Project Special Provisions

U-5168
City of Jacksonville
Traffic Signal System

Final

July 20, 2011

Prepared for:
North Carolina Department of Transportation

PROJECT SPECIAL PROVISIONS

FINAL

TIP U-5168

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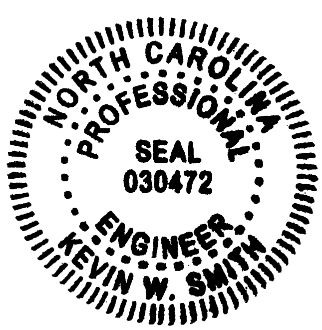
PREPARED FOR:

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

INTELLIGENT TRANSPORTATION SYSTEMS SECTION



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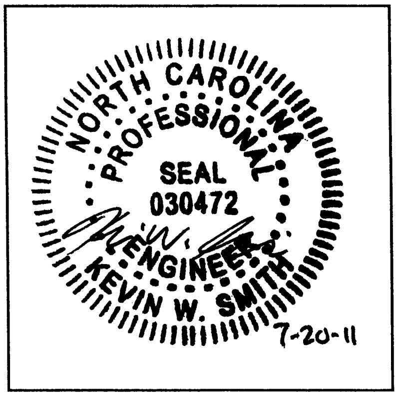
Prepared by: KWS



Project Special Provisions

Intelligent Transportation Systems Section

Prepared By: KWS

20-July-11

Contents

1. GENERAL REQUIREMENTS

1.1. DESCRIPTION

A. General

Furnish, install, and fully integrate new fiber optic communications cable, existing fiber optic communications cable, new cellular and wireless radio communications links, new and existing traffic signal controllers and cabinets, new closed-circuit television (CCTV) camera units and control cabinets, new dynamic message sign (DMS) units and control cabinets, new central hardware and software, and new traffic operations center to form a complete and operational central distributed processing traffic signal system for the City of Jacksonville in North Carolina.

Furnish, install, and fully integrate new 2070L traffic signal controllers and new model 332 and 336 style cabinets to replace existing NEMA controllers and cabinets at locations shown in the Plans. Fully integrate existing 2070L traffic signal controllers with signal system. Integrate signal controllers with Ethernet switches and fiber optic network.

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

Furnish and install new fiber optic communications cable to be used by the City of Jacksonville IT Department. City IT cables will be installed as shown on the Plans by lashing to existing cables and new messenger cable installed under this project. City IT cables will be installed concurrently with signal system cables and terminate at locations shown on the cable routing plans. **The installation of City IT cables shall be at the discretion of the Engineer, as it is dependent on funding. In the event that the Engineer directs the Contractor to not install City IT cables, those associated pay items will be removed from the contract and there will be no renegotiation in the price allowed for remaining pay items.**

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

Furnish and install new dynamic message sign (DMS) assemblies at locations shown in the Plans. Fully integrate DMS assemblies with Ethernet switches and the fiber optic communications network or cellular communications as shown in the Plans.

Complete and fully integrate a new traffic operations center (TOC) to be housed at the Jacksonville Public Safety Complex located at 206 S. Marine Boulevard in Jacksonville. Terminate all fiber optic communications cables in the Public Safety Complex Server Room as shown in the Plans, and integrate with new TOC.

Complete and fully integrate a new signal maintenance shop (Signal Shop) to be housed in Building 3B of the Jacksonville Public Services Complex located at 350 S. Marine Boulevard in Jacksonville. Install and fully integrate remote TOC operations at the Signal Shop as shown in the Plans. Install and integrate a test cabinet and controller with the communications network.

B. Standard Specifications

Conform to these Project Special Provisions, the Plans, the NCDOT 2006 Standard Specifications for Roads and Structures (also referred to as the "Standard Specifications"), and Section 1087 (Pavement Markings) of 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. MATERIALS

A. Qualified Products

Furnish new equipment, materials, and hardware unless otherwise required. Inscribe 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.

Furnish factory assembled cables without adapters, unless otherwise approved by the Engineer, for all cables required to interconnect any field or central equipment. This equipment may include, but is not limited to, conflict monitors, codecs, and Ethernet switches.

ITS & Signal Equipment Qualified Products List (QPL) is available on the Department's website. The QPL website is:

http://www.ncdot.org/doh/preconstruct/traffic/ITSS/SMS/qpl/

Certain signal and communications equipment, material, and hardware shall be pre-approved on the QPL by the date of installation. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project. Consult the QPL website to obtain pre-approval procedures.

B. Observation Period

Prior to final acceptance, all Contractor-furnish equipment and software shall successfully complete a 60-day observation period. The 60-day observation period is considered to be part of the work included in the total contract time and must be completed prior to final acceptance of the project.

Final acceptance will occur following the successful completion of the 60-day observation period and after all documentation requirements have been fully satisfied. Refer to in Section 43 (Testing and Acceptance) in these Project Special Provisions for additional requirements.

C. 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 one year in length, whichever is greater, from the date of final acceptance of the project by the Department. Include unconditional coverage for all parts and labor necessary or incidental to repair defective equipment or workmanship and malfunctions that arise during warranty period.

Ensure 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 receipt of the Department's written final acceptance of the project, transfer manufacturer's warranties with proper validation by the manufacturer to the Department or its designated maintaining agency.

D. Firmware Licensing and Upgrades

Provide the Department with a license to duplicate all programmable devices in equipment for maintenance and software upgrades. Provide binary or hexadecimal format files for each device that may be programmed by the Department. Ensure files are provided on PC compatible compact disks or other approved media.

Ensure 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.

Provide licensed copies of all software/firmware to the department. The department shall have the right to install any and all software/firmware for maintenance and support on all hardware provided under this contract. This shall include, but not be limited to all servers for the Signal System, CCTV System, LAN System, traffic controllers and network. Provide software/firmware for maintenance and support of workstations, laptop computers, System Support software, Utility software, traffic controllers, DMS systems and controllers, CCTV systems and controllers, and all other programmable devices.

E. Wire and Cable

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

Provide either 0.05" x 0.30" aluminum wrapping tape or 0.06" stainless steel lashing wire for lashing cables to messenger cable. Use 0.045" stainless steel lashing wire to lash fiber-optic communications cable to messenger cable.

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.

F. Painting

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

1.3. CONSTRUCTION METHODS

A. General

Before beginning signal work, verify 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 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.

Locate existing conduit, cable runs, inductive detection loops, lead-in, junction boxes, and detection equipment before installing or using equipment that can damage or interfere with such facilities. The locations of existing inductive detection loops shown are approximate.

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

Ensure that an IMSA certified, or equivalent, Level II traffic qualified signal technician is standing by to provide supervision and 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 services.

Immediately cease work and notify the Engineer and 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 or above Technicians to perform all cabinet placement, cabinet wiring and controller programming. Program the controllers and wire the cabinets according to the traffic signal and electrical plans, 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.

B. Regulations and Codes

Furnish material and workmanship conforming to the NEC, NESC, UL, 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. Comply with NESC Part 2 if working within the power space on utility poles. In the event of a conflict between the NEC, NESC, UL, local safety codes in effect on the date of advertisement and these Specifications, the cited documents will govern.

Where required, conform to ITE, IEEE, AASHTO, and ASTM in effect on the date of advertisement.

Notify the Engineer, local traffic enforcement agency, local utility company, and 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, NEC, local utility companies, and local ordinances.

Fully comply with all City of Jacksonville local ordinances for working hours and noise levels.

C. Utility Services

Coordinate all work to ensure electrical power of proper voltage, phase, frequency, and ampacity is available to complete the work. Use electrical services cables with THWN insulation.

When electrical, telephone, and telecommunication service is not furnished by the Department and is required, contact the utility company and make application to ensure 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 and the City will be responsible for direct payment of monthly utility company usage charges. The Contractor will be responsible for all expenses associated with utility installation costs, hookups, etc.

D. Maintenance and Repair of Material

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

Maintain and repair all signal and communications related equipment within the project construction limits until completion of the observation period and receipt of written notification of final acceptance 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.

For all failures, malfunctions, or damages to equipment, begin necessary repairs within two hours of notification. Complete repairs within four hours of notification. Comply with Section 150 of the Standard Specifications for maintenance of traffic flow. The inability to contact the supervisory employee or prearranged alternate will not extend repair time requirements.

Remove and replace all signal and communications related equipment that fails. The Department will furnish the Contractor replacement equipment for Department-furnished equipment that fails.

Except for damages and malfunctions caused by the Contractor's work activities, the Contractor will not be held responsible for pre-existing conditions 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. Repair scratches, dents, or other damage to the cabinet that occur while the cabinet is in under the Contractor's responsibility.

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 maintenance and emergency service necessary to ensure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option will be deducted from payment due the Contractor, plus $2,500 liquidated damage per occasion, per day, or any portion thereof, until corrected.

Perform maintenance (testing) on all Traffic Signal Conflict Monitors every twelve (12) months for the life of the project beginning with the initial test and every twelve (12) months thereafter. Provide the initial test date via the manufacturer's certification or via testing prior to installation of the conflict monitor at an intersection. Use the ATSI Incorporated Model PCMT-2600 Conflict Monitor Tester, or an Engineer approved equivalent. Ensure that the Conflict Monitor Tester is maintained and calibrated per the manufacturer's recommendation. Provide to the Engineer a copy of the manufacturer's certification that the Conflict Monitor Tester is in proper working order before testing the Traffic Signal Conflict Monitors. Perform the test on the Traffic Signal Conflict Monitors per the manufacturer's recommendation. For each Traffic Signal Conflict Monitor tested, provide two (2) dated copies of the test results: submit one (1) copy to the Engineer and place one (1) copy in the traffic signal cabinet.

Maintain traffic signal system equipment until completion of the 60-day Observation Period and written notification of final acceptance of the project has been received from the Engineer.

This requirement for maintaining and repairing said equipment shall remain in effect in the event of a natural disaster such as flood, ice storm, tropical storm or hurricane.

Make entries into the maintenance diaries housed inside each traffic signal controller cabinet upon each visit to the controller cabinet. Maintain these diaries through final acceptance of the project.

E. Performance of Warranty Repair and Maintenance

Provide authorization to the City of Jacksonville to perform all warranty repairs after project acceptance. The decision to perform warranty work at a City facility by City technicians or to have warranty work performed by the vendor shall be at the discretion of the State. Provide any training required by the manufacturer to authorize the City to perform warranty work and ensure manufacturer will furnish parts to the City for all warranty repairs at no cost to the City of Jacksonville. In addition, ensure the manufacturer agrees to provide prompt technical support to the City technicians for a period of one year after the end of the warranty period at no cost to the City of Jacksonville. Defective parts replaced under warranty by the City will be returned to the vendor at the vendor's request. Provide schematics, part lists, and other documentation to perform bench repair to the City within two weeks upon request. The City of Jacksonville agrees not to divulge any proprietary information in the schematics, part lists, and other documentation upon request from the vendor. After project acceptance and at the request of the City, manufacturer shall perform warranty repairs to equipment which fails during the warranty period at no cost to the City of Jacksonville including freight costs to ship repaired equipment back to the City. Ensure all equipment is repaired and returned to the City within twenty-one calendar days of receipt by the manufacturer.

F. Inspections

The Department may access the Contractor's equipment to perform railroad, signal, and preventative maintenance inspections, or conflict monitor certification as necessary. The Contractor shall be present for these inspections.

G. Removal of Existing Equipment and Material

Remove all Department-owned signals and communications related equipment and material that will not be used. Assume ownership of the removed poles, cabinet foundations, messenger cable, guy assemblies, interconnect cable, communications cable, and supporting hardware. Return all other traffic signal equipment and material (including wireless radio transceivers and antennas) between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Division 3 Traffic Services Office, located at 5504 Barbados Boulevard in Castle Hayne 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 Jacksonville owned signals and communications related equipment and material that will not be reused. Assume ownership of the removed poles, cabinet foundations, messenger cable, guy assemblies, interconnect cable, communications cable, and supporting hardware. Return all other traffic signal equipment and material to the City Public Safety Complex located at 206 S. Marine Boulevard in Jacksonville, between 8:00 AM and 12:00 PM, Monday through Thursday, or at a time mutually agreed to by the Contractor and the Signal System Manager. 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.

The Department will deduct the cost of Department-owned or City-owned equipment damaged by the Contractor from money due to the Contractor.

H. Emergency Vehicle Preemption Systems

Where required, preserve the existing emergency vehicle preemption systems functionality during signal cabinet change-outs or other cabinet modifications by reusing and/or providing all necessary equipment and hardware. This work shall be considered incidental to the installation of new signal cabinets.

At locations shown in the Plans, the Contractor is to implement and install new emergency vehicle preemption systems. Coordinate emergency vehicle preemption work with the proper operating authority. Contact the proper operating authority and schedule installation of emergency vehicle preemption equipment.

I. Emergency Generator Provisions

Where required, preserve the existing emergency generator functionality during signal cabinet change-outs or other cabinet modifications by reusing and/or providing all necessary equipment including lockable power inlet box and manual transfer switch. Comply with all requirements shown in the Detail drawings in the Plans for emergency generator provisions to ensure that the existing functionality is maintained. This work shall be considered incidental to the installation of new signal cabinets.

At locations shown in the Plans, the Contractor is to implement and install new emergency generator provisions including lockable power inlet box and manual transfer switch. Comply with all requirements shown in the Detail drawings in the Plans for emergency generator provisions.

J. Timing of Signals

Implement timing values for signal controllers. Extract all parameters necessary to implement coordinated signal operations from the existing controllers. Make any modifications to the cycle, split, and offset information extracted from the existing controllers that are necessary to implement the timing plans into the new 2070 controllers and system database. The Engineer may, at his/her option, observe the loading of the timing plans.

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, 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.

K. Wire and Cable

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

Splice all electrical wire and cable at recessed-screw, barrier type terminal blocks, in junction boxes, or in condulets. 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 shoulder eyebolts, washers, nuts, thimbleyelets, three-bolt clamps, J-hooks, split bolt connectors, grounding clamps, and lashing material.

L. Electrical Services and Grounding

Where electrical services do not include an external electrical service disconnect, modify service to include electrical service disconnect and a new grounding electrode system.

Provide a grounding electrode system at all new electrical services. In addition to NEC requirements, test grounding electrode resistance for a maximum of 20 ohms. Furnish and install additional ground rods to grounding electrode system as necessary to meet test requirements.

Modify existing electrical services, as necessary, to meet the grounding requirements of the NEC, these Standard Specifications and the project plans. Remove any ground rods in the cabinet foundation and install a new grounding electrode system. Cut off abandoned ground rods in the cabinet foundation flush with the foundation surface. Where a grounding electrode system is connected to the electrical service in accordance with the NEC, test grounding electrode resistance for a maximum of 20 ohms. Grounding electrode resistance test must be verified or witnessed by the Engineer or the Engineer's designated representative. Furnish and install additional ground rods to grounding electrode system as necessary to meet the Standard Specifications and test requirements.

Follow test equipment's procedures for measuring grounding electrode resistance. When using clamp-type ground resistance meters, readings of less than 1 ohm typically indicate a ground loop. Rework bonding and grounding circuits as necessary to remove ground loop circuits and retest. If a ground loop cannot be identified and removed to allow the proper use of a clamp-type ground resistance meter, use the three-point test method.

Submit a completed Inductive Loop & Grounding Test Form available on the Department's website.

http://www.ncdot.gov/doh/preconstruct/traffic/ITSS/ws/signal_data.xls

Provide a length of marker tape 6" to 12" below finished grade directly over grounding electrodes and conductors.

M. Electrical Bonding

Using an approved termination means, connect a #14 AWG minimum, 19-strand copper conductor (Type THWN) with green insulation to serve as an equipment grounding conductor to metal poles, vehicular and pedestrian signal pedestals, and other metallic components. Use messenger cables on wood poles and metal strain poles to provide effective ground fault current path to cabinet ground.

N. Contractor's Office

Throughout the project until final acceptance, the Contractor shall maintain full-time staffed office with storage and testing facilities within the Jacksonville City Limits.

O. Related Projects

The current Piney Green Road Widening Project (NCDOT TIP # U-3810) is widening Piney Green Road between Marine Boulevard and Lejeune Boulevard, relocating existing utility poles and upgrading traffic signals. According to the Sequence of Construction in these Project Special Provisions, the Contractor is to begin installing fiber optic cable in this area first. Coordinate with the Engineer on how to proceed if U-3810 utility relocations have not been completed and construction in these areas is on the critical path of the project schedule.

Other TIP projects, ongoing and planned, for the project area include the White Street Extension Roadway Project (NCDOT TIP # U-4007A), the Western Parkway Roadway Project (NCDOT TIP # U-4007B), and Camp Lejeune Base Entry Road Project (NCDOT TIP # U-5132). New conduit and/or fiber optic cable is being installed under U-4007A and U-4007B for use by the Jacksonville Signal System communications network as shown in the Plans. New and upgraded signals that will be included in the Jacksonville Signal System along with roadway improvements are being done under U-5132. Maintain ongoing coordination with the Engineer on the progress of these other projects. Coordinate with the Engineer on how to proceed if any facilities or communications designated as existing in the Plans have not been fully completed.

The City has general maintenance backlog work for public safety that will need to be continued throughout the duration of this project. Coordinate with Engineer if construction is not complete for actions to be taken until construction is complete.

P. Sequence of Construction

At the direction of the Engineer, install new messenger cable throughout the entire project area at the beginning of construction to reserve spot on existing utility poles for fiber optic cable to be install for the Jacksonville Signal System. Identify fiber optic cable attachment location by installing communications cable ID markers on messenger cable.

Perform construction of the project in the sequence called for in these Project Special Provisions. All work not performed in accord with the sequence of construction must be approved by the Engineer. Adherence to the sequence of construction must be reflected in the Contractor's project schedule and all updates to the project schedule. As new intersections are installed but are not under monitoring and supervision of the new central system, maintain existing signal coordination and common controller clock time. All clocks that are updated shall be updated from a single clock source. Review each intersection that has been installed but is not online on a weekly basis in the form of a field visit and review the controller clock for drift against the common time source. Reset clock to common time source if it has drifted. Record time and date of each visit, activity performed, and person performing visit. Maintain a record of clock maintenance activity in a single document and furnish to the Engineer for review upon request. Failure to visit each intersection that is not online to check and update clocks will result in a liquidated damage of $1,500 per visit not performed.

For the Sequence of Construction, the areas of interest have been defined a Zone.

Zones A and Zone B include traffic signals that are currently operating in existing closed loop systems. Construction shall have minimal disruption to the existing signal 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. Establish time-based coordination within the limits of the prior closed loop system and maintain controller clocks. Construction at locations within Zone A shall be completed first. Construction at locations within Zone B shall be completed after Zone A and following the completion of planned roadway re-surfacing projects. Coordinate with the Engineer on the status and schedule of these roadway re-surfacing projects within Zone B.

Zone C includes traffic signals that are not currently operating in a closed loop system, but construction at these locations shall be completed following the completion of planned roadway re-surfacing projects. Coordinate with the Engineer on the status and schedule of these roadway re-surfacing projects within Zone C.

Zone D includes traffic signals and communications cables that are within the project limits of U-3810 (Piney Green Road from Marine Boulevard to Lejeune Boulevard). Fiber optic cable in this zone shall be installed first, provided that the U-3810 utility relocations have been completed. All signal integration for traffic signals, future CCTV, and future DMS will be completed under U-3810.

All work at the TOC shall commence following the completion of all intersection and communications work. The Contractor will not have access to the TOC facility until the new Public Safety Complex has been completed and officially occupied by the City.

Q. Electrical Requirements

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), the National Electrical Safety Code (NESC), the Telecommunications Industry Association (TIA), and Underwriters Laboratories (UL).

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.

1.4. REQUIREMENTS FOR CABLES CROSSING RAILROADS

Copies of all executed railroad agreements and related correspondence may be obtained from the Resident Engineer.

A. 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 owned by the Norfolk Southern Railway Company herein called the Railroad Company. Install fiber optic communications cable as shown on the Plans.

B. Requirements for Insurance

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 rights(s) of way under the terms of the contract by carrying insurance of the following kinds:

B.1. Contractor's General Liability and Railroad Protective Liability Insurance

i. Furnish a certificate of general liability insurance and railroad protective liability insurance evidencing a combined single limit of a minimum of $1,000,000.00 per occurrence of general liability insurance and $1,000,000.00 per occurrence of railroad protective liability insurance naming Norfolk Southern Railway Company as the certificate holder and as an additional insured on both the general and railroad protective liability insurance policy.

ii. 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.

iii. Certificates shall make reference to the project, milepost and county. Certificate description and project designation to include the following information: Installation of fiber optic communications cable over tracks of the Norfolk Southern Railway Company, Onslow County (include Railroad Milepost) identified as NC Project U-5168 (Jacksonville Signal System).

Use the address below for the Certificates of Insurance holder:

Norfolk Southern Corporation

Attn. Risk Manager

Three Commercial Place

Norfolk, VA 23510

iv. All 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 Corporation

Attn. Risk Manager

Three Commercial Place

Norfolk, VA 23510

COPY NOTICE TO:

Department of Transportation

Utilities Coordination Unit

c/o State Railroad Agent

1556 Mail Service Center

Raleigh, NC 27699-1556

v. Carry all insurance herein specified until the final inspection and acceptance of the project, or that portion of the project within railroad right of way, by the Department of Transportation or, in the case of subcontractors, until the Contractor furnishes a letter to the Engineer stating that the subcontractor has completed his subcontracted work within railroad right of way to the satisfaction of the Contractor and the Contractor will accomplish any additional work necessary on railroad right of way with his own forces. 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.

vi. 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.

<u>Send to Department:</u>

Department of Transportation

Utilities Coordination Unit

c/o State Railroad Agent

1556 Mail Service Center

Raleigh, NC 27699-1556

C. 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.

D. 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.

E. 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.

F. 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 is 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.

G. 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.

H. 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.

I. 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.

1.5. MEASUREMENT AND 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 to mobilize personnel, materials and equipment to the project site.

2.2. MEASUREMENT AND PAYMENT

Mobilization will be paid for as contract lump sum price.

Partial payments for 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 on each of these partial pay estimates, 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.

Such price and payment includes but is 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 that shall be performed for costs incurred prior to beginning work on the various items on the project site.

Payment will be made under:

Mobilization..Lump Sum

3. GUARDRAIL

3.1. DESCRIPTION

Construct permanent steel beam guardrail, in accordance with the requirements of the contract and at the locations designated on the plans or as directed.

3.2. MATERIALS

Refer to Division 10 of the Standard Specifications for the following items.

Item	Standard Specifications Section
Rail Elements	1046-2
Posts and Offset blocks	1046-3
Hardware	1046-4
Anchors	1046-5
Welded Wire Fabric	1070-3
Organic Zinc Repair Paint	1080-9
Guardrail and Barrier Delineators	1088-2
Guardrail End Delineation	1088-3
Select Material, Class VI	1016

Supply material in accordance with the Department's Brand Certification Program for Guardrail.

3.3. CONSTRUCTION METHODS

Erect the rail elements to produce a smooth continuous rail paralleling the line and grade of the highway surface or as shown on the plans. Lap the rail elements in the direction of traffic. Re-lap the rail elements if required by traffic phasing. Field drill holes for special details. Field punching holes is allowed. Attach terminal sections, when required, to the ends of each installation and lap on the face of the rail.

Install shop curve guardrail in accordance with the plans.

Posts may be power driven, or set by hand. Protect the top of steel posts by a suitable driving cap if power driven. If set by hand, dig post holes to the depth and at the locations shown on the plans.

Thoroughly ram the bottom of the post holes so that the posts will have a stable foundation. Set the posts plumb and accurately space and line. Backfill the post holes in 6" layers with suitable material and thoroughly compact by tamping or puddling.

Where rock interferes with the proper installation of the post, excavate a shaft in the rock not less than 9" wide, parallel to the roadway, by 23" long, perpendicular to the roadway, and 24" deep. Place the post against the roadside edge of the shaft and fill in behind the post with Select Material Class VI, up to the top elevation of the rock. Fill the remainder of the hole with earth material. Where timber posts are to be driven in fill slopes 1 1/2:1 or steeper and the fill height is 15 feet or more, auger a 6" diameter pilot hole to the full depth of the post before driving.

Where steel posts are required to be installed at box culverts, weld the post to the anchor plate, cut off, and align in accordance with the details shown in the plans or as directed.

Use the same type of guardrail posts and offset blocks throughout the project unless otherwise directed or detailed in the plans.

After galvanized guardrail has been erected, clean all scarred, scratched, or abraded areas of all loose spelter coat and rust. Paint with organic zinc repair paint 3 mils thick.

When guardrail is being constructed near traffic, conduct operations so as to constitute the least hazard to the public. Schedule and conduct operations to construct and complete each individual continuous guardrail installation in the least possible time.

Do not begin work on any section of new guardrail until preparations are made to fully complete the installation of the section as a continuous operation. Once work is initiated on a section, pursue the work to its completion unless inclement weather or other conditions beyond the control of the Contractor interfere with the work. Begin attachment of the rail elements at the approach end of the guardrail and continue in the same direction as the movement of traffic.

When directed, install guardrail posts and blocks at locations that are in addition to those required by the plans.

Install tubular triple corrugated steel beam guardrail on concrete bridges or driven posts or at locations shown in the plans in accordance with the details shown in the plans and as directed. Where the tubular triple corrugated steel beam guardrail is to be mounted on concrete, use steel posts, weld the post to the anchor plate, cut off, and align in accordance with the details shown in the plans or as directed.

3.4. GUARDRAIL DELINEATORS

Use any of the several alternate delineator types for guardrail shown in the plans, but only one delineator type for guardrail at any one time throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the guardrail as shown in the plans. Only one attachment position will be permitted throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops, or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

3.5. MEASUREMENT AND PAYMENT

Steel Beam Guardrail will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Steel Beam Guardrail, Shop Curved will be measured and paid for in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of the outermost post in the length of guardrail being measured.

Guardrail Anchor Units, Type __ will be measured and paid for as units of each that have been completed and accepted. No separate measurement will be made of any rail, terminal sections, posts, offset blocks, concrete, hardware, or any other components of the completed unit that are within the pay limits shown on the plans for the unit as all such components will be considered to be part of the unit.

Additional Guardrail Posts will be measured and paid for in units of each for additional posts required but not shown in the plans.

There will be no measurement or payment made for Guardrail Delineators as they are considered incidental to the other pay items in this Specification.

There will be no measurement or payment made for Guardrail End Delineation as it is considered incidental to the other pay items in this Specification.

Such price and payment includes, but is not limited to furnishing and erecting posts, offset blocks, rail, terminal sections, miscellaneous hardware, and all other materials, field curving and shop curving of the rail; removing temporary guardrail; excavation; furnishing and installing additional guardrail posts and additional offset blocks; backfilling; fabrication; welding; galvanizing; furnishing and installing guardrail delineators and end delineation.

Payment will be made under:

Steel Beam Guardrail .... Linear Foot

Steel Beam Guardrail, Shop Curved .... Linear Foot

Guardrail Anchor Units, Type 350 .... Each

Guardrail Anchor Units, Type CAT-1 .... Each

Additional Guardrail Posts .... Each

4. SIGNAL HEADS

4.1. DESCRIPTION

Furnish and install vehicle and pedestrian Light Emitting Diode (LED) signal heads, visors, interconnecting brackets, wire entrance fittings, mounting assemblies, signal cable, lashing wire, pedestrian push buttons, R10-3B pedestrian push button signs, grounding systems, and all necessary hardware in accordance with the plans and specifications.

4.2. MATERIALS

Material, equipment, and hardware furnished under this section shall 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 thick. Do not apply paint to the latching hardware or rigid vehicle signal head mounting brackets for mast-arm attachments.

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 ¼-inch vertical conduit entrance hubs with the hubs capped on the lower plate and 1 ½-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 that 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 long square head bolts for attachment to pedestal. Provide a center post for multi-way slipfitters.

For light emitting diode (LED) traffic signal modules, provide the following requirements for inclusion on the Department's Qualified Products List for traffic signal equipment.

1. Sample submittal,

2. Third-party independent laboratory testing results for each submitted module with evidence of testing and conformance with all of the Design Qualification Testing specified in section 6.4 of each of the following Institute of Transportation Engineers (ITE) specifications:

- Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement
- Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement
- Pedestrian Traffic Control Signal Indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules.

VTCSH Circular Supplement. (Note: The Department currently recognizes two approved independent testing laboratories. They are Intertek ETL Semko and Light Metrics, Incorporated with Garwood Laboratories. Independent laboratory tests from other laboratories may be considered part of the QPL submittal at the discretion of the Department,

3. Evidence of conformance with the requirements of these specifications,

4. A manufacturer's warranty statement in accordance with the required warranty, and

5. Submittal of manufacturer's design and production documentation for the model, including but not limited to, electrical schematics, electronic component values, proprietary part numbers, bill of materials, and production electrical and photometric test parameters.

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 installation of the modules. During the warranty period, the manufacturer must provide replacement modules within 45 days of receipt of modules that have failed at no cost to the State. Provide manufacturer's warranty documentation to the Department during evaluation of product for inclusion on the Qualified Products List (QPL).

B. Vehicle Signal Heads

Comply with the ITE standard "Vehicle Traffic Control Signal Heads". 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 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 complete, watertight connections of the vehicle signal heads to the messenger cable. Fabricate mounting assemblies from malleable iron or steel 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.

Provide LED vehicular traffic signal modules (hereafter referred to as modules) that consist of an assembly that uses 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.

For the modules, provide spade terminals crimped to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard signal head. Do not provide other types of crimped terminals with a spade adapter.

Ensure the power supply is integral to the module assembly. On the back of the module, permanently mark the date of manufacture (month & year) or some other method of identifying date of manufacture.

Tint the red, yellow and green lenses to correspond with the wavelength (chromaticity) of the LED. Transparent tinting films are unacceptable. Provide a lens that is integral to the unit with a smooth outer surface.

B.1. LED Circular Signal Modules

Provide modules in the following configurations: 12-inch circular sections, and 8-inch circular sections. All makes and models of LED modules purchased for use on the State Highway System shall appear on the current NCDOT Traffic Signal Qualified Products List (QPL).

Provide the manufacturer's model number and the product number (assigned by the Department) for each module that appears on the 2006 or most recent Qualified Products List. In addition, provide manufacturer's certification in accordance with Article 106-3 of the Standard Specifications, that each module meets or exceeds the ITE "Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement" dated June 27, 2005 (hereafter referred to as VTCSH Circular Supplement) and other requirements stated in this specification.

Provide modules that meet the following requirements when tested under the procedures outlined in the VTCSH Circular Supplement:

Module Type	Max. Wattage at 165° F	Nominal Wattage at 77° F
12-inch red circular	17	11
8-inch red circular	13	8
12-inch green circular	15	15
8-inch green circular	12	12

For yellow circular signal modules, provide modules tested under the procedures outlined in the VTCSH Circular Supplement to insure power required at 77° F is 22 Watts or less for the 12-inch circular module and 13 Watts or less for the 8-inch circular module.

Note: Use a wattmeter having an accuracy of ±1% to measure the nominal wattage and maximum wattage of a circular traffic signal module. Power may also be derived from voltage, current and power factor measurements.

B.2. LED Arrow Signal Modules

Provide 12-inch omnidirectional arrow signal modules. All makes and models of LED modules purchased for use on the State Highway System shall appear on the current NCDOT Traffic Signal Qualified Products List (QPL).

Provide the manufacturer's model number and the product number (assigned by the Department) for each module that appears on the 2006 or most recent Qualified Products List. In addition, provide manufacturer's certification in accordance with Article 106-3 of the Standard Specifications, that each module meets or exceeds the requirement for 12-inch omnidirectional modules specified in the ITE "Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement" dated July 1, 2007 (hereafter referred to as VTCSH Arrow Supplement) and other requirements stated in this specification.

Provide modules that meet the following requirements when tested under the procedures outlined in the VTCSH Arrow Supplement:

Module Type	Max. Wattage at 165° F	Nominal Wattage at 77° F
12-inch red circular	12	9
12-inch green circular	11	11

For yellow arrow signal modules, provide modules tested under the procedures outlined in the VTCSH Arrow Supplement to insure power required at 77° F is 22 Watts or less.

Note: Use a wattmeter having an accuracy of ±1% to measure the nominal wattage and maximum wattage of a circular traffic signal module. Power may also be derived from voltage, current and power factor measurements.

C. Pedestrian Signal Heads:

Provide pedestrian signal heads with international symbols that meet the MUTCD. Do not provide letter indications.

Comply with the ITE standard for "Pedestrian Traffic Control Signal Indications" and the following sections of the ITE standard for "Vehicle Traffic Control Signal Heads" in effect on the date of advertisement:

- Section 3.00 - "Physical and Mechanical Requirements"
- Section 4.01 - "Housing, Door, and Visor: General"
- Section 4.04 - "Housing, Door, and Visor: Materials and Fabrication"
- Section 7.00 - "Exterior Finish"

Provide a double-row termination block with three empty terminals and number 10 screws for field wiring. Provide barriers between the terminals that accommodate a spade lug sized for number 10 terminal screws. Mount the termination block in the hand section. Wire all signal sections to the terminal block.

Where required by the plans, provide 16-inch pedestrian signal heads with traditional three-sided, rectangular visors, 6 inches long. Where required by the plans, provide 12-inch pedestrian signal heads with traditional three-sided, rectangular visors, 8 inches long.

Design the LED pedestrian traffic signal modules (hereafter referred to as modules) for installation into standard pedestrian traffic signal sections that do not contain the incandescent signal section reflector, lens, eggcrate visor, gasket, or socket. Provide modules that consist of an assembly that uses LEDs as the light source in lieu of an incandescent lamp. Use LEDs that are aluminum indium gallium phosphorus (AlInGaP) technology for the Portland Orange hand and countdown displays. Use LEDs that are of the latest indium gallium nitride (InGaN) technology for the Lunar White walking man displays. 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.

Provide modules in the following configuration: 16-inch displays which have the solid hand/walking man overlay on the left and the countdown on the right, and 12-inch displays which have the solid hand/walking man module as an overlay. All makes and models of LED modules purchased for use on the State Highway System shall appear on the current NCDOT Traffic Signal Qualified Products List (QPL).

Provide the manufacturer's model number and the product number (assigned by the Department) for each module that appears on the 2006 or most recent Qualified Products List. In addition, provide manufacturer's certification in accordance with Article 106-3 of the Standard Specifications, that each module meets or exceeds the ITE "Pedestrian Traffic Control Signal Indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules" dated March 19, 2004 (hereafter referred to as PTCSI Pedestrian Standard) and other requirements stated in this specification.

Design all modules to operate using a standard 3 - wire field installation. Provide spade terminal crimped to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard pedestrian signal housing. Do not provide other types of crimped terminals with a spade adapter.

Ensure the power supply is integral to the module assembly. On the back of the module, permanently mark the manufacture (month & year) or some other method of identifying date of manufacture.

Provide module lens that is hard coated or otherwise made to comply with the material exposure and weathering effects requirements of the Society of Automotive Engineers (SAE) J576. Ensure all exposed components of the module are suitable for prolonged exposure to the environment, without appreciable degradation that would interfere with function or appearance.

Design the walking man and hand as a solid display. Ensure the hand/walking man symbols for the 16-inch display modules meet the dimension requirements cited in PTCSI Pedestrian Standard Table 1 "*Dimensions of Signal Sizes*" for Class 3 or Class 4. Ensure the hand/walking man symbols for the 12-inch display module meet the dimension requirements cited in PTCSI Pedestrian Standard Table 1 "*Dimensions of Signal Sizes*" for Class 2.

Provide the countdown number display that is at least 9 inches high by 6 inches wide. Ensure the minimum luminance value for the countdown number display is 1,400 cd/m^2. Provide the countdown number display that will conform to the chromaticity requirements of the hand symbol as specified by section 4.2 (Chromaticity) of the PTCSI Pedestrian Standard.

Furnish the countdown display to continuously monitor the traffic controller to automatically learn the pedestrian phase time and update for subsequent changes to the pedestrian phase time. Design the countdown display as a double row of LEDs or with a minimum thickness of 0.5 inch. Ensure the countdown display blanks-out during the initial cycle while it records the countdown time. Ensure that the countdown display is operational only during the flashing don't walk, clearance interval. Blank-out the countdown indication after it reaches zero and until the beginning of the next flashing don't walk indication. Design the controlling circuitry to prevent the timer from being triggered during the solid hand indication.

Provide modules that meet the following requirements when tested under the procedures outlined in the PTCSI Pedestrian Standard:

Module Type	Max. Wattