish and install server computers, workstation computers, laptop computers, and peripheral equipment in the TOC at the Municipal Operations Center and the ROC at the Garland Center with all software and hardware to provide fully operational computing platforms and systems to accomplish the operational requirements of the computerized signal system.

Furnish and install the video server and video subsystem components as detailed in **Section 33** of these Project Special Provisions.

Install all computer hardware and peripherals as shown in the Block Diagram contained in the Plans.

31.2. MATERIALS

A. General

Furnish hardware that operates at 115 VAC ± 10 percent at 60 Hz. Furnish hardware that operates in a +40 to +122 degree Fahrenheit environment at 20 to 80 percent relative humidity.

All workstations, laptop computers, and servers shall be from the same manufacturer. Servers and workstations that use proprietary power supplies will not be accepted.

B. Surge Suppression Strips

Provide surge suppression power strips with an illuminating on/off switch, isolating filter banks, a minimum of six 120 VAC, 60 HZ outlets, and a minimum of 808 Joules.

C. Applications Servers

C.1. General

Furnish all software licenses, diskettes, compact discs, manuals, and documentation for all software installed on computers furnished under this project.

C.2. Distributed Processing Signal System Server

Furnish Distributed Processing Signal System server (herein referred to as the "Signal System Server") to host the signal system central software on a client/server environment over the City of Gastonia Signal System LAN.

C.2.1. Features

Furnish Signal System Server computer with the following minimum features:

- Clock speed of 2400 megahertz (minimum),
- Dual processor support
- 1 GB of RAM expandable to 4 GB of RAM
- SVGA video card with 64 MB of video memory, 64-bit graphics chip, with display resolutions up to 1600 x 1200,
- Keyboard and pointing input devices
- Rack mountable in standard EIA 19" equipment rack (maximum 3 RU)
- Minimum 2 PCI expansion slots
- Minimum 2 Universal Serial Bus Ports
- One (minimum) EIA 232/EIA 422 serial port
- Intel Pentium IV processor, or approved equivalent,
- Operating system: Windows Server 2003 or approved equivalent,
- Minimum 160 GB hard drive
- 3.5-inch, 1.44 MB floppy drive,
- 4X DVD+R/+RW and 24X CD-ROM drives
- Provide Network Ethernet Interface 10Base TX/100BaseTX (10 Mb/s, 100 Mb/s, 1000 Mb/s Ethernet) RJ-45 connection and all software and hardware required for interface with the City of Gastonia Signal System LAN. Furnish network interface card that complies with IEEE 802.3
- Provide modem with 1,200 baud through 56,000 bps raw throughput for data and 14,400 bps raw throughput for fax with RJ-11 connector and that comply with the following:
    - Data Compatibility: V.34, V.FC, V.32, V.32bis, V.22, V.22bis, V.90, V.92
    - Fax Compatibility: V.17, V.29, V.27ter
    - Error Control: V.42/MNP 2-4 (hardware based)
    - Data Compression: V.42bis/MNP 5 (hardware based)

C.3. Distributed Processing Signal System Communications Server

Furnish a Distributed Processing Signal System Communications Server (herein referred to as the "Communications Server"). Furnish Communications Server that is equipped with all hardware

and software required for the Distributed System Software to meet all of the data communications requirements discussed in **Section 30** of these Project Special Provisions, including once-per-second polling of all traffic signal controllers.

Furnish Communications Server that has the same features as the Signal System Server as well as those that follow.

Furnish Communications Server that is rack mountable in standard EIA 19" equipment rack.

Furnish sever that is expandable to 64 port through addition of PCI 16 port expansion modules or through use of USB port-based modules.

Furnish serial port expansion modules that have the following features:

- PCI or USB compatible
- Provide minimum data transfer rates of 38.4 Kbps to all ports at all times
- Support data transfer rates up to 115.2 Kbps
- Contain 16 EIA-232 asynchronous serial ports: with DB-25 connectors or connectors as approved by the Engineer
- Support full modem control and full hardware hand-shaking (CTS, RTS, DSR, DTR and DCD) on all channels
- Can be configured using the server operating system and sever applications that support the use of configured serial ports

Furnish an initial two expansion modules (for a total of 32 serial ports) to mate with communications channel central fiber optic transceivers.

C.4. CCTV Video Server

Furnish a Video Server to process video from and control CCTV cameras in the field. Furnish video server that has the same features as the Signal System Server as well as those that follow.

- Rack mountable in standard EIA 19" equipment rack.
- Video capture card capable of digitizing and displaying full color, full motion (30 frames per second) composite (NTSC/PAL) video in real time. The video card resolution shall be a minimum 640x480 for NTSC and 704x476 for PAL. The video card shall come with all drivers and accessories required for operation. The capture card shall be PCI or USB compatible.

- 19-inch LCD monitor, minimum 1280x1024 native resolution, minimum contrast ratio of 500:1, 0.294 mm pixel pitch or better, VGA and SVGA compatible.

C.5. Remote Access Server

Furnish Remote Access Server to host remote access software and allow up to eight simultaneous users to access all services on the LAN via dial-up modem, ISDN connection, fractional or full T-1 connection, DSL connection, Cable modem connection, or full bandwidth Ethernet connection. Furnish minimum six client licenses of remote access software compatible with notebook computers to be installed under this project.

C.5.1. Features

Furnish Remote Access Server with same features as the Signal System Server with the following exceptions:

- five (minimum) EIA 232/EIA 422 serial ports
- Do not furnish unit with external port expansion module

Furnish remote access server with remote access software with the following features:

- Support of up to 8 simultaneous users initially with expansion capability of up to 12 simultaneous users
- Provision of each user with a Windows desktop with access to all applications and services on the TOC LAN at their remote location. When logged into remote access server, upon providing username and password, remote user shall be provided with a Windows desktop on their remote computer.
- Client software that is fully functional on all versions of MS Windows 95 or higher
- Allows remote user to access all drives on servers on the LAN and transfer files between their remote station and server on the LAN through windows file access methods such as Windows Explorer
- Supports remote user automatic reconnection if communication connection is lost
- Supports use of client remote access configuration by means of standard windows, menu driven interface.
- Shall support all services available over the LAN (including printers, KVM switch, and servers)
- Shall require no more than 64 Mb of RAM to support each user

- Provide security and user authentication features and functionality
- Utilize Windows XP Remote Desktop functionality or approved equal.

Furnish server with all required operating system and third party support software to fully operate remote access server.

D. Keyboard Video Mouse Switch

Furnish Keyboard-Video-Mouse (KVM) switch that allows a single keyboard, mouse, and RGB monitor to access and switch between multiple application servers in the TOC rack cabinet. Furnish KVM switch unit that has the following features:

- Rack mountable with a maximum height of 1.75 inches
- Control of a minimum of 8 servers using a single unit
- Multiple switching methods including front panel, keyboard, or on-screen display
- Compatible with servers furnished under this project
- Compatible with keyboard, monitor, and pointing device supplied with rack cabinets under this project

Furnish all necessary cabling to integrate KVM switch.

E. Computer Workstations

E.1. Single Monitor Computer Workstations

Provide single monitor workstation computer with Windows XP operating system with the following minimum features:

- 19-inch LCD flat panel monitor,
- 3 monitor outputs,
- processor clock speed 3.0 GHz,
- 512 MB of RAM expandable to 16 GB of RAM,
- SXGA video card,
- keyboard and pointing input devices,
- tower chassis,
- 160 GB hard drive,
- 3.5-inch, 1.44 MB floppy drive,

- CD-RW and DVD-ROM drives,
- one RS 232 serial port,
- one parallel port,
- two USB ports,
- Network Ethernet Interface 100BaseTX (100 Mb/s Ethernet) RJ-45 connection and all software and hardware required for interface with the Division's computer network,
- modem with 56,000 bps for data and 14,400 bps for fax with RJ-11 connector.

Provide modems that comply with the following:

- Data Compatibility: V.34, V.FC, V.32, V.32bis, V.22, V.22bis, V.90, V.92
- Fax Compatibility: V.17, V.29, V.27ter
- Error Control and Data Compression: V.42/MNP 2-4 error control (hardware based), V.42bis/MNP 5 data compression (hardware based)
- Ethernet: IEEE 802.3

E.2. Dual Monitor Computer Workstations

Provide dual monitor workstation computer that meets all of the minimum requirements listed above for a single monitor workstation.

Provide two (2) 19-inch LCD flat panel monitors and dual monitor card and all required cables with computer workstation.

F. Notebook Computers

Provide notebook computers with Windows XP operating system with the following minimum features:

- Processor clock speed 2.4 GHz,
- 512 MB of RAM expandable to 16 GB of RAM,
- 15 inch TFT display,
- 120 GB hard disk,
- one diskette drive that will accept 3.5-inch, 1.44 MB diskettes (internal or external),
- one internal CD-RW,
- one DVD-ROM drive (internal or external)

- one parallel port,
- one RS-232 serial port,
- one USB port
- AC adapter/charger, and a car cigarette lighter adapter cable,
- fully charged battery capable of a minimum of 2 hours of continuous operation,
- one spare battery,
- sound card with built in speakers,
- full function keyboard,
- pointing device that is integral to the case (clip on devices will not be acceptable),
- one cable 10 feet long for connection to a controller port,
- one cable 10 feet long for connection to network port on the workstation computer,
- video capture card capable of digitizing and displaying full motion composite (NTSC/PAL) video in real time, or external device capable of digitizing.
- full screen source editing features,
- one on board modem that provides 56,600 bps for data and 14,400 bps for fax with RJ11 connector,
- 100Base TX (100 Mb/s Ethernet) with RJ-45 connector on board,
- IEEE 802.11g wireless network adapter card
- cushioned, soft-side carrying case.

Provide modems that comply with the following:

- Data Compatibility: V.34, V.FC, V.32, V.32bis, V.22, V.22bis, V.90, V.92
- Fax Compatibility: V.17, V.29, V.27ter
- Error Control and Data Compression: V.42/MNP 2-4 error control (hardware based), V.42bis/MNP 5 data compression (hardware based)
- Ethernet: IEEE 802.3

G. Printer

Furnish color laser printers with the following features:

- Utilizes the PCL 6 printer language featuring commands for fully integrated HP-GL/2 vector graphics and advanced imagery/special effects printing with a minimum of 80 internal, scaleable fonts.
- Utilizes the latest version of Windows print typefaces.
- Provides a minimum of 16 MB of RAM.
- Provides modular input/output (I/O) and Ethernet 10/100 Base-T network communications protocols.
- Comes equipped with an Ethernet 10/100 Base-T network interface card and an RS-232 serial (9-pin) interface, bi-directional IEEE 1284 ECP-compliant parallel interface, and one (1) open EIO expansion slot.
- Prints a minimum 17 pages per minute (ppm) for both color and black and white prints.
- Provides 1,100 sheet capacity and 3 input trays supporting 8.5 x 11 inch, 8.5 x 14 inch, and 11 x 17 inch media.

H. GPS Antenna

Furnish global positioning system (GPS) antenna for precise timing and synchronization applications. Furnish GPS antenna with the following minimum features:

- GPS receiver and antenna in a single environmentally sealed enclosure
- Generates a pulse-per-second (PPS) output synchronized to UTC within 50 nanoseconds (one sigma), outputting a time tag for each pulse
- RS-422/485 communications

Furnish the following accessories with the GPS antenna. These items are considered incidental to furnishing, installing, and integrating the GPS antenna.

- Mounting pole with standard 1"-14 straight thread
- RS-422 Interface cable of sufficient length (but not greater than 400 feet) to route from GPS antenna to server, including all required connectors and adapters
- RS-422 to RS-232 converter, including all cables to connect with server
- Windows-based software program for monitoring GPS operations and communications
- DC Power supply

Furnish GPS antenna that is Trimble Acutime 2000 model or approved equivalent.

31.3. CONSTRUCTION METHODS

A. General

Furnish and install the central hardware required to support the software functions called for in **Section 30** of these Project Special Provisions.

Furnish and install the hardware at the TOC and ROC as shown in the block diagram in the Plans.

B. Surge Suppression Strips

Furnish and install surge suppression power strips for all computer hardware and peripherals, video subsystem, local area network, and central communications equipment not connected to a UPS.

C. Applications Servers

C.1. Distributed Processing Signal Server

Install distributed processing signal system server into equipment rack cabinet at TOC as shown in the Plans. Integrate with LAN switch, KVM switch, and UPS. Integrate with signal system communications server using direct serial, parallel, USB, or network connection. Fully configure server to operate distributed system processing software.

C.2. Signal System Communications Server

Install signal system communications server into equipment rack at TOC as shown in the Plans. Integrate with LAN switch, KVM switch, and UPS. Integrate with distributed processing signal server using a direct serial, parallel, USB, or network connection. Integrate with fiber optic communications system using serial communications ports and fiber optic transceivers. Fully configure server and ports to facilitate signal system communications.

C.3. CCTV Video Server

Install video server into equipment rack at TOC as shown in the Plans. Integrate with LAN switch, KVM switch, and UPS. Integrate with video matrix switch and digital video recorder (DVR).

C.4. Remote Access Server

Install remote access server into LAN equipment rack cabinet at the TOC. Integrate with LAN switch, KVM switch, UPS, and the existing City of Gastonia firewall. Coordinate with Engineer to determine available firewall ports.

Install and configure software with usernames, passwords, and Remote Access Windows desktop

that allows client user gaining access to the LAN via the server, has complete access to all software applications on the LAN, available to a local user. Configure new notebook computers and up to two additional dial-up remote users as designated by the Engineer for remote dial-in access. Install all third party software and drivers required to create fully functional remote access server. Install all client software on new notebook computers and dial up remote workstations (as designated by the Engineer) required for operation of all software services available on the LAN.

D. Keyboard Video Mouse Switch

Install KVM switch into LAN equipment rack cabinet at the TOC. Integrate with application servers, LAN switch, microcomputer workstations on the LAN, and rack cabinet drawer monitor, keyboard, and mouse called for in **Section 34** of these Project Special Provisions.

E. Computer Workstations

Install two (2) single monitor computer workstations and one (1) dual monitor computer workstation in operator work centers at the TOC as shown in the Plans. Integrate with LAN switch, UPS, and KVM switch. Integrate monitor card with local monitor and large screen display system.

Install one (1) dual monitor computer workstation at the ROC. Integrate with LAN switch. Integrate monitor card with local monitor and video monitor.

Fully configure microcomputer workstations with all client software to operate all signal system subsystems including distributed processing signal system and CCTV subsystem.

F. Notebook Computers

Furnish four (4) notebook microcomputers. Deliver notebooks to the TOC prior to the start of the scheduled training. Fully configure notebook computers with all client software to operate all signal system and subsystems, including distributed processing signal system and the CCTV subsystem. Configure notebook computers with client version of local intersection software to enable direct connection of notebook computer to the local distributed processing intersections for upload, download, monitoring, and manipulation of local intersection controller databases. Fully configure notebook computers such that when plugged into a network outlet on the City of Gastonia Signal System LAN, the user is able to login to the system as though he/she were logging in from any other workstation on the LAN.

G. Printer

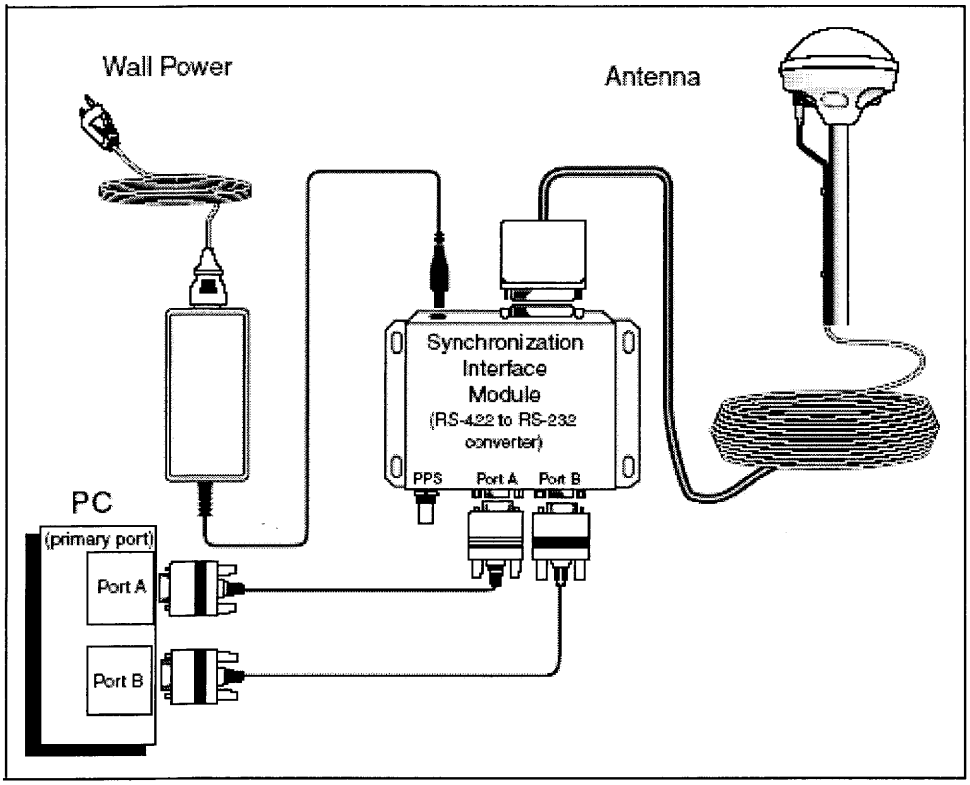
Install two (2) printers in the Municipal Operations Center building. Integrate with the LAN.

Install one (1) printer in the ROC.

H. GPS Antenna

Install GPS antenna on side of MOC building or other location approved by the Engineer. Mount antenna using method approved by the Engineer such that the antenna has an unobstructed view of the sky and is not within close proximity to other transmitting antennas such as radars, satellite communication equipment, and cellular communication equipment. Ensure that antenna is properly grounded in accordance with the Standard Specifications and the manufacturer's recommendations to insure all electronic components downstream of the antenna, including the synchronization interface module and the signal system computer hardware, are isolated from electrical transients and surges. Route interface cable from antenna to signal system server as shown in the Plans using methods approved by the Engineer.

Integrate GPS antenna with server such that the software can perform clock synchronization tasks. The following diagram details all of the required connections.



I. Computer Hardware Integration

Fully integrate computer hardware equipment to form complete and operational systems as called for in these Project Special Provisions and shown on the block diagram in the plans. Install

and configure all central computer hardware at the TOC and ROC to accomplish the functionality called for in these Project Special Provisions and hardware functionality required to support the computer software to be installed on to the computing hardware called for under this project. Integrate with LAN equipment and field equipment.

Prior to installing and configuring the computer hardware at each facility, develop a computer hardware architecture and system design document that shows the entire layout of the computer hardware systems and their interconnection. The function, description, and model number of each computer hardware component will be shown in the document. The report will describe the network topology in text and using graphics.

31.4. METHOD OF MEASUREMENT

Actual number of applications servers furnished, installed, integrated, and accepted.

Actual number of KVM switches furnished, installed, integrated, and accepted.

Actual number of microcomputer workstations furnished, installed, integrated, and accepted.

Actual number of notebook computers furnished, installed, integrated, and accepted.

Actual number of printers furnished, installed, integrated, and accepted.

Actual number of GPS antennas furnished, installed, integrated, and accepted. All required installation accessories, including but not limited to cables, converters, mounting equipment, power supply, and software, shall be considered incidental and will not be paid for separately.

Lump sum for computer hardware integration. This shall include the installation, testing, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to install and make fully operational the computer hardware equipment at the TOC and at the ROC.

All cabling required, sockets, port adapters, or other accessories required to configure, integrate, and interconnect computer equipment shall be considered incidental and shall not be paid for separately. This shall include provision of the surge suppression power strips and uninterrupted power supplies.

31.5. BASIS OF PAYMENT

The quantity of signal system distributed processing servers, measured as provided above, will be paid for at the contract unit price each for "Signal System Processing Server."

The quantity of signal system communication servers, measured as provided above, will be paid for at the contract unit price each for "Signal System Communications Server."

The quantity of CCTV video servers, measured as provided above, will be paid for at the contract unit price each for "CCTV Video Server."

The quantity of remote access servers, measured as provided above, will be paid for at the contract unit price each for "Remote Access Server."

The quantity of KVM switches, measured as provided above, will be paid for at the contract unit price each for "KVM Switch."

The quantity of single monitor computer workstations, measured as provided above, will be paid for at the contract unit price each for "Computer Workstation (1 Monitor)."

The quantity of dual monitor computer workstations, measured as provided above, will be paid for at the contract unit price each for "Computer Workstation (2 Monitor)."

The quantity of notebook computers, measured as provided above, will be paid for at the contract unit price each for "Notebook Computer."

The quantity of printers, measured as provided above, will be paid for at the contract unit price each for "Printer."

The quantity of GPS antennas, measured as provided above, will be paid for at the contract unit price each for "GPS Antenna."

The quantity of computer hardware integration, measured as provided above, will be paid for at the contract unit price lump sum for "Computer Hardware Integration." Partial payment for this item will be made as follows: 10% of the lump sum price upon completion of the Hardware Integration Architecture, 40% of the lump sum price upon delivery and installation of the computer hardware at the TOC and ROC, and 50% of the lump sum price upon successful completion of the Observation Period.

Payment will be made under:

Signal System Processing Server.....Each

Signal System Communications Server.....Each

CCTV Video Server.....Each

Remote Access Server.....Each

KVM Switch.....Each

Computer Workstation (1 Monitor).....Each

Computer Workstation (2 Monitor) ..... Each

Notebook Computer ..... Each

Printer ..... Each

GPS Antenna ..... Each

Computer Hardware Integration ..... Lump Sum

32. LOCAL AREA NETWORK

32.1. DESCRIPTION

Furnish, install, configure, and test a 10/100 Fast Ethernet local area network (LAN). Furnish LAN than interconnects central hardware including computer workstations, server computers, plotters, printers, and CCTV central equipment (including DVR, Video Matrix Switch, and large screen display devices). Furnish LAN connections as shown on the block diagram between equipment at the TOC and the ROC. Furnish a 10/100 Fast Ethernet LAN connection between the TOC and the MRTMC. LAN connections within the TOC and ROC shall be made with TIA/EI 568B Category 5E wiring.

32.2. MATERIALS

A. General

Furnish equipment for the LAN that complies with IEEE standard 802. Furnish Ethernet LAN switches and router manufactured by the same vendor and fully compatible and interoperable with the network monitoring software and network hardware operating system software.

Furnish network hardware that operates in a 32 to 122 degree Fahrenheit environment at 5 to 95 percent relative humidity. Furnish network hardware with that operates from at 115 VAC ±10 percent at 60 Hz power feeds.

B. Network Performance Management Software

Furnish network performance management and remote monitoring (RMON) software. Furnish the license(s) and additional copies of the software to allow it to be installed on all the notebook computers furnished with the project.

The software shall use a GUI to configure, manage, and monitor the local network. At a minimum, the software shall provide the following functions:

- Automatically detect all devices in the network and display them in a graphic map.
- Detect bottlenecks.
- Detect card failures.
- Detect switch failures.
- Detect router failures
- Detect hub failures.

- Detect cable failures.
- Provide network performance information.

In addition, furnish network management performance software that:

- Allows the configuration and backup of configurations currently running on the device
- Uses SNMP logging, paging and email alert capabilities.
- Support TFTP transfers
- Supports Secure SNMP Version 3 or latest approved equal that runs under Windows 2003, XP, NT, ME, or 98, or other approved operating system
- Supports full RMON-1 application, automatic baseline alarms, MIB expressions, email/pager event notification, advanced event actions, real time tabular/graphical displays, device specific applications, programming interfaces, optional WEB/Printed Reports, and recording of historical data to a log.
- Supports and implements full Cisco IOS Firewall feature set (latest release) including data encryption for data passing through a router.

C. Ethernet LAN Switches

Furnish LAN switches with the functionality and features described herein.

C.1. General

Provide a Managed Ethernet LAN switch connectivity point for networked hardware. LAN switch shall feature each of the following attributes:

- A switch fabric/back plane capable of providing maximum transmission bandwidth, simultaneously to the number of ports required.
- Be modular and expandable to accommodate additional ports up to 50% of the initial bandwidth.
- A 10 Base-T network management port and software that supports simple network management protocol (SNMP) Management Information Base (MIB) II, SNMP MIB extensions, bridging MIB (RFC 1493) and remote monitoring (RMON). This port shall allow a notebook computer with network management software to monitor traffic over all switched segments of the network.
- Fault-tolerant power supplies. Failed power supply shall be hot swappable. Only one power supply shall be required for operation. Failed power supply shall be automatically

detected and reported to the network management software.

- Be rack mountable in a standard 19" equipment rack.
- Power control switch
- Power on/off indicator

As a minimum, the front panel shall include the following per-port status LED indications:

- Link Integrity
- Disabled
- Activity
- Speed
- Full-Duplex

Use RJ-45 type connectors for all interface ports.

Furnish equipment that meets the IEEE standard 802.3. Furnish equipment manufactured by Cisco Systems unless otherwise approved by the Engineer.

Furnish LAN Switch with 120 VAC power and network management port for remote network management via IBM compatible PC.

C.2. LAN Switch (24-Port, Fiber)

Furnish LAN switch with a minimum of twenty four (24) 10/100 Ethernet ports and a minimum of two (2) fiber optic ports.

C.3. LAN Switch (4-Port)

Furnish LAN switch with a minimum of four (4) 10/100 Ethernet ports.

C.4. LAN Switch (4-Port, Fiber)

Furnish LAN switch with a minimum of four (4) 10/100 Ethernet ports and a minimum of two (2) fiber optic ports.

D. Wireless LAN Access Point

Furnish stand-alone wireless LAN access points to serve as a gateway between wireless devices such as notebook computers and the LAN switch in the TOC. Provide access points that support data rates up to 54 Mpbs and conform to the following wireless standards:

- IEEE 802.11g

- IEEE 802.11b
- IEEE 802.3
- IEEE 802.3u

Furnish access points with a minimum of one (1) 10/100 (MDI/MDI-X) auto-cross over port using RJ-45 cabling.

Furnish access points that conform to the following physical and environmental features:

Dimensions	maximum of 7.5 x 2.0 x 7.0 inches
Weight	maximum of 18 oz.
Power	external 12V DC
Operating Temperature	32 to 122 degrees F
Operating Humidity	10% to 80% non-condensing

Furnish access points that have the following security features installed and activated at the time of approval:

- Unique (non-default) SSID
- Disabled SSID broadcast
- Unique (non-default) password for administrative access
- Enabled MAC address filtering for TOC wireless devices
- Wi-Fi Protected Access (WPA) with dynamic 256-bit encryption key

Furnish access points that support event logging functions.

E. T1 Router

Furnish rack-mountable T1 routers with point-to-point VPN capability to serve as network gateway between the LAN at the City of Gastonia TOC and the MRTMC for traffic monitoring functions. Furnish modular router with minimum two (2) expansion ports. Furnish router with expansion modules that provide minimum two (2) 10BaseT/100BaseT Ethernet auto-sensing ports. Furnish router that can isolate LAN services at the TOC and the external LAN services at the MRTMC such that only network traffic required to provide remote access to the CCTV server at each facility from workstation computers at each facility is passed. Furnish router with LED or other approved indicators for the following functions:

- Transmit

- Receive
- Full duplex/collision
- Flow control
- Link
- Speed

Furnish router with RJ-45 type connector interface ports, maximum 1 RU height, and mountable in standard 19" equipment rack. Furnish equipment that meets the IEEE standard 802.3. Furnish equipment manufactured by Cisco Systems unless otherwise approved by the Engineer.

Furnish Router with 120 VAC power and network management port for remote network management via IBM compatible PC.

F. VPN Firewall

Furnish an Ethernet switch with integrated firewall and virtual private network (VPN) access functionalities in a single unit. Furnish unit with the following features:

- Four (4) Fast Ethernet (10/100 Mbps) ports
- Up to 60 Mbps of firewall throughput
- 3 Mbps of Triple Data Encryption Standard (3DES) VPN throughput
- 4.5 Mbps of Advanced Encryption Standard-128 (AES) VPN throughput

Provide user license to allow at least 10 concurrent remote users to access the signal system LAN.

G. Category 5E Cable and Wall Information Outlets

Furnish coaxial, Category 5E network cable, RS-232, monitor cabling, and all other cabling in the lengths required to interconnect devices as called for in the plans, specifications, and manufacturers requirements. Furnish quality and grade of cable capable of being operable at up to twice the distance installed on this project. Furnish cabling meeting all manufacturers' requirements and all applicable standards for performance and safety.

Furnish wall information outlets as required, with RG-45, RJ-11, BNC, or other connectors as required to terminate cabling in walls and floors for connection to devices and components.

H. LAN Patch Panel

Furnish LAN Patch Panels in the locations shown in the Plans. Patch panels shall be rack-

mounted.

Furnish patch panels that meet or exceed Category 5E transmission requirements of TIA/EIA-568A supporting bandwidths up to 100 MHz. Furnish patch panels that are UL-listed. Furnish patch panels that provide for rear punchdown termination of horizontal cables from the office workspaces, provide at least 48 ports and occupy no more than 2 RUs mounting height EIA standard 19" equipment rack. All ports shall provide 8-position modular jacks for jumper cables and they shall be accessible from the front of the patch panel. Jumper cables shall be neatly arranged using cable management guides or an approved equivalent.

32.3. CONSTRUCTION METHODS

A. LAN Integration

Fully integrate switches, routers, firewall, and external modems, with computer and central system hardware to form a complete local area network that allows users from the City of Gastonia TOC and ROC and NCDOT's MRTMC as shown on the block diagram in the Plans to access applications on application servers and the CCTV central hardware. Fully integrate network to allow the notebook computer users to be able to connect to the network via the LAN port or Card on the notebook computer using a network cable or via the wireless LAN access point.

Prior to installing and configuring the LAN, develop a LAN architecture and design document that shows the entire LAN topology, the bandwidth of the links, the IP addressing schema to be used, and the actual network hardware that will be used, listed by port number. The report will describe the network topology in text and using graphics.

Fully integrate LAN equipment to provide virus protection, user authentication, and security functions to prevent unauthorized users and data from entering the signal system LAN.

B. Ethernet LAN Switches

Install 24-port LAN switch into equipment rack cabinet in TOC as shown in the Plans. Integrate with UPS. Fully integrate with application servers, video matrix switch equipment, computer workstations, printer, and plotter. Fully configure switch with performance monitoring software and operating system software/firmware.

Install 4-port LAN switch at the ROC as shown in the Plans. Integrate with UPS. Fully integrate with computer workstation and video server. Fully configure switch with performance monitoring software and operating system software/firmware.

Install 4-port LAN switch with fiber optic ports in the communications closet at the Garland Municipal Business Center as shown in the Plans. Integrate with the UPS. Fully configure switch

with performance monitoring software and operating system software/firmware.

C. Wireless LAN Access Point

Install two (2) wireless LAN access points in the Traffic Services Building. Position the access points as directed by the Engineer to provide wireless LAN access coverage in the Signal Shop area and parking facilities. Integrate the access points with the 24-port Ethernet Switch in the TOC using Category 5E cabling as directed by the manufacturer. The access points shall be mounted on walls near the ceiling to provide adequate coverage areas.

D. T1 Router

Procure a leased T1 connection between the MRTMC and the TOC for traffic monitoring functions. The Engineer will provide authorization to the Contractor for T1 service to be obtained in the name of the Department and for the monthly T1 service bills to be sent directly from the utility company to the Department. The Department will be responsible for direct payment of monthly T1 service bills received from the utility company.

The T1 interface shall have the following characteristics:

- Transmit Bit Rate — 1.544 Mbps +/- 50 bps/32 PPM
- Receive Bit Rate — 1.544 Mbps +/- 50 bps/32 PPM
- Line Code — AMI, B8ZS
- AMI Ones Density — Enforced for N x 56 Kbps channels
- Framing Format — D4 (SF) and ESF
- Output level (LBO) — 0, -7.5, or -15 dB
- Input Level — +1 dB0 down to -24 dB0
- DTE Interface (WIC mode) — Fractional Service
- DTE Interface (VIC mode) — G.704/structured
- DCE Interface — G.704/structured

Perform work required to install one (1) T1 routers in the communications rack cabinet in the TOC and one (1) router in the communications rack at the MRTMC. All work performed at the MRTMC shall be approved by the Engineer prior to commencing any work at these locations. No access to the facilities shall be permitted without prior approval of the Engineer for each visit. Fully document all planned modifications and adjustments to MRTMC system hardware and software prior to beginning any work at these locations. Configure routers to allow City of Gastonia users to

view CCTV video streams from the MRTMC and to allow MRTMC users to view CCTV video streams from the City of Gastonia. Assign level of rights at a minimum below all NCDOT users. Integrate routers with the 24-port Ethernet Switch in the TOC to accomplish LAN to LAN connection between the TOC and the MRTMC.

E. VPN Firewall

Install one (1) VPN firewall switch at the TOC. Integrate with LAN switch at TOC to allow only authorized remote users to access the signal system LAN. Install VPN software as required on all notebook computers provided under this project.

F. Category 5E Cable and Wall Information Outlets

Route Category 5E network cabling in raised floors, drop ceilings, existing cable raceways, and locations approved by the Engineer at the TOC and ROC, to interconnect networked devices.

G. LAN Patch Panel

Install LAN patch panel into communications rack cabinet at the TOC. Integrate LAN cabling with patch panel and network devices.

32.4. METHOD OF MEASUREMENT

Actual number of Ethernet LAN switches furnished, installed, and accepted.

Actual number of wireless LAN access points furnished, installed, and accepted.

Actual number of T1 routers furnished, installed, and accepted.

Actual number of VPN firewalls furnished, installed, and accepted.

Lump sum for LAN integration including configuration and integration of LAN hardware, firmware, and software to complete the LAN architecture. Integration of the existing City of Gastonia firewall and integration of Internet based software applications with Gastonia's existing Internet connection infrastructure shall be incidental and not paid for separately.

The procurement of T1 circuits to remote facilities shall be incidental to the installation of the T1 routers and not paid for separately.

Payment for all cabling, adapters, sockets, and other hardware shall be considered incidental and no separate payment will be made.

32.5. BASIS OF PAYMENT

The quantity of Ethernet LAN switches of the type indicated, measured as provided above, will be paid for at the contract unit price each for "LAN Switch (_____)."

The quantity of wireless LAN access points, measured as provided above, will be paid for at the contract unit price each for "Wireless Access Point."

The quantity of T1 routers, measured as provided above, will be paid for at the contract unit price each for "T1 Router."

The quantity of VPN firewalls, measured as provided above, will be paid for at the contract unit price each for "VPN Firewall."

The quantity of LAN integration, measured as provided above, will be paid for at the contract unit price lump sum for "LAN Integration." Partial payments for this item will be made on the following schedule: 50% upon completion and acceptance of the LAN architecture and design document; installation, integration and acceptance of LAN equipment at the TOC, 20% upon installation, integration and acceptance of LAN equipment at the ROC, 10% upon installation, integration and acceptance of LAN equipment at the MRTMC, and 20% upon installation, integration and acceptance of the entire project.

Payment will be made under:

LAN Switch (24-Port, Fiber) ..... Each

LAN Switch (4-Port) ..... Each

LAN Switch (4-Port, Fiber) ..... Each

Wireless Access Point ..... Each

T1 Router ..... Each

VPN Firewall ..... Each

LAN Integration ..... Lump Sum

33. CENTRAL VIDEO EQUIPMENT

33.1. DESCRIPTION

Provide the central video hardware and software at the TOC necessary to control and monitor the closed circuit television (CCTV) cameras installed at locations shown in the Plans. The central video equipment shall include (but not be limited to) a video server and software, video transceivers, a video matrix switch, video monitors, camera control panels, and digital video recorder (DVR).

Provide the traffic monitoring equipment and software necessary at the ROC and MRTMC to allow users to control and view the video from the CCTV cameras located in the field. Control shall be over the LAN from any workstation connected to the LAN. Use broadband services provided by others to retransmit the video to the MRTMC for viewing at the site.

33.2. MATERIALS

A. General

All central video equipment shall operate at 115 VAC (+/- 10 percent) at 60 Hz (+/- 10 percent). The equipment shall operate in a +32 to +120 degree F environment at 20 to 80 percent relative humidity.

Control consoles, with an integrated joystick device, shall be furnished and installed in the TOC and the ROC. The console shall enable an operator to control, on a one-camera-at-a-time basis, using a joystick device, any connected remote camera's pan, tilt, zoom, and iris functions. Control of any connector camera's pan, tilt, zoom, and iris functions shall also be available through the system software. Pan, tilt, zoom, and iris functions shall be facilitated through the use of presets in the CCTV software.

B. Video Optical Transceiver with Control Data (VOTR-D)

The video optical transceiver with control data (VOTR-D) shall consist of a pair of electronic units referred to as the video optical transmitter with control data (VOT-D) and video optical receiver with control data (VOR-D). When interconnected by means of a single-mode fiber optic cable the units shall communicate real-time National Television Standards Committee (NTSC) compliant video from input to output and shall support full duplex RS-232 digital status and control signal communications. The VOT-D shall be interfaced to an NTSC video signal by means of a BNC connector with 75 ohms impedance. The VOR-D shall provide NTSC RS-250B compatible electrical signal at the BNC output connector driving a 75 ohm impedance. The NTSC output signal level shall be 1 volt peak-to-peak.

The function of the VOTR-D pair shall be to communicate NTSC video, associated status, and control data from a closed-circuit television (CCTV) camera location to the TOC using one single-mode fiber.

Variable optical attenuators to accommodate a flexible separation distance between each VOT-D and VOR-D pair shall be provided and shall be incidental to the cost of the VOTR-D devices. The equipment shall not cause rapid aging of the optical receiver, nor allow the optical receiver to reach optical or electrical saturation thereby causing high bit errors.

The VOTR-D shall have a Mean Time Between Failure of 43,800 hours when operated as a pair.

B.1. Optical/Electrical Parameters

An ST type connector on each of the transmitter and receiver units shall provide the optical interface. The optical interface shall accommodate a single mode fiber operating at 1310 nm and/or 1550 nm. The VOTR-D shall accommodate a minimum link loss budget of 25 dB at 1310 nm and/or 18 dB at 1550 nm including a 3 dB safety margin. The optical dynamic range shall be equal to or exceed the link loss budget. When a signal complying with NTSC standards and EIA-250C is applied to the transmitter inputs, the output of the receiver shall provide an undistorted, NTSC and EIA-250C standard signal output when link loss budget is not exceeded. The optical transmitter shall use high reliability laser diodes and optical sensors.

B.1.1. Video Communications

When operated within its power, link loss budget and environmental specifications the VOTR-D pair shall comply with EIA-250C, medium haul video transmission standards. The VOTR-D shall provide a 10 MHz (3 dB) minimum video bandwidth. The transmission technique use between the receiver and transmitter shall be frequency modulation. Differential gain and differential phase shall comply with EIA-250C medium haul video requirements. Video linearity shall be 3% percent maximum. Output voltage shall be one volt peak-to-peak per EIA-170. Signal-to-noise shall comply with requirements specified in EIA-250C when measured at the output of the VOR-D with input signals to the VOT-D in compliance with EIA-250C and fiber interconnected to accommodate signal loss within specified link budget. Signal-to-noise (S/N) shall be 60 dB minimum at the receiver electrical output with an equal or greater S/N of the input signal to the video optical transmitter.

B.1.2. RS-232/RS-422 Communications

The VOTR-D shall provide a communications reliability of one error in 109 bits minimum when operated within link loss budgets, power tolerances and operating environment as specified. Full duplex RS-232 communications shall be accommodated at data rates of 1200, 2400, 4800, 9600 and

19.2 kbps.

B.1.3. Modulation and Multiplexing

Frequency multiplexing and frequency modulation and demodulation shall be utilized.

B.1.4. Electrical Interfaces

- Video Electrical Signal – The transmitter shall contain a BNC connector that will accepts an NTSC color video signal complying with EIA-250C signal standards. Input impedance shall be 75 ohms. Receiver shall contain a UG-88 BNC connector and shall provide a 75 ohm impedance. Output signal level shall comply with NTSC and associated EIA-250C video standards.
- Camera Control Digital Signal – The VOTR-D shall accommodate an RS-232 and RS-422 interfaces with dip switch selectability. Input and output signals shall comply with EIA standards. When the dip-switch is in RS-422 mode, the VOT-D shall convert the RS-422 format to RS-232 and then to an optical format for transmission to the VOR-D and vise-versa. The VOR-D shall provide both, via dip-switch selection, RS-232 and RS-422 signal formats and the selection of this format shall be independent of the format selected on the VOT-D. A standard RJ-45 or DB-25 connector shall be provided to accommodate this interface. Any necessary cable adapter and cables necessary to interface with the CCTV field equipment and the communications server shall be provided and shall be incidental to the cost of the VOTR-D devices.

B.2. Physical Requirements

Connectors shall be located on the transceivers for convenient cable attachments. Strain relief shall be included on all cables provided with the transceivers. Signal indicators shall be easily viewable when the transceivers are mounted in equipment cabinets and in the TOC. All connectors and indicators shall be marked. All replaceable components shall be marked, and all markings shall conform to supplied documentation, including schematics and parts lists. The transceivers' external markings shall include the product name, model number, part number, serial number, manufacturer's name, and manufacturer's address.

Construction and materials selection for the transceivers shall prevent fungus growth and cathodic action.

Standalone, shelf mountable, VOT-D devices are to be provided at field CCTV camera locations. VOT-D devices shall be external to the new CCTV equipment. Furnish standalone transceivers in an aluminum housing that has been treated to prevent corrosion. The standalone VOT-D devices shall

be interchangeable between field cabinets. For this reason, the transceivers shall conform to standard mounting and interconnection provisions within the field cabinet. The mounting plate for the transceivers shall have mounting holes manufactured to tolerances to assure interchangeability of units within field cabinets.

Rack-mounted chassis shall be used to house the VOR-D devices installed in the TOC. VOR-D rack-mounted chassises shall be provided and shall be incidental to the cost of the VOR-D devices. The chassis shall be fabricated of anodized aluminum, designed for mounting in a 19-inch rack, not exceed three (3) standard mounting units in height (5.25 inches). The chassis shall contain a power converter compatible with VOR-D card power requirements. The chassis shall include provisions for interconnecting cabling. The chassis shall be designed to accommodate a minimum of ten (10) VOR-D cards that shall be easily mountable and removable from the chassis. When installed in the chassis, VOR-D cards shall be securable. The front panel shall include functional identification markings in compliance with EIA 606.

B.3. Power Requirements

The VOTR-D power input circuitry shall be designed to protect the electronics from damage from a power surge or an under voltage condition without causing damage to electronics. Over and under voltage condition is considered to be a power failure and therefore the VOTR-D does not have to perform to specification during this condition. The VOTR-D shall automatically recover from an over or under voltage condition when the prime power has returned to values defined by this specification.

Standalone VOT-D devices shall receive the power from a step-down transformer supplied with the unit. The transformer shall receive 120 VAC ±15%, 60 Hz ±10% prime power from a utility power strip within a field cabinet. A three-prong, DB-9 power connector shall be provided with the transformer. The power cable from the transformer to the transceiver shall be 6 feet (minimum) and terminated with a compatible female connector or with leads prepared for easy attachment to a terminal block on the VOT-D. Open power terminals shall not be used. Power input requirements (voltage and current) shall be marked on the transceiver housing.

The VOR-D chassis shall be capable of receiving 115 VAC ±10 percent, 60 Hz ±5 percent power, and have the means to convert the input power as needed to support the power requirements of the VOR-D electronics. Provisions shall be included in the design to prevent damage from lightning, caused by any metallic cable interconnect with the VOR-D. The VOR-D chassis shall include AC-to-DC power conversion, power filtering and regulation to accommodate internal circuit requirements. Power interconnect to the VOR-D chassis shall be through a DB-9 power connector

or screw terminals on the electronics unit. Open power terminals are unacceptable.

B.4. Environmental Requirements

The VOTR-D shall conform to performance specification when operated in the following environment:

- Temperature: -22°F to +160°F
- Humidity: 0 to 98 percent relative humidity with minimal condensation

No cooling air flow shall be required for VOTR-Ds in field cabinets. The unit shall be sealed to prevent damage by blowing sand and dust within a field cabinet. Units shall be shipped with protective covers over all connectors.

C. CCTV Control Panel

Furnish desktop camera control panels at each workstation in the TOC and ROC with the following operating elections:

- 10-digit keypad for video switching (camera and monitors) with a 3-digit LCD display
- Operating mode
- Pan/tilt position control using a joystick
- Focus: near/far
- Zoom: in/out
- Iris: open/close
- Auto iris override
- Preset selection (allow user to select up to ten different presets stored in the camera receiver driver)

The control panel shall interface to a serial communications board furnished and installed in the workstation.

D. Video CODEC

D.1. Functional Requirements

Furnish video encoder/decoder (CODEC) units to support transmission of digitally-compressed video over Ethernet communications when integrated with LAN switches or T1 routers. The video compression algorithm shall be based on MPEG-4 or H.263 standards. The video shall support resolutions up to a maximum of 720 x 625. The video CODEC units shall provide a LCD display

indicating diagnostic data including data rate, quality level, frame rate, video status, and board temperature. All supporting user interface software shall be provided with each encoder and decoder unit.

Encoder units installed at the TOC rack cabinet shall take as inputs 30 frame per second NTSC video from the video matrix switch or other analog output device. Once encoded, the digital video stream will be available over the local area network and the broadband link between the TOC and MRTMC. For workstations connected directly to the LAN and notebook computers connected directly to the LAN or through the remote access server, furnish software based decoder that is capable of selecting any of the compressed video streams on the LAN and opening up a streaming video window that is sizable and scaleable by the user. The software will permit the opening of the streaming video using a standard windows based internet browser. At the MRTMC, furnish hardware based decoders that decompress encoded video back to NTSC video. At the ROC, furnish hardware based decoder that decompresses encoded video back to NTSC video.

D.2. Electrical Requirements

The video CODEC unit shall operate at 115 VAC +/- 10 percent at 60 Hz and consume no more than 100 W. CODEC unit shall be provided with any necessary power adapters.

D.3. Physical Requirements

The video CODEC units shall consume no more than 2 rack units of mounting height in a standard EIA 19" rack cabinet. Rack mounting kits shall be supplied for each video encoder and decoder unit.

D.4. Environmental Requirements

The video CODEC units shall operate between 23 to +140 degrees F.

D.5. Communication Requirements

The video CODEC unit shall provide a minimum of one (1) NTSC composite video input (BNC). Where multiple inputs are available, they shall be capable of being switched remotely to the single digital video output using software encoder switching controls.

The video CODEC units shall support a minimum of two (2) bi-directional data channels for camera control and other peripherals. The video CODEC shall also support telnet access for administration of codec setup parameters. Data channels shall support RS-232/RS-422 communications up 19.2 kbps per channel. Data ports shall be addressable. The video CODEC units shall support encoding rates from 56 kbps to 2.0 Mbps.

D.6. Compatibility Requirements

CODEC units provided at the MRTMC shall be Protronix Pro-VX2-R model or approved equivalent for to ensure compatibility with existing equipment.

E. Video Matrix Switch

The video matrix switch (VS) shall enable the selective routing of video signals complying with National Television Standards Committee (NTSC), CCTV, and composite video signals. Selective signal routing shall be accomplished by switching video input signals to one or more video output ports. The number of input and output ports shall be modular, facilitating expansion of video switching capacity by the addition of input and output modules. Switching control shall be accomplished by an Electronic Industries Association (EIA) RS-232 control interface to the video switch.

The VS shall receive EIA RS-250B or short haul and medium haul video signals at its input and shall not compromise the RS-250 video transmission specification at the video output port.

The VS output signals shall supply inputs to local monitors, video capture cards, video recorders as well as video optical transmitters. The VS shall support wrap-around video where an output is switched to a special video processor and the output of the video processor is "wrapped around" to the input of the VS, allowing selection of processed or unprocessed video for local display, recording, and distribution to remote sites. The VS shall support synchronous switching of the video channels (and companion audio channels) provided in NTSC form by the cable television provider.

The video switch at the TOC shall be provided with a minimum of forty (40) inputs and a minimum of forty (40) outputs. Any input shall be selectable for switch connection to any, or to multiple, outputs. The video switch shall be expandable, within the chassis up to 200 inputs and sixty (60) outputs by adding additional video input and/or output cards.

The VS shall contain all circuitry necessary to convert prime AC power into DC power required by circuitry. Internal power circuitry shall protect the internal logic from "hard" circuit failures during under- and over-voltage conditions normally experienced with commercial power. The power shall be provided to the VS chassis through a disconnectable power cord with a standard, 3-prong power utility outlet compatible, male connector and a locking type female connector that attaches to the VS's electronic chassis's male connector. Either a screw on type or twist lock type of connector is suitable, allowing power to be disconnected. Connectors and power cable shall comply with National Electrical Code and shall support additional power, which may be required for modular, expanded switch operation power.

E.1. Electrical Signal Interface

E.1.1. Input Signals/Video

The VS shall accept NTSC video inputs attached by means of BNC-type connectors. The interconnect impedance shall be 75 ohms, unbalanced-to-ground, terminating. Video input signal accommodation shall be 1.0 volts, peak-to-peak (p p), ±3 dB. The input shall reject a "common mode" input signal in the frequency range of 0 to 4.2 MHz by a minimum of 40 dB. Return loss shall be a minimum of 40 dB over a frequency range of 0 to 5.0 MHz.

E.1.2. Output Signals/Video

The output signals of switched inputs shall be through BNC connectors, with output being dual, 75-ohm source terminated. Return loss of a video output shall be a minimum of 40 dB over a frequency range of 20 Hz to 5 MHz. Output video level shall comply with RS-250B requirements of 1-volt p-p. Output gain of any video channel shall be adjustable to unity from an input reference (+0.05 dB). Gain stability shall be 0 to +0.05 dB. The switched input signal as provided at the video output channel shall not be distorted by the switching process other than switching delays as specified herein.

E.1.3. Electrical Signals Control

The external switching control signals shall be interfaced by an RS-232 communications cable attached to a DB-15S or DB-25S connector. Data rate for control shall be selectable from 2400, 4800, 9600, or 19.2 kbps. Normal operation shall be 19.2 kbps, and any factory settings for the interface shall be at 19.2 kbps. Full duplex communications shall be accommodated over the link. The RS-232 interface shall communicate over a minimum distance of 100 feet without the need for short haul modems. The interface used shall be compatible with the video controller utilized in the system. Interface protocol and message structure shall be operationally compatible between the video switch and the video controller. A non-proprietary protocol and message structure shall be used.

E.2. Signal Transfer and Switching Specifications

The electrical signal transfer and switching functions shall comply with the following specifications:

Video Channel Isolation (Cross Talk)	50 dB over a 25 MHz bandwidth; 40 dB to 50 MHz bandwidth from 25 MHz
Differential Delay	±0.5° at 5 MHz
Minimum Channel Bandwidth (-3 dB)	25 MHz

Group Delay	Less than 5 msec at from 100 KHz to 5 MHz
Differential Gain	0.15%, 10 to 90% APL, over a 5 MHz bandwidth
Differential Phase	0.15°, 10 to 90% APL over a 5 MHz bandwidth
Transit Response than 5%	Rise/fall time less than 3.0 msec and overshoot less
Hum and Noise	80 dB RMS below 1 V p-p over a 10 MHz bandwidth
Switching Time Control	Vertical blank interval (per SMPTE RP 168) with vertical timing reference present
Switching Time	Less than 2 microseconds
Variation in Switching Time with Single Input Signal to Multiple Output Channels	Differential delay shall not exceed 10 msec
Slew Rate	150 volts per microsecond
End-to-End and Signal-to-Noise (S/N) Ratio (assuming input signal is compliant)	57 dB

The VS shall conform to waveform distortion and non-linearity chrominance-to-luminance delay, envelop delay, and other time based specifications as defined in RS-250B related to short haul video transmission. Input signal differences, when selected for distribution on a number of output channels, shall not vary by more than the specified amounts stated herein. Signal distortion, delays, and signal-to-noise shall be independent of the number of output channels assigned to a given input channel.

E.3. Physical

The VS shall be compatible with a standard, 19-inch EIA electronic mounting rack. The panel height shall not exceed 10.5 inches. Depth shall not exceed 20 inches.

All connectors, switches, indicators and replaceable components shall be clearly marked. Switches and indicators shall have functional markings. Connectors shall include jack number and function (such as video source 1). Markings shall be permanent and shall not deteriorate through normal use.

E.4. Maintainability

The VS shall include built-in test (BIT) features and shall generate failure messages

communicated to the video controller. The VS shall contain indicators on the front panel to support maintenance activities. Controls to support diagnostic and maintenance shall be included. As a minimum the front panel shall contain:

- Switch(es) Power on/off with power status indicator
- Indicators BIT fail

Design shall be modular allowing easy replacement of modular components. The VS shall provide video loss detection.

E.5. Video Annotation

The VS shall provide the following video annotation capabilities:

- Camera identification number
- System date and time
- 40-character site description message
- Black or white character display on a per camera basis

F. Video Multiplexer

Furnish and install 16-channel video multiplexer that provides frame-to-frame combining of up to sixteen color video signals.

Furnish video multiplexer with the following characteristics:

- Receive, as inputs, sixteen (16) NTSC color video signals
- Utilize standard BNC connectors for input and output
- Synchronize the video input frames to a clock signal generated internally to the video multiplexer
- Digitally combine up to sixteen video signals to create a single NTSC video output signal.
- Provide one, four, nine, or sixteen separate images on a single monitor.
- Have a RS-232 input for control and configuration via an external computer
- Have MS Windows based software, that when loaded onto a computer that is connected to the multiplexer via its serial port, allows for the configuration and control of the unit.
- Furnish unit that has Ethernet LAN connectivity, is IP addressable, and has software that

permits unit control by users on the LAN.

- Furnish unit that may be controlled via the Central video software called for to be furnished under this project
- Have published, available communications protocol and command strings for integration into a control interface developed by third party source
- Be mountable in a standard 19" equipment rack and have a height of no more than 3.5 inches (2 RU)
- Operating temperature Range — 14 Degrees F to 131 Degrees F
- Humidity — 0%-95%, non-condensing
- Size — less than 3.5" (2 RU) tall
- Power — 120 VAC
- Video Input — 1 volt peak to peak
- Video Output — 1 volt peak to peak
- End-to-End and Signal-to-Noise (S/N) — 60 dB

The output signal of the video multiplexer shall be wrapped around as an input to the video switch.

G. Digital Video Recorder (DVR)

Furnish and install digital video recorder (DVR) to archive video from CCTV cameras in the field. Furnish DVR that is compatible with the video matrix switch and CCTV software.

Furnish and install DVR unit with the following minimum features:

- Minimum 80 GB of memory
- MPEG or M-JPEG compression format
- Minimum image resolution of 720x480 (NTSC) and 720x578 (PAL)
- One (1) BNC video input
- One (1) video output (analog or SVGA)
- Rack mountable and no larger than 4 RU (7 inches)

Furnish unit that has Ethernet LAN connectivity, is IP addressable, and has software that permits unit control by users on the LAN.

H. LCD Video Monitors

Furnish new minimum 40" LCD video wall monitor. The video monitors will be used in a 24/7/365 environment at the TOC and ROC.

LCD Video Monitor shall be UL listed, FCC Part 15 compliant, and shall meet FCC Class A or Class B device requirements, and Bellcore GR-1089-CORE electromagnetic compatibility requirements. Equipment shall meet the following specifications, standards, and subparts as applicable.

All video monitor equipment shall have any safety handling related instructions plainly marked on its case.

All switches, indicators, and connectors shall be clearly and permanently marked as to identity and function. Printed circuit boards shall have permanent markings, including a part number and functional name. Each removable module shall, as a minimum, include a permanently attached (e.g., stamped, etched, etc.) part number. Each removable module shall also include a permanently attached serial number. All component identifications shall correctly correspond to schematics, parts lists, and written narratives included in operation/maintenance manuals.

Display monitors shall provide the following features and functions at a minimum:

- 1280 x 768 native pixel resolution
- 16.7 million displayable colors
- Brightness of at least 450 candela per square meter
- Contrast ratio of 600:1 or better
- 15:9 aspect ratio
- One BNC or RCA connector for NTSC composite color video input
- One digital RGB DVI input
- One S-video input
- One Analog RGB computer UXGA video input
- RS-232 DB-9 interface control port
- Audio L/R stereo inputs and outputs
- Infrared remote control
- Switching between video inputs via remote control, on the monitor panel, or via serial

port

- Horizontal and Vertical viewing angles of at least 160 degrees
- Swing-out articulating arm wall-mounting brackets

Each LCD video display monitor shall have a nominal operating temperature range of 5°C to +40°C and 20 to 80 percent relative humidity, non-condensing.

Each video display monitor shall weigh no more than 100 pounds without attachments/brackets and no more than 150 pounds with mounting brackets and tilting hardware. Each display cabinet should be no more than 12" deep, 49" wide, and 31" high.

Each LCD video display panel shall operate from 115 V +/- 10%, 60 Hz +/- 5% VAC input power. Power consumption shall be no more than 550W per display panel. Each video display panel shall be supplied with all the necessary hardware needed for mounting to wall as directed by the engineer.

33.3. CONSTRUCTION METHODS

A. General

Install and test all central video equipment in accordance with the manufacturer's recommendations.

Route all cabling in ceiling, floor, conduit, or cable raceways unless otherwise approved by the Engineer.

B. Video Optical Transceiver with Control Data (VOTR-D)

Furnish, install, and fully integrate VOT-D units in the CCTV cabinets in the field as shown in the Plans.

Furnish, install, and fully integrate VOR-D units into the rack cabinet at the TOC. Integrate control data from VOR-D with video server and integrate video from VOR-D with video matrix switch. Furnish all cables required to connect transceivers with communications network.

Furnish and install video transceiver rack chassis(es) into the rack cabinet at the TOC. Furnish jumpers of sufficient length to connect the transceivers to the fiber termination panel.

C. CCTV Control Panel

Furnish, install, and fully integrate CCTV control panels at each workstation provide under this project at the TOC and ROC. Furnish any additional hardware (serial boards, cables, etc.) necessary to connect the control panel to the workstation.

D. Video CODEC

Install eight (8) video codec units in the rack cabinet at the TOC to encode eight NTSC outputs from the video matrix switch into MPEG-4 digital video for distribution over the LAN.

Install two (2) video CODEC units at the MRTMC into existing rack cabinet to decode MPEG-4 digital video streams. Fully integrate with existing LAN switch and existing video matrix switch.

Install one (1) video CODEC unit at the ROC into new rack cabinet to decode MPEG-4 digital video. Fully integrate with new LAN switch and LCD video monitor.

E. Video Matrix Switch

Install new video matrix switcher into equipment rack cabinet in TOC as shown in the Plans. Integrate all matrix switcher sub-components to create a fully operational matrix switcher. Fully integrate new video monitors, workstation video capture cards, DVR, video multiplexer, matrix switcher network interface, and video feeds from field CCTV units into new matrix switcher. Integrate with the UPS.

F. Video Multiplexer

Install video multiplexer into video equipment cabinet at the TOC. Route 16 outputs from the video matrix switcher to the video multiplexer 16 input channels. Route the video multiplexer output to an input on the video multiplexer. Integrate video multiplexer control to allow for unit control via client software resident on all of the workstations and notebook computers in the Gastonia System.

Integrate with UPS.

G. Digital Video Recorder (DVR)

Install digital video recorder into video equipment rack in TOC and integrate with video matrix switch to provide digital recording of all video streams from CCTV cameras in the field. The schedule and nature of the video recording shall be user-defined and accomplished by integrating DVR with LAN switch. Furnish software to control DVR and view video over the LAN on all workstations and notebook computers provided under this project.

H. LCD Video Monitor

Install one (1) LCD video monitor on the wall in the TOC as shown in the Plans. Insure that monitor is installed securely and in a fashion that allows for their removal for maintenance and access to monitor display controls. Connect, configure, and fully integrate new monitor with the video matrix switch. This includes installation of cabling and connection of monitors to power

source. Route cabling in ceiling, floor, and raceways as approved by the Engineer.

Install two (2) LCD video monitors on the wall in the ROC as shown in the Plans. Insure that monitor is installed securely and in a fashion that allows for its removal for maintenance and access to monitor display controls. Connect, configure, and fully integrate new monitor with the video server. This includes installation of cabling and connection of monitors to power source. Route cabling in ceiling, floor, and raceways as approved by the Engineer.

33.4. METHOD OF MEASUREMENT

Actual number of video optical transceivers with data furnished, installed, integrated, and accepted.

Actual number of CCTV control panels furnished, installed, integrated, and accepted.

Actual number of video CODEC units furnished, installed, integrated, and accepted.

Actual number of video matrix switches furnished, installed, integrated, and accepted.

Actual number of video multiplexers furnished, installed, integrated, and accepted.

Actual number of digital video recorders furnished, installed, integrated, and accepted.

Actual number of LCD video monitors furnished, installed, integrated, and accepted.

No direct measurement will be made for surge suppression strips. These will be considered incidental to the devices attached to them.

No direct measurement will be made for cabling used to interconnect devices within buildings including coaxial cabling, network cabling, serial cabling, and power cabling. These items will be considered incidental to the devices they are connected.

Configuration and integration of central video components will be considered incidental and shall not be measured separately.

33.5. BASIS OF PAYMENT

The quantity of video optical transceivers with data, measured as provided above, will be paid for at the contract unit price each for "Video Optical Transceiver with Data" in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of CCTV control panels, measured as provided above, will be paid for at the contract unit price each for "CCTV Control Panel" in accord with the following conditions: 75% of

the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of video CODEC units, measured as provided above, will be paid for at the contract unit price each for "Video Codec" in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of video matrix switches, measured as provided above, will be paid for at the contract unit price each for "Video Matrix Switch" in accord with the following conditions: 75% of the payment will be made upon acceptance of the Video Matrix Switch; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of video multiplexers, measured as provided above, will be paid for at the contract unit price each for "Video Multiplexer" in accord with the following conditions: 75% of the payment will be made upon acceptance of the Video Multiplexer; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of digital video recorders, measured as provided above, will be paid for at the contract unit price each for "Digital Video Recorder" in accord with the following conditions: 75% of the payment will be made upon acceptance of the Digital Video Recorder; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

The quantity of LCD video monitors, measured as provided above, will be paid for at the contract unit price each for "LCD Video Monitor" in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 90 day observation period).

Payment will be made under:

Video Optical Transceiver with Data .....Each

CCTV Control Panel.....Each

Video Codec.....Each

Video Matrix Switch.....Each

Video Multiplexer.....Each

Digital Video Recorder.....Each

LCD Video Monitor.....Each

34. RACK CABINETS

34.1. DESCRIPTION

Furnish, install, and integrate rack cabinets at locations shown in the Plans.

34.2. MATERIALS

A. General

Furnish equipment cabinets with railings and sockets for mounting of EIA 19" mountable equipment. Furnish units with removable and adjustable shelves and pull out drawers capable of holding 1.5 times the heaviest component required to be placed on shelf or drawer (when fully extended). Furnish Rack cabinets that are modular with removable side panels with open front and back sections. Furnish racks with cable management and raceways to facilitate neat and orderly organization of all cables routed to equipment on the rack. Furnish rack cabinets with accessories to ensure cables are not kinked or pinched and that all minimum bend radii of cables are preserved. Furnish rack cabinet units that may be aggregated into single units of up to four bays wide. Furnish units with ventilation fans audible no more than 46 dba at a distance of 4 feet from the unit. Furnish units with each bay a width of no more than 24" and a minimum of 84" of continuous useable rack space beginning no more than 6" above the floor. Furnish rack cabinets with maximum height of no more than 12" less than the ceiling of the room they are to be installed in. Furnish units made of quality, non-corrosive materials and non-pealing paint. Furnish rack cabinets that are same color and same manufacturer.

B. TOC Rack Cabinet

Furnish 3-bay equipment rack cabinets for installation in TOC. Add UPS to each bay.

For rack cabinet furnished in the bay that contains the KVM switch, supply drawer style, retractable keyboard with collapsing LCD, 14.1" monitor that consumes no more than 1 RU of rack space. Retractable keyboard/monitor shall be installed at 4.5' high and shall come equipped with keyboard, video, and mouse cables that allow it to be connected to the local analog port on the KVM switch.

C. Uninterruptible Power Supply

The following components in the TOC shall be connected to a single, new Uninterruptible Power Supply (UPS) unit as part of the final system:

- Distributed System file server (both server and monitor)

- All workstations (both workstations and monitors)
- Ethernet LAN switch, 10/100 Base-T hub
- Communications server
- CCTV control panels and video matrix switch
- System communications rack cabinet (called for in Section 14 of these Project Special Provisions)
- Video Server

Furnish UPS units that are capable of detecting a power failure and providing back-up power to the listed components within twenty (20) milliseconds. The transition to the UPS source from primary power shall occur without loss of data or damage to the equipment being provided with back-up power.

Furnish UPS units that are sized such that each is capable of providing back-up power for the total load of all equipment connected to the UPS plus an additional load of twenty-five percent of the total load for at least thirty (30) minutes of operation. The UPS units shall be capable of interfacing with the Distributed System Software such that upon sensing a loss of power, a system shutdown can be initiated and completed within the specified UPS span of operation.

The UPS unit shall include:

- Commercial 115 VAC, 60 Hz power interconnection and power loss sensing and alarm report via the Distributed System Software
- Power protection and filtering
- Power conversion for battery charging
- Batteries to support thirty (30) minutes of operation with loss of power
- Battery status sensing and low battery alarm reporting via the System Software
- Battery charging and charge management
- Battery power conversion and filtering as necessary for interface compatibility with installed equipment

UPS units shall be connected to commercial power. The UPS units and power interconnect shall comply with article 645 of the National Electric Code (NEC).

34.3. CONSTRUCTION METHODS

A. General

Install rack cabinets at locations shown on the plans and as approved by the Engineer. Install cabinets such that access to both the front and back of cabinet is available. Route cabling in cabinets using raceways.

B. Rack Cabinets

Integrate keyboard, mouse, and retractable monitor with KVM switch.

C. Uninterruptible Power Supply

Install uninterruptible power supply (UPS) units in each equipment rack cabinet at the TOC to supply uninterrupted power in the event of a failure of primary power to supply 15 minutes of back up power for all devices that will ultimately populate the rack bay under this project. Integrate with equipment in rack bay. Configure UPS unit servicing the LAN Switch and Router for access via LAN and dial up modem and integrate with LAN and dial-up modem. Configure and integrate all other UPS units for remote access via the LAN.

Install uninterruptible power supply (UPS) units in the equipment rack cabinet at the ROC to supply uninterrupted power in the event of a failure of primary power to supply 15 minutes of back up power for all devices that will ultimately populate the rack bay under this project. Integrate with equipment in rack bay.

34.4. METHOD OF MEASUREMENT

Actual number of rack cabinets of each size furnished, installed, integrated, and accepted. UPS units and retractable keyboard and monitor shall be considered incidental and shall not be paid for separately.

34.5. BASIS OF PAYMENT

The quantity of 3-bay rack cabinets, measured as provided above, will be paid for at the contract unit price each for "Rack Cabinet (3-Bay)."

Payment will be made under:

Rack Cabinet (3-Bay) .....Each

35. SYSTEM FURNITURE

35.1. DESCRIPTION

Furnish the following items for the TOC:

- Operator Console
- Chair
- Printer stand

Furnish the following items for the ROC:

- Operator Console
- Chairs

35.2. MATERIALS

A. General

Furnish matching modular office furniture. Provide desk and printer stand that are durable, resistant to damage from hot and cold cups, scratch resistant and have a wood grain mahogany finish. Desk bases shall be constructed of steel reinforced resinate.

B. Operator Console

Furnish an operator console workstation as shown in the details of the Plans with the following features:

- A locking door with slide-out shelf for storage of a tower case CPU
- Wiring grommets in the rear of the workcenter for cable management
- A full-length hutch 30-inch (H) x 12-inch (D) with a monitor shelf, locking storage cabinet and open storage
- One (1) letter/legal file drawer

C. Chair

Furnish high back office chair, with the following features:

- Dual-wheel castors (minimum of five)
- Five blade support base
- High back

- Arm rests
- Pneumatic adjustment
- Swivel/tilt tension adjustment
- Brown fabric furnishings

D. Printer Stand

Furnish printer stand, with castors and at least one drawer for the storage of supplies.

35.3. CONSTRUCTION METHODS

A. General

Assemble furniture as necessary.

B. TOC Furniture

Furnish and install the following furniture items at the TOC:

- Two (2) operator console workstations
- Two (2) chairs
- Two (2) printer stands

C. ROC Furniture

Furnish and install the following furniture items at the ROC:

- One (1) operator console workstations
- One (1) chair
- One (1) printer stand

35.4. METHOD OF MEASUREMENT

Lump sum for the operator consoles, chairs, and printer stand to be installed in the TOC.

Lump sum for the operator console, chair, and printer stand to be installed in the ROC.

35.5. BASIS OF PAYMENT

The TOC furniture, measured as provided above, will be paid for at the contract unit price lump sum for "TOC Furniture."

The ROC furniture, measured as provided above, will be paid for at the contract unit price lump sum for "ROC Furniture."

Payment will be made under:

TOC Furniture.....Lump Sum

ROC Furniture .....Lump Sum

36. SUBMITTAL DATA

36.1. DESCRIPTION

The intent of this Section of the Project Special Provisions is to provide the requirements and process by which submittal data shall be reviewed.

36.2. SUBMITTALS

A. General

Provide the submittal data which meets the requirements of this Section. All documentation, except as otherwise specifically approved by the Engineer, shall meet the following requirements:

Provide reproducible documents no larger than 22 x 34 inches in size for any documentation which exceeds the size of 11 x 17 inches. No documentation shall be smaller than 8.5 x 11 inches. Reproducible documents shall not be folded or creased.

All documentation shall be considered as an item of work and shall be completed before acceptance of the Project.

B. Project Implementation Schedule

Develop and submit to the Engineer, a Project Implementation Schedule in accordance with Section 108-2 of the Standard Specifications.

The project implementation schedule shall address all major activities, components, and milestones of the project, and shall at a minimum include the following:

- Contractor Submissions
- Equipment Deliveries
- Sample and Materials Testing
- Major Construction Events
- System Installation Milestones
- In-Place Component Testing
- Training
- 90-Day Observation Period
- Final Acceptance

C. Certification

Certify, in writing on a form acceptable to the Engineer, that certain equipment and/or material being furnished meets all the requirements of these Project Special Provisions and the Standard Specification. Certifications shall be provided to the Engineer before that equipment or material is installed. As a minimum, certifications shall be provided for all new cable.

D. Submittal Data

Identify all proprietary parts in contractor-furnished equipment. The Department reserves the right to reject equipment that uses proprietary components that are not commercially available through electronic supply houses.

For contractor-furnished equipment that is listed on the QPL, furnish submittals in the format defined by the QPL.

Submit for review by the Engineer 40 days prior to installation, catalog cut sheets and specifications for all standard, off-the-shelf items and shop drawings for all non-catalog or custom items prior to the purchase of, or fabrication of, any equipment or material for use on this project. All such documentation shall meet the size requirements described above. Provide four (4) copies of all submittals. One (1) of these copies will be returned with appropriate notations. Submit one (1) copy of reproducible drawings. The reproducible drawing, with appropriate notations, will be returned after necessary record prints have been made.

The purpose of the submittal data is to show specifically and in detail how the Contractor intends to satisfy the requirements of these Project Special Provisions and the Plans. If pre-printed literature is used to satisfy some or all of these requirements, cross off and initial statements on the literature which conflict with these Project Special Provisions or Plans. Attach appropriate statements clearly indicating each requirement given in these Project Special Provisions and provide a comparison on how the submittal meets or exceeds the requirements. Clearly label each item of submittal data with the bid item number or other description of the item(s) to which it applies.

Each formal submittal shall contain sufficient information and details to permit the Engineer to fully evaluate the situation. Submittals which are, in the judgment of the Engineer, insufficient to permit proper evaluation will be rejected. Do not deviate from formal submittals marked "Approved" or "Approved as Noted" without the written consent of the Engineer.

Because of the nature of this work, detailed submittal data is required prior to approval of most of the items in order to avoid non-conformance that does not become apparent until it is too late to correct without serious consequences. In addition, because certain groups of items as set forth below

are closely interrelated, it is required that the submittals on the items in each group always be made as a group with complete information being resubmitted each time, if more than one submittal is necessary. Plan the submittal data effort accordingly.

In order to expedite the submittal data process and equipment review, address all of the requirements of these Project Special Provisions and the Plans in the submittal data, leaving nothing to assumption and clearly addressing the functional and technical interrelationships among the various items. Except for cabinets, detailed wiring diagrams are not required as part of the submittal data nor will they be reviewed unless specifically required by these Project Special Provisions or by the Engineer's request.

Submittal data for the items in each of the following groups shall be submitted as an integrated unit:

- Group A – Cabinet and Controller Equipment
- Group B – Computer Hardware and Peripherals, System Software
- Group C – Fiber Optic Network Cable and Equipment, Transceivers
- Group D – Central Video System, CCTV Camera Assemblies
- Group E – Field Hardware and Equipment
- Group F – System Support Equipment and Test Equipment
- Group G – Furniture

The items in each of these groups will also be reviewed and approved as an integrated unit. Submittals for items not included in the above groups may be made independently.

The submittal data for Groups B and D shall list the Project Special Provision section and sub-section requirements for each hardware item and software item being considered for use on this project. It shall also show the corresponding data from the hardware item and software item being submitted and how the submittal meets or exceeds the requirements. Attach appropriate documents or statements indication how the submittal will fulfill the Project Special Provisions. This shall be all-inclusive for each pay item in Groups B and D. Hardware submittals and software submittals that do not address all the requirements in the Project Special Provisions will be rejected for insufficient information.

Plan for any given package of submittal data to be in the hands of the Engineer for forty (40) calendar days. Following review of the submittal data, the Engineer will return to the Contractor one (1) copy or an agreed upon number of the submittal marked "Approved", "Approved as Noted" or

"Rejected". The Engineer will also mark each item which must be resubmitted. Proceed with any items marked "Approved". Also proceed with items marked "Approved as Noted" if resubmission is not required. Do not proceed with any items, which are marked "Rejected", or with items for which resubmission is required but shall proceed immediately to correct said items and resubmit them for review. No time extensions shall be granted as a result of the need to resubmit various items for review. Review by the Engineer of various items shall not relieve the Contractor of his obligation to furnish and install the work in accordance with these Project Special Provisions and the Plans.

Develop a submittal data transmittal form and submit the same to the Engineer for approval as to format. Assign a submittal number to each submittal package, which shall be transmitted under the cover of the approved form. The numbering system shall be logical and ascending. Specifically list on the transmittal sheet each item or element included. (An element is one part of several parts of information related to the same bid item.) When drawings are submitted, each shall be listed separately. Completely fill out all portions of the transmittal sheet except those reserved for use by the Engineer. The transmittal sheet will be used by the Engineer to indicate the action taken on the submittal package and a copy of the transmittal sheet showing these actions will be returned to the Contractor. Only clearly related items shall be transmitted under the same transmittal sheet.

36.3. METHOD OF MEASUREMENT

Submittals shall be incidental to the contract price for each item requiring submittal data.

36.4. BASIS OF PAYMENT

No separate payment shall be made for submittals.

37. DOCUMENTATION

37.1. DESCRIPTION

This section specifies the documentation to be provided by the Contractor.

37.2. DOCUMENTATION

Provide as-built documentation. All documentation, except as otherwise specifically approved by the

Engineer, shall meet the following requirements:

- Provide any documentation that exceeds the size of 11x17 inch paper in a reproducible format 22x34 inches in size.
- No documentation shall be smaller than 8.5x11 inches.
- Reproducibles shall not be folded or creased.

Provide documentation, at a minimum, for the following.

A. As-Built Drawings

Prepare as-built drawings that depict any change of components, measurement or layout of the Plans. All construction changes, with the final location and depth of conduits, wiring external to the cabinet, locations of splice closures, system detector locations, and SMFO cable terminations, etc., shall be shown in detail on reproducible format. The Plans shall include all field installations including the SMFO cable network installed. The Plans shall include a schematic drawing of the downtown cable network that depicts the inner duct in which the SMFO cable for the signal system is installed.

One (1) reproducible drawing of the Plans and one electronic copy of the plans will be provided to the Contractor for his use. Provide any other base maps that may be necessary to comply with this requirement.

Any changes made to the original plans shall be made by modifying the original electronic files such that all changes are marked with callout boxes.

Within ten (10) days after the observation period begins, furnish one reproducible copy of the draft as-built plans in hard copy format for review. Provide draft hard copy as-builts on 22x34 inch bond plan sheets.

Correct any comment to the draft as-built plans upon review by the Engineer prior to the

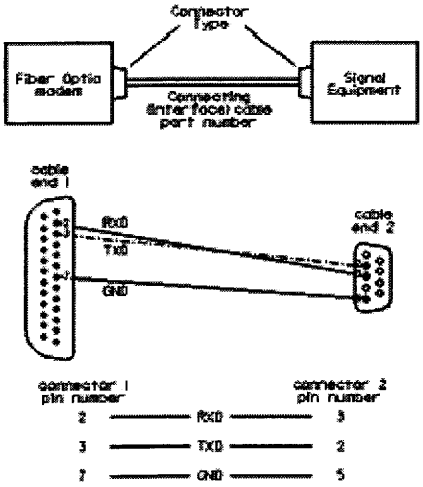
acceptance of the project. Submit final as-built plans in electronic and hard copy format. Provide electronic plans in Microstation (latest release) format on CD. Submit hard copy as-builts on 22x34 inch vellum plan sheets.

The Engineer will provide electronic copies of MicroStation design files for the original plans (including splice details) for the Contractor's use in preparing as-built drawings. Any other base maps that may be necessary for the Contractor to prepare the as-built drawings in accordance with this special provision will be the Contractor's responsibility. Use CADD conventions that are consistent with those used on the original plans. Designate any changes to drawings in a method approved by the Engineer. Correct any errors to the as-built plans upon review by the Engineer prior to the acceptance of the project. Submit final as-built plans in electronic and hard copy format. Provide electronic plans in MicroStation (latest release in use by the Department) format on compact disc (CD).

B. Wiring Diagrams

Provide detailed wiring diagrams that include interconnection (wired and wireless) of equipment with pinout configurations, pin functions, and cable part numbers. This includes configurations at each controller or equipment cabinet and at central locations. Provide system connection diagrams showing system interconnection cables and associated terminations. Use naming convention approved by the Engineer and conforming to Belcore standards.

Example:



Provide one electronic copy of the wiring diagrams in Microstation format.

C. Splice Diagram

Prepare as-built splice diagrams that depict the communications cable plant as constructed. The splice diagram shall depict the splices made at each splice enclosure by identifying fiber spliced and buffer tube. The splice diagram shall be in a format similar to those provided with the project plans. All expressed fibers, spare fibers, used fibers and capped fibers shall be identified.

Original splice diagrams will be provided in electronic format in a Microstation format. Designate any changes to these diagrams by using a method as approved by the Engineer. Furnish as-built splice diagrams in Microstation format on a CD and in hard copy format.

D. Manuals and Equipment Documentation

D.1. Cabinets, Controllers and Test Equipment

Furnish documentation in accordance with the Standard Specifications with the following additions:

- Operating instructions and maintenance manuals shall be bound, and consist of minimum 8.5x11 inch with 11x17 inch minimum schematics. Operating instructions and maintenance manuals shall be provided for each type of traffic signal equipment, including controllers, controller software, traffic signal monitors, and detector cards. One set of such manuals and instructions shall be provided with each controller.
- Except for the test cabinet, two sets of operating instructions and two sets of maintenance manuals shall be furnished for each item of test equipment specified in these Project Special Provisions.
- The controller cabinet and CCTV cabinet wiring diagrams shall be provided on 22x34 inch plan sheets, and shall include field hook-ups, system and local detectors, fiber optic communications interface connections, preemption wiring, surge protection, and all auxiliary relays. If any changes are made to the diagrams, the hardcopy shall be hand-marked with all changes. Two (2) copies of the cabinet wiring diagrams shall be provided for each controller and CCTV assembly provided. One copy shall be submitted to the Engineer and the other shall be placed in the cabinet for future reference.

Five (5) copies of draft documentation shall be submitted to the Engineer for written approval no later than the delivery of the corresponding equipment. Upon written approval by the Engineer, submit final documentation for field hardware prior to the end of the 90-day observation period.

In addition to the documentation specified above, provide and install in a weatherproof holder that is mounted within each cabinet, prints of schematic diagrams applicable to the equipment

contained in the cabinet.

D.2. Computer/Peripheral Hardware

Furnish one (1) copy per notebook computer and workstation of all manuals provided with the following computer hardware. Bound documentation must be furnished. On-line help systems may not be substituted. If necessary, the Contractor shall obtain printed documentation from the hardware manufacturer. Third party users manuals are not acceptable. Manuals shall be provided for at least, but not be limited to, the following:

- Central Computer and LAN Equipment (including Ethernet switch and hubs, file server, and microcomputer workstations)
- Printers
- Communications server
- Notebook computer
- Video server
- Video Switch

Submit documentation material to the Engineer for review and approval a minimum of forty (40) days prior to the beginning of the 90-day observation period.

D.3. Computer/LAN/CCTV/Peripheral Manufacturer Supplied Software

Submit four (4) copies of standard documentation for the operating system and all computer/LAN/CCTV/peripheral manufacturer supplied software.

Submit this documentation to the Engineer a minimum of forty (40) days prior to the start of the 90-day observation period.

D.4. Distributed Signal System Software

Provide and submit to the Engineer for written approval, full and complete documentation for all of the Distributed Signal System Software that has been furnished and installed as part of this project.

New flow charts and descriptive graphics shall be prepared and furnished as necessary, indicating connection to and relationship to existing program modification, additions and changes to the base software and their programs or routines.

Prepare and supply complete and fully debugged listings of all source coding provided with and used in the development of this system. Three (3) copies of the source code shall be provided on

CD-ROM.

Supply three (3) copies of the distributed processing traffic signal system software documentation (and three (3) copies of the CCTV software, if a stand alone package is furnished) to the Engineer forty days (40) before the initial applications software test. From the date of computer delivery until acceptance of the project, update the Engineer's software documentation within two (2) weeks of performing any software changes. If the software documentation does not reflect the current software operation, the Engineer may stop all work on the project until the software documentation is updated. Maintain one (1) debugged and current backup version of the software on disk on-site at all times, once the computer has been delivered. Failure to maintain this documentation shall be grounds for the Engineer to halt the project until it is provided.

Supply four (4) additional current traffic control applications software documentation manuals, four (4) copies of distributed signal system software on CD-ROM, and two (2) copies of program listings to the Engineer prior to acceptance of the project. Also demonstrate to the Engineer that the backup version of the program on disk is debugged and current. Provide this backup version to the Engineer after acceptance of the project.

D.5. CCTV Field Equipment

Furnish one (1) copy of manuals for each camera site detailing: the operation of; the maintenance and troubleshooting procedures for; and parts lists for each piece of equipment furnished. This shall include, but not be limited to:

- CCTV cameras
- Pan-tilt units
- Camera housings
- Camera control receiver
- CCTV central equipment (monitors, DVR, etc.)

D.6. Traffic Control System User's Manual

Submit four (4) copies of the System User's Manual for review and approval by the Engineer 40 days prior to the initial applications software test.

These manuals shall consist of two (2) volumes:

- Procedures for equipment setup, program loading, operating procedures, operational options, program monitoring, recovery procedures, and error message definition and corrections.

- Procedures for preparing, updating, and troubleshooting the database and pattern histories.

The operation of the TOC LAN, file servers, microcomputer workstation, printers, and plotter shall be described in detail with respect to display of program information and parameters, changing of input parameters, and operation of special keys and other equipment.

Sample output formats shall be provided. They shall be reproductions of laser printer, plotter, and workstation display outputs. The computer information required to provide such a display shall be illustrated with the appropriate output format.

A complete list of error messages associated with the software operation shall be provided for both the system operation and the database and pattern history. Each error message that could appear during system operation shall be defined as to the actual meaning, cause, and corrective action to be taken. This information shall be in addition to the basic troubleshooting and malfunction information that shall be provided.

This System User's Manual shall be continually updated on a monthly basis to reflect the current applications software. Failure to perform this task shall allow the Engineer to halt work on the project until this task is corrected and demonstrated to the satisfaction of the Engineer.

Submit to the Engineer five (5) final copies of the System User's Manuals immediately prior to the acceptance of the project. These manuals shall be updated to reflect the current system operation and the Engineer's comments. The Engineer shall approve in writing these manuals before final acceptance of the project.

D.7. Signal Inventory Forms

Prepare and submit a signal inventory sheet for each project intersection. The form shall be provided by the Engineer. The Engineer may provide either a paper copy or an electronic copy of the form. If electronic forms are provided, complete an electronic form for each location and submit a paper copy of each completed form to the Department along with corresponding electronic copies on a CD-ROM. Provide the signal inventory forms at the end of the project, after all system upgrades have been completed, but prior to final system acceptance.

37.3. METHOD OF MEASUREMENT

All documentation shall be considered incidental to the construction of the system and shall be completed before acceptance of the Project.

37.4. BASIS OF PAYMENT

Preparation of as-built drawings shall be considered incidental to the bid items and no separate payment shall be made.

38. SYSTEM SUPPORT AND TEST EQUIPMENT

38.1. DESCRIPTION

Furnish fiber-optic system support equipment and signal system support equipment with all necessary hardware in accordance with the Plans and these Project Special Provisions. Comply with the provisions of Section 1700 of the Standard Specifications.

38.2. MATERIALS

A. General

Furnish equipment with test probes/leads, batteries (for battery operated units), line cords (for AC operated units), and carrying cases. Provide operating instructions and maintenance manuals with each item.

Prior to starting any system testing or training, furnish all fiber-optic system and signal system support equipment.

B. Signal System Support Equipment

Furnish new, unused signal system support equipment to the Engineer in the quantities shown below:

- Four (4) 2070L signal controllers as specified in **Section 26**
- Two (2) base-mounted 336 cabinets as specified in **Section 26**
- Two (2) pole-mounted 332 cabinets as specified in **Section 26**
- Eight (8) detector cards as specified in **Section 26**
- Four (4) conflict monitors as specified in the Standard Specifications
- Four (4) model 200 load switches as specified in the Standard Specifications
- Four (4) DC isolators and four (4) AC isolators as specified in the Standard Specifications
- Ten percent (10%) of surge protectors of each type installed as specified in the Standard Specifications
- Two (2) flasher modules as specified in the Standard Specifications
- Six (6) flash transfer relays as specified in the Standard Specifications
- Two (2) GPS receivers with cigarette light adapters as specified in **Section 30**

B.1. Controller Tester

B.1.1. General Features

Provide bench type aluminum housing. Input panel and output panel shall be mounted at an angle to provide ease of viewing. Ensure that the tester incorporates handle(s) and a place to the store the C1 and C11 harness' for ease in transport. Suit case style housing is not acceptable.

Provide tester with a power switch and pilot lamp.

Provide terminations for each C1S and C11S connector pin, in the tester, so each function will be available for troubleshooting and/or testing.

Provide an internal DC power supply to operate output LED indicators, so that no power is drawn from the controller under test.

Provide means for testing controller AC power interruption, adjustable from .1 seconds to 2.5 seconds (minimum). Ensure power receptacle for controller is fuse protected.

Provide the following test points for external measurement:

- Neutral – Connected to power line neutral.
- Logic Ground – Connected to controller logic ground.
- Power Interrupt – Connected to the power interrupt circuit (12 VDC circuit).

Ensure test points are five-way binding post type.

Provide neatly screened labeling for all inputs and outputs. Stickers, overlays or "taped-on" labels are not acceptable. Ensure labeling corresponds to Econolite's Oasis 2070 controller software as given in this specification.

Provide rubber "feet" to minimize slippage on bench top.

B.1.2. Output Display

Provide a LED for each controller output. Ensure that each of the 8 vehicle phases, pedestrian phase, and four overlap LED indicators are of appropriate color, and are identified with the appropriate C1 pin number.

Provide LEDs that are the bright, wide angle viewing type. Ensure the color of the LED can be distinguished without power applied to the output display (diffused type).

Provide a display that is phase oriented with LEDs arranged in vertical rows. Phase function shall be indicated (1, 2, 3, etc.). Each overlap shall be indicated (A, B, C, D). Other C1 outputs

should be placed in an area separate from the intersection display and overlap display. C11 outputs shall be in an area separate from all other outputs.

Ensure each LED output indicator is identified with the appropriate C1 pin number. Ensure that the functions of the outputs are labeled per Econolite's Oasis 2070 controller software, version 3.00.11 (found in the chart below). No other vendor specific functionality shall be present on the display panel:

C1 Connector	Oasis Function
35	2PY
36	6PY
37	4PY
38	8PY
83	-
84	-
91	-
93	-
100	-
101	FLASH
102	DETECTOR RESET
103	WATCHDOG

B.1.3. Input Panel

Provide "on-off-momentary" toggle action switches for all inputs. Ensure switches lock into position when the user pushes the switch "up", and is momentary when the user pushes the switch "down".

Ensure each switch is labeled as per the functions of the default program for Econolite's Oasis 2070 controller software, version 3.00.11. Ensure the switch is also identified with the appropriate C1 pin number. No other vendor specific functionality shall be present on the input panel. The Oasis defaults for inputs are listed in the chart located on the following page.

C1 Connector	Oasis Function
56	Det. 1 / Ø1
39	Det. 2 / Ø2

C1 Connector	Oasis Function
58	Det. 3 / Ø3
41	Det. 4 / Ø4
55	Det. 5 / Ø5
40	Det. 6 / Ø6
57	Det. 7 / Ø7
42	Det. 8 / Ø8
60	Det. 11 / Ø1
43	Det. 12 / Ø2
62	Det. 13 / Ø3
45	Det. 14 / Ø4
59	Det. 15 / Ø5
44	Det. 16 / Ø6
61	Det. 17 / Ø7
46	Det. 18 / Ø8
63	Det. 32 / Ø2
65	Det. 34 / Ø4
64	Det. 36 / Ø6
66	Det. 38 / Ø8
76	Det. 42 / Ø2
78	Det. 44 / Ø4
77	Det. 46 / Ø6
79	Det. 48 / Ø8
47	Det. 22 / Ø2
49	Det. 24 / Ø4
48	Det. 26 / Ø6
50	Det. 28 / Ø8
67	2 Ped
69	4 Ped
68	6 Ped
70	8 Ped
51	Preempt 1
54	-

C1 Connector	Oasis Function
75	-
81	Flash Sense
71	Preempt 3
72	Preempt 4
52	Preempt 2
53	Manual Control Enable
82	Stop Time
80	Advance
73	Preempt 5
74	Preempt 6

B.2. Signal Monitor Tester with Notebook Computer

Furnish a stand-alone portable signal monitor test unit with notebook computer intended for use on work-bench. The Tester shall use/control an Intel-based notebook computer for input/output. The Tester shall test Signal Monitor displays, timing and voltage functions, and input/output combinations of either true or false conflicts. Any software provided with the tester shall be modular, menu driven, and offer a "help" screen. A video "setup/usage" training tape shall be provided with each unit. All input/outputs shall be in plain English. It shall be possible to generate a hardcopy printout, or to store the results to a disk file. A "No Faults Detected" indication shall be displayed as appropriate.

B.3. Test Cabinet/Controller

Furnish and install a test cabinet/controller at the TOC. The test cabinet shall include a 2070L controller in a Type 336 cabinet. The test cabinet shall include a full compliment of detector amplifiers, switch packs, a signal monitor, and one fiber optic transceiver. The test cabinet shall also contain two (2) AC Isolators, two (2) DC Isolators and a Rail Road preempt test panel. Rail Road preempt test panel should be of the same type provide for Rail Road crossing locations in the field. The test cabinet and panel shall be fully labeled.

B.3.1. Construction

The test cabinet shall have a heavy-duty aluminum dolly base with heavy duty casters. The base shall accommodate a fully equipped base-mounted cabinet/controller. A pole or pedestal shall be attached to the base to support a display panel, which shall be located beside the cabinet convenient

for use by maintenance personnel. The panel shall have all indicators and switches on the front, and shall have a suitable aluminum enclosure. The panel shall be fully labeled.

B.3.1.1 Indicators

The panel shall contain indicators to display the outputs of all the cabinet's traffic signal load switches. Red, yellow, and green indicators shall be used to display the outputs of the traffic signal load switches. In addition, indicators shall be provided for four (4) pedestrian displays and four (4) special functions. The indicators shall use incandescent bulbs or LED's that are user replaceable.

B.3.1.2 Controls

The panel shall be equipped with controls which are connected to simulate all of the inputs, for test purposes, to the controller which are not already accommodated by switches in the controller cabinet.

B.3.1.3 Harnesses

The panel shall be connected to the controller cabinet by means of harnesses. The harnesses shall be concealed in the pedestal or pipe supporting the panel and shall enter the cabinet from the bottom.

B.3.2. Connection to System

The test controllers will be connected to the system on dedicated communication channels. Furnish and install a jumper cable sixteen (16) feet (minimum). This jumper cable shall be used to connect the test cabinet's fiber optic transceiver to the communication system. (The connection point will be the fiber termination panel at the TOC).

C. Fiber Optic System Support Equipment

Furnish new, unused fiber optic system support equipment to the Engineer in the quantities shown below:

- Three percent (3%) of each fiber count of fiber optic cable installed as specified in **Section 15**, excluding Gastonia Electric Department cable
- Five (5) fiber optic interconnect centers as specified in **Section 16**
- Eight (8) fiber optic transceivers as specified in the Standard Specifications
- Two (2) VOT-D units as specified in **Section 33**
- Two (2) VOR-D units as specified in **Section 33**
- Two (2) aerial splice enclosures as specified in the Standard Specifications

- Eight (8) mechanical ST-type splice connectors as specified in **Section 16**
- Eight (8) factory connectorized (ST-type) pigtails of ten foot length as specified in **Section 16**
- Five (5) units of heat shrink tubing for risers as specified in the Standard Specifications.

C.1. Fiber-optic Restoration Kit

Furnish a fully functional fiber-optic restoration kit consisting of the following items (minimum):

- Plier-type strippers
- Non-niks fiber stripper tool with procedures
- Buffer tube stripper tool with procedures
- Fiber-optic Cleaver (average cut less than 0.5 degrees from perpendicular) Diamond Blade
- Screw driver set
- 48 Alcohol wipes
- Tape, ¾-inch, electrician
- Kim wipes
- Metal ruler
- Tweezers
- Crimping pliers
- CamSplice assembly manual
- CamSplice assembly fixture
- 12, Non-adhesive, mechanical, CamSplice, splices
- 2 Mechanical Splice Trays, 12 CamSplices Capacity, Compatible with the Interconnect Centers being installed in the Traffic Signal Controller Cabinets
- Scissors
- Hard-sided, padded, storage case

C.2. Fiber-optic Power Meter

Furnish fiber-optic power meters for measuring absolute power and link losses, as well as

monitoring power levels and testing threshold levels. Provide the following features:

Spectral range	750 nm to 1700 nm
Calibrated wavelengths	850, 1310, and 1550 nm
Accuracy	± 3 percent (± 0.1 dB at -20 dBm at 70 degrees F) at calibrated wavelengths
Readout resolution	4 digits, 0.01 dBm
Display	Backlit LCD
Fiber-optic connector	ST type
Power-up stabilization	Less than five seconds at ambient temperature
Tone threshold settings	User selectable from 1 to 35 dB, plus OFF
Analog output port	Voltage: 0 to + 1 V FSD of linear power range Output impedance: 5 kilohms, nominal
Temperature	Operating: 32 to 122 degrees F Storage: 0 to 150 degrees F
Relative humidity	5 to 95 percent, non-condensing
Battery power	Alkaline: 28 hours NiCad: 8 hours (recharger and NiCad batteries provided)
Carrying case	

C.3. Optical Light Generator

Furnish optical light generators for measuring absolute power and link losses, as well as monitoring power levels and testing threshold levels. Provide the following features:

Calibrated wavelengths	1310 nm, and 1550 nm
Accuracy	3 percent at 70 degrees F at calibrated wavelengths
Fiber-optic connector	ST type
Power-up stabilization	Less than five seconds at ambient temperature
Temperature	Operating: 32 to 122 degrees F Storage: -10 to 150 degrees F
Relative humidity	5 to 95 percent, non-condensing
Battery power	Alkaline: 28 hours NiCad: 8 hours (recharger and NiCad batteries provided)
Carrying case	

D. CCTV System Support Equipment

Furnish one (1) CCTV assembly as specified in **Section 29.**

D.1. CCTV Test Monitor

Furnish portable color CCTV test monitor to allow for the field testing of CCTV assembly installations in the field and in the shop.

Furnish one (1) portable color monitor meeting the following specifications:

- Display — 4" Liquid Crystal Display, active matrix
- Input Signal — 2 NTSC inputs
- Color — Full Color or Black and White
- Picture Elements — 480 (H) x 234 (V)
- Dot Pitch — 0.171 (W) x 0.264 (H)
- Back Light — Built In
- Controls — Color, brightness, on/off, tint, red & blue drive
- Supply voltage — 12 VDC, 500 mA
- Connectors — Switchable video – BNC; Power – DC jack
- Operating Temperature — 32 degrees F to 104 degrees F
- Dimensions (maximum) — 5.5 inches (W) x 3.6 inches (H) x 1.8 inches (D)o
- Weight (maximum) — 1 lb

Include 12 feet of power and video cables with the monitor and case. Furnish monitor with all equipment necessary to operate from 120 VAC power source.

E. Wireless Radio System Support Equipment

Furnish two (2) spread spectrum wireless radio modem units as specified in **Section 28.**

38.3. METHOD OF MEASUREMENT

Actual number of 2070L controllers furnished and accepted.

Actual number of 336 cabinets furnished and accepted.

Actual number of 332 cabinets furnished and accepted.

Actual number of detector cards furnished and accepted.

Actual number of conflict monitors furnished and accepted.

Actual number of load switches furnished and accepted.

Actual number of DC isolators furnished and accepted.

Actual number of AC isolators furnished and accepted.

Actual number of surge protectors furnished and accepted.

Actual number of flasher modules furnished and accepted.

Actual number of flash transfer relays furnished and accepted.

Actual number of GPS receivers furnished and accepted.

Actual number of controller tester units furnished and accepted.

Actual number of signal monitor tester units furnished and accepted. Notebook computer shall be considered incidental to the signal monitor tester and will not be paid for separately.

Actual number of test cabinet and controller units furnished and accepted.

Linear feet of fiber optic cable furnished and accepted.

Actual number of fiber optic interconnect centers furnished and accepted.

Actual number of fiber optic transceivers furnished and accepted.

Actual number of VOT-D units furnished and accepted.

Actual number of VOR-D units furnished and accepted.

Actual number of splice enclosures furnished and accepted.

Actual number of ST splice connectors furnished and accepted.

Actual number of ST pigtails furnished and accepted.

Actual number of heat shrink tubing for risers furnished and accepted.

Actual number of fiber optic restoration kits furnished and accepted.

Actual number of fiber optic power meters furnished and accepted.

Actual number of optical light generators furnished and accepted.

Actual number of CCTV assemblies furnished and accepted.

Actual number of CCTV test monitors furnished and accepted.

Actual number of spread spectrum wireless radio modems furnished and accepted.

38.4. BASIS OF PAYMENT

The quantity of 2070L controllers, measured as provided above, will be paid for at the contract unit price each for "Furnish 2070L Controller."

The quantity of base-mounted 336 cabinets, measured as provided above, will be paid for at the contract unit price each for "Furnish 336 Cabinet."

The quantity of pole-mounted 332 cabinets, measured as provided above, will be paid for at the contract unit price each for "Furnish 332 Cabinet."

The quantity of detector cards, measured as provided above, will be paid for at the contract unit price each for "Furnish Detector Card."

The quantity of conflict monitors, measured as provided above, will be paid for at the contract unit price each for "Furnish Conflict Monitor."

The quantity of load switches, measured as provided above, will be paid for at the contract unit price each for "Furnish Load Switch."

The quantity of DC isolators, measured as provided above, will be paid for at the contract unit price each for "Furnish DC Isolator."

The quantity of AC isolators, measured as provided above, will be paid for at the contract unit price each for "Furnish AC Isolator."

The quantity of surge protectors, measured as provided above, will be paid for at the contract unit price each for "Furnish Surge Protector."

The quantity of flasher modules, measured as provided above, will be paid for at the contract unit price each for "Furnish Flasher Module."

The quantity of flash transfer relays, measured as provided above, will be paid for at the contract unit price each for "Furnish Flash Transfer Relay."

The quantity of GPS receivers, measured as provided above, will be paid for at the contract unit price each for "Furnish GPS Receiver."

The quantity of controller tester units, measured as provided above, will be paid for at the contract unit price each for "Furnish Controller Tester."

The quantity of signal monitor tester units, measured as provided above, will be paid for at the contract unit price each for "Furnish Signal Monitor Tester."

The quantity of test cabinet and controller units, measured as provided above, will be paid for at the contract unit price each for "Furnish Test Cabinet/Controller."

The quantity of fiber optic drop cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Furnish Drop Cable."

The quantity of fiber optic cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Furnish Communications Cable (___-Fiber)."

The quantity of fiber optic interconnect centers, measured as provided above, will be paid for at the contract unit price each for "Furnish Fiber Optic Interconnect Center."

The quantity of fiber optic transceivers, measured as provided above, will be paid for at the contract unit price each for "Furnish Fiber Optic Transceiver."

The quantity of VOT-D units, measured as provided above, will be paid for at the contract unit price each for "Furnish VOT-D."

The quantity of VOR-D units, measured as provided above, will be paid for at the contract unit price each for "Furnish VOR-D."

The quantity of splice enclosures, measured as provided above, will be paid for at the contract unit price each for "Furnish Splice Enclosure."

The quantity of ST splice connectors, measured as provided above, will be paid for at the contract unit price each for "Furnish ST Splice Connector."

The quantity of ST pigtails, measured as provided above, will be paid for at the contract unit price each for "Furnish ST Pigtail."

The quantity of heat shrink tubing for risers, measured as provided above, will be paid for at the contract unit price each for "Furnish Heat Shrink Tubing."

The quantity of fiber optic restoration kits, measured as provided above, will be paid for at the contract unit price each for "Furnish Fiber Optic Restoration Kit."

The quantity of fiber optic power meters, measured as provided above, will be paid for at the contract unit price each for "Furnish Fiber Optic Power Meter."

The quantity of optical light generators, measured as provided above, will be paid for at the contract unit price each for "Furnish Optical Light Generator."

The quantity of CCTV assemblies, measured as provided above, will be paid for at the contract unit price each for "Furnish CCTV Assembly."

The quantity of CCTV test monitors, measured as provided above, will be paid for at the contract unit price each for "Furnish CCTV Test Monitor."

The quantity of spread spectrum wireless radio modems, measured as provided above, will be paid for at the contract unit price each for "Furnish Wireless Radio Modem."

Payment will be made under:

Furnish 2070L Controller ..... Each

Furnish 336 Cabinet ..... Each

Furnish 332 Cabinet ..... Each

Furnish Detector Card ..... Each

Furnish Conflict Monitor ..... Each

Furnish Load Switch ..... Each

Furnish DC Isolator ..... Each

Furnish AC Isolator ..... Each

Furnish Surge Protector ..... Each

Furnish Flasher Module ..... Each

Furnish Flash Transfer Relay ..... Each

~~Furnish LED Traffic Signal Module ..... Each~~

Furnish GPS Receiver ..... Each

Furnish Controller Tester ..... Each

Furnish Signal Monitor Tester ..... Each

Furnish Test Cabinet/Controller ..... Each

Furnish Drop Cable ..... Linear Foot

Furnish Communications Cable (12-Fiber) ..... Linear Foot

Furnish Communications Cable (24-Fiber) ..... Linear Foot

Furnish Communications Cable (36-Fiber) ..... Linear Foot

Furnish Communications Cable (48-Fiber) ..... Linear Foot

Furnish Communications Cable (72-Fiber) ..... Linear Foot

Furnish Communications Cable (144-Fiber) ..... Linear Foot

Furnish Fiber Optic Interconnect Center ..... Each

Furnish Fiber Optic Transceiver ..... Each

Furnish VOT-D ..... Each

Furnish VOR-D ..... Each

Furnish Splice Enclosure ..... Each

Furnish ST Splice Connector ..... Each

Furnish ST Pigtail ..... Each

Furnish Heat Shrink Tubing ..... Each

Furnish Fiber Optic Restoration Kit ..... Each

Furnish Fiber Optic Power Meter ..... Each

Furnish Optical Light Generator ..... Each

Furnish CCTV Assembly ..... Each

Furnish CCTV Test Monitor ..... Each

Furnish Wireless Radio Modem ..... Each

39. TESTING & ACCEPTANCE

39.1. DESCRIPTION

Test all equipment, cable and software furnished and installed under this Contract. Conduct this testing in the presence of the Engineer. **The Department reserves the right to perform any inspections deemed necessary to assure that the equipment conforms to the requirements specified herein.**

Perform factory and field testing (both pre- and post-installation) on the local and master controllers, cabinets, and related hardware.

Cable provided under this contract shall have been pre-tested in accordance with the EIA/TIA Fiber Optic test procedures and as required by Bellcore GR-20-CORE. Supply proof of successful testing, including documentation of test results.

39.2. EQUIPMENT TESTS

A. Factory Tests

Test a representative, random sample of the equipment furnished to prove compliance with the environmental and electrical requirements of the Project Special Provisions.

Select at least one (1) of each or five (5) percent of the total field units supplied, whichever is greater, for testing. Field units are defined as follows:

- CCTV Camera Assembly

Properly operate test field units for two (2) hours after having been stabilized at the minimum specified temperature, humidity, and voltage. After these tests, operate test units in a proper manner for two (2) hours at the specified normal input voltage after the temperature has been stabilized at 68 degrees F.

The Engineer may accept certified test reports from previously conducted tests of the same models and series as the ones being supplied if the procedure was satisfactory and the documented results indicate compliance with the environmental and voltage specifications.

B. Workshop

The Engineer shall witness all tests.

Provide an enclosed workshop with a test board for testing new controllers and cabinets before installation. Locate the workshop within the City of Gastonia. Ensure that the workshop provides

protection from weather and sufficient space to house two test observers, test material, and controllers and cabinets being tested.

Upon receipt of the traffic signal controller cabinets and controllers in Gastonia, set up the designated cabinet/controller for each intersection at your facility in Gastonia. Load all local phase timings and coordinated system parameters onto the controllers prior to beginning the test period.

Test controllers and cabinets for proper operation, color sequence, flashing operations (including late night flash) and phase timings. Demonstrate that malfunction management programming cards are properly programmed before installation at intersections. Demonstrate that simultaneous inputs to conflicting phases will cause the malfunction management unit to revert the cabinet to flashing operation.

Connect and test each unit to ensure that controllers and cabinets operate without malfunction for at least eight (8) hours in the workshop before installation at an intersection. Following this test, and prior to installation, the Engineer will inspect the equipment in operation to insure conformance to the requirements of the Plans and these Project Special Provisions. These inspections by the Engineer will be made in minimum size lots of five (5) cabinets.

Demonstrate to the Engineer that all of the equipment furnished, installed or modified at each location operates in full compliance with the Plans and these Project Special Provisions.

39.3. CABLE TESTS

Fiber optic cable tests shall be performed on all cable after installation, splicing and termination. All of the fibers shall pass these tests.

Following the fiber optic cable installation, test the entire length of each fiber in each cable using an optical time domain reflectometer (OTDR) at both 1310 nm and 1550 nm. The Engineer or his representative will witness all OTDR tests. Provide the Engineer with durable, labeled plots of the results for each fiber. Also provide these plots on electronic media. Submit calculations demonstrating that the OTDR results for each fiber meet the attenuation requirements of these Project Special Provisions, and that the installation process has not impaired the optical properties of the cable.

If the OTDR results indicate that the cable, splices, or terminations do not meet the attenuation specifications, or if they indicate that the optical properties of the cable have been impaired during installation, then, at your expense, take such action as the Engineer may approve to correct the problem. This may entail complete replacement of the fiber optic cable.

At a minimum, include the following documentation and tests in the fiber optic cable testing

program:

- List of test equipment.
- Cable attenuation measurements in both directions, including average link losses, for every fiber in every segment of every cable.
- Loss for each splice and connection.
- OTDR trace for each fiber with every event annotated.

39.4. INTERSECTION OPERATIONAL TESTS

The Department will conduct complete intersection inspections and operational tests for each project intersection. These inspections and tests will determine whether all the field equipment at each location is installed and permanently labeled properly, and that all functions are in conformance with the Contract Documents. The intersection operational tests will be a non-central controlled functional test of the local controller, including the time-base coordination, emergency vehicle preemption and railroad preemption functions, system detectors, and the full operation of the intersection. All work at the intersection except fiber optic cable installation and termination must be completed for the operational test. This work includes the installation of risers, conduit, junction boxes, conduit entrance into the existing foundation, fiber optic interconnect center, and fiber optic transceiver.

39.5. SYSTEM OPERATIONAL TEST

All equipment and software provided in this project shall be fully installed and operational prior to the start of the system operational test. These test procedures shall demonstrate that all equipment is fully integrated and operational, and is properly controlling the system.

Testing of the software and hardware at the TOC, ROC, MRTMC, Division 12 Office, and other necessary locations shall include demonstrating proper operation based on these project special provisions. These tests shall also demonstrate the proper function of the CCTV surveillance system, including camera selection, pan/tilt/zoom functions, and remote monitoring of video images. These tests shall also demonstrate the proper operation of the new intersections on the graphics display system, the full functionality of the installed operator workstation, and demonstrating proper reception of video signals on the monitor, video equipment, including multiplexers, screen splitters, and control panels.

Submit a system acceptance test procedure to the Engineer for review and approval before any tests are to be conducted.

Submit a System Operational test plan a minimum of sixty (60) days prior to the scheduled start of the test. Within thirty (30) days of receipt, the test plan will be reviewed by the Engineer, and either approve it or indicate changes that are required for approval. The Contractor shall then submit the revised test plan. This process shall be repeated until the Engineer is able to approve the test plan.

Provide an operational test matrix at least four weeks prior to the scheduled beginning of the system operational test. The test matrix shall include columns for a description of the test, a summary of the test procedures, a column with sufficient space for comments and a status (pass/fail) column.

Repair or replace any component or software module that fails the System Operational Test. Retest repaired or replaced component(s) or software module.

The testing shall include, but not be limited to, the following:

- Demonstration of all key functions of the distributed processing signal system software, including but not limited to:
    - Uploading and downloading of controller data
    - Remote access and paging
    - All monitoring functions
    - Detector logging
    - Signal monitor logging and uploading
    - Traffic responsive operations
    - Event scheduler
    - Security functions
    - Graphic displays
    - Reports
- Power failure recovery, auto re-boot, and start-up of the distributed processing signal system software
- Database access, modification, storage, and retrieval
- Database backup and restoration from archived backup
- Dial-up and remote access to the signal system software and CCTV software from the

notebook computers, the MRTMC, and Division 12 Office

- Local Area Network operations
- Demonstrate that all features of the CCTV central software operates as called for with all field equipment

39.6. OBSERVATION PERIOD

Upon successful completion of the System Operational Test and the correction of all known deficiencies, including minor construction items and punch-list items developed by the Engineer, a ninety (90) day Observation Period shall commence. The purpose of this period is to determine that all components of the signal system function in accordance with the Plans and these Project Special Provisions over an extended length of time.

System or component failures that occur during the ninety (90) day Observation Period shall be responded to by the Contractor within two (2) hours, and corrected within twenty-four (24) hours. Failures that affect any of the major system components defined below for more than seventy-two (72) hours shall suspend the timing of the ninety (90) day Observation Period beginning at the time when the failure occurred. After the cause of such failures has been corrected, timing of the ninety (90) day observation period shall resume. System or component failures that necessitate a redesign of any component, and failures in any of the major system components exceeding a total of three (3) like major system components in any thirty (30) day period for the entire complement of major system components, shall terminate the ninety (90) day Observation Period and shall cause the ninety (90) day Observation Period to be restarted from zero when the redesigned component has been installed and/or the failures corrected. The major system components are:

- Local controllers and cabinets
- Fiber Optic Communication Network, including transceivers
- System hardware and software
- CCTV System
- Local Area Network

The ninety (90) day Observation Period is considered to be a part of the work included in the total contract time and must be completed prior to acceptance of the Project. All documentation required by **Section 37** and elsewhere in these Project Special Provisions shall be completed prior to the end of the ninety (90) day Observation Period.

Final Acceptance will occur at the successful completion of the ninety (90) day Observation

Period and after all documentation requirements have been fully satisfied.

39.7. FINAL ACCEPTANCE

After all equipment and software comprising the system has been accepted, satisfactory completion of the system acceptance test, and after the training is complete, a 90-day observation period begins. This observation period shall serve to evaluate full-scale operation of the system under normal conditions. The City will be responsible for operating the system during this period. The goal of the observation period is to demonstrate that the system has been properly installed and integrated, performs properly, and complies with the Contract Documents.

Upon successful completion of the observation period, the Department will accept the system, providing that all errors and omissions in documentation supplied by you have been fixed, and all other requirements of the Contract Documents have been met. Final acceptance will be in writing from the Department.

39.8. BASIS OF PAYMENT

Testing will not be measured for separate payment. Include the cost of all required testing in the unit bid price for other items furnished on this project.

40. TRAINING

40.1. DESCRIPTION

Provide training for the installation, operation and maintenance of the computerized traffic system.

40.2. MATERIALS

Provide training to properly install, operate, maintain, diagnose and repair each piece of equipment and the software associated with the system. Provide approved manufacturer's representatives or other qualified personnel to conduct training courses. Provide training for a total of fifteen City and Department personnel.

Prior to commencement of the training course, submit detailed course curricula, draft manuals, and handouts, and resumes of the instructors for review and approval. The Engineer may request modification of the material and request courses desired by the City and Department.

For all training programs, a staff of engineers, technicians, and maintenance personnel familiar with traffic signal systems will be the training participants. A "day" of training shall consist of training conducted between the hours of 8:30am and 4:30 pm. For each session, provide training materials (manuals, notebooks, hand-outs, etc.) as specified in the Documentation Section of these Project Special Provisions.

Qualified instructors shall present all training courses, lectures, and demonstrations in person. The Engineer shall approve all instructors.

Unless otherwise specified, accommodate a minimum of fifteen (15) persons at each session. Limit all hands-on computer exercises to two participants per computer. Furnish additional networked computers (equivalent to those furnished with the project) as necessary to maintain that ratio of two participants per computer.

Conduct all training courses at a location provided by the Contractor within the city of Gastonia and at a time mutually agreed upon, but not later than the start of system acceptance testing. Provide training material, manuals, and other handouts to serve not only as subject guidance, but also as quick reference for use by the students. Deliver course material in reproducible form immediately following the course.

A. Subject Areas

Provide the training sessions at the required durations as listed in the Table below. A more

detailed description of the required content of each training session is provided in the following sections. As part of the Project Implementation Schedule, propose the time of occurrence of each such training schedule.

Subject	Minimum Duration
System Overview	1 Day
Computer Hardware, Traffic Control Center LAN and Peripherals – Session 1	1 Day
Computer Hardware, Traffic Control Center LAN and Peripherals – Session 2	1 Day
Traffic Control Applications Software – Session 1	1 Day
Traffic Control Applications Software – Session 2	2 Days
Traffic Control Applications Software – Session 3	3 Days
Traffic Control Applications Software – Session 4	1 Day
Traffic Control Applications Software – Session 5	2 Days
2070L Controller Programming, TBC Operation, TR Operation, Controller Hardware and Cabinet Hardware Assemblies, Utility Software (for Signal Timing Personnel and Maintenance Personnel)	3 Occurrences at 5 Days Each
Fiber Optic Communications System	2 Occurrences at 3 Days Each
Central Communications Equipment	3 Days
CCTV System – Session 1	1 Day
CCTV System – Session 2	1 Day

B. Required Content and Format

B.1. Traffic Control System Overview

This training session shall consist of a lecture and discussion on the overall. The purpose of the session is to provide an overview of the traffic control system. This training session shall have a minimum duration of one (1) day.

B.2. Computer Hardware, Control Center LAN and Peripherals

The training session shall consist of classroom training and workshops regarding the operation of each of the traffic control system hardware elements and the operator interface. Conduct training by experienced vendor personnel.

The first session shall involve the operation and maintenance procedures for each element of the

traffic control system hardware. As part of this session, stress the precautions that must be observed when operating the equipment. As a minimum, cover the following subjects in this segment of the training session:

- Overview of equipment functions and interactions.
- Computer system operation; restart, cold start.
- Functional operation of the servers, Ethernet Control Center LAN and DAT backup system (including maintenance, paper replacement, etc.)
- Traffic Control Center and Signal Shop workstation and printer operation, maintenance, paper replacement, etc.
- Central communication operation.
- Troubleshooting and problem identification of equipment.

At a minimum, the second session shall consist of the following:

- Operating system, including network operating system
- Operating system commands, including loading and executing programs, and archiving data to the backup system
- Detection of abnormal conditions within the operating system and hardware
- File management and disk organization
- Techniques for creating and editing files, including those used for the traffic control system databases

Each of these two training sessions shall have a minimum duration of one (1) day (lectures and/or workshops).

B.3. Traffic Control Applications Software

These two (2) sessions of training for NCDOT and City staff shall include the basic theory and functional application and operation of the traffic control software supplied by the Contractor, including the interface between the application program and the microcomputer operating system. This training system shall include but not be limited to:

B.3.1. Session 1

The first session shall cover the fundamentals of the traffic control software supplied by the Contractor. This shall include, but not be limited to:

- Time-of-day operation and event scheduling
- Traffic responsive pattern selection algorithms

The first session of this training course shall consist primarily of lectures and shall have a minimum duration of one (1) day.

B.3.2. Session 2

The second session shall include, but not be limited to:

- Reporting capabilities
- Interactive database manipulation
- Theory and application of traffic responsive operation
- Special function features

The second session shall include a mixture of lectures and workshops and shall have a minimum of duration of two (2) days.

B.3.3. Session 3

The third session shall consist of an overview of the two previous sessions. The training shall emphasize operation of the system including recommended procedures. Allow sufficient time to answer NCDOT and City questions. This session shall consist of a mixture of lectures and "hands-on" workshops and shall have a minimum duration of three (3) days. Course material shall include the software documentation and the system user's manuals.

B.3.4. Session 4

The fourth session shall cover the development and modification of screens used in the graphics display of the traffic control applications software. This fourth session shall include lecture and classroom exercises and shall have a minimum of duration of one (1) day. Course material shall include the software documentation and the system user's manuals.

B.3.5. Session 5

The fifth session shall cover the creation, placement and operation of the dynamic portions of the graphics display of the traffic control applications software. Upon completion of this session the NCDOT and City personnel shall be able to prepare dynamically functioning graphics for the traffic control applications software. This fifth session shall include lecture and classroom exercises and shall have a minimum of duration of two (2) days. Course material shall include the software documentation and the system user's manuals.

Maintain the order of these sessions as described above. The length of the sessions may vary with the mutual consent of the City NCDOT and the Contractor.

B.4. 2070L Controller Programming

Hold three identical controller training sessions for maintenance personnel. Each of the identical training sessions shall consist of five (5) consecutive days, beginning on a Monday. **Conduct one of these training sessions prior to the installation of any new controllers and cabinets on the project.**

These three sessions include training for NCDOT and City traffic engineering, signal timing, and maintenance personnel on controller and internal TBC operation and cabinet assemblies.

B.4.1. Controller and TBC Operation

The controller training session for signal timing engineers and technicians shall consist of formal classroom presentation of the functional operation of the 2070L controller furnished by the Contractor, followed by a "hands-on" workshop focusing on actual entry of timing data. The formal presentation and workshop shall have a combined duration of two (2) days. This session shall be taught by experienced vendor personnel who thoroughly understand both the traffic engineering aspects of signal timing and the entry of timing into the controller and internal TBC's. This session shall cover the entry and editing of:

- All local intersection timing parameters
- All coordination timing parameters
- All parameters and threshold levels associated with traffic responsive operation.

Conduct this session after the system software and test controller are operational and include opportunities for "hands-on" entry and editing of the timing and use of local controller utility software.

B.4.2. Controller and Cabinet Assemblies

A field service specialist(s) employed by the traffic signal controller manufacturer shall conduct the classes. Each maintenance training class shall consist of a formal classroom presentation which covers routine maintenance and troubleshooting procedures for each type of controller and cabinet assembly furnished by the Contractor, followed by a "hands-on" workshop wherein maintenance personnel will troubleshoot simulated controller and cabinet assembly faults to the component level.

The controller maintenance training shall include a session on signal monitors and a session on detector amplifiers. The signal monitor training shall cover theory of operation, routine

maintenance, troubleshooting procedures, and periodic testing to verify that conflict conditions are reliably detected. Detector training shall cover the functional operation, routine maintenance, and troubleshooting procedures for the detector hardware furnished under this contract by the Contractor, including the detector sensor units, lead-in cables, and the loop wire. The training shall include "hands-on" experience in troubleshooting simulated detector problems including malfunctioning sensor units, lead-in cable problems, and roadway loop problems. The training shall include a full description of the detector test procedures.

B.5. Fiber Optic Communications System

Provide two (2) identical training sessions on the maintenance of the fiber optic communications system shall be held. Each shall be presented by field service specialist(s) employed by the vendors of both the active and passive elements of the fiber optic system. Each identical session shall consist of one (1) formal classroom presentation and one (1) workshop. The training shall cover the procedures for cable terminations and troubleshooting problems in the communications cable network such as the location of cable breaks, emergency (mechanical) splicing procedures, permanent (fusion) splicing procedures, identifying problems associated with the field electronics and the use of the fiber optic test equipment furnished by the Contractor. Each of the identical sessions shall have a minimum duration of three (3) days. These two identical sessions shall be held a minimum of two (2) weeks apart from each other.

B.6. Central Communications Equipment

Provide a training session, conducted by experienced vendor personnel and consisting of both operation and maintenance training of the Central Communication Equipment for the signal system. As a minimum, this session shall include the following subjects:

- Operational theory
- Operational procedures
- Troubleshooting procedures
- Communications validation
- Local Area Network Hardware/Software

Provide a workshop session to reinforce the lectures and demonstrate troubleshooting and problem identification of equipment to the component level as well as validation of communications.

This lecture/workshop training session shall have a minimum duration of three (3) days.

B.7. CCTV Central and Field Equipment

Provide two sessions for the CCTV central and field equipment training. The first session shall address the maintenance of the CCTV equipment. The training shall address the preventative maintenance and trouble shooting procedures for all the field and central equipment including the video transceivers.

This session shall consist of a mixture of lecture and hands-on workshops and shall have a minimum duration of one (1) day.

The second session shall address the operational theory and procedures of the CCTV system. This training shall be oriented towards users of the system. The training shall address the use of, but not limited to, the following devices:

- Video Server
- Camera control software
- Camera control panel
- Video switch

Include "hands-on" training workshop with a minimum duration of one (1) day as part of this session. The CCTV training sessions shall be presented by field service specialist(s) employed by the suppliers of the CCTV system components.

40.3. METHOD OF MEASUREMENT

Training will not be measured, and will be paid on a lump sum basis.

40.4. BASIS OF PAYMENT

Payment will be made under:

Training.....Lump Sum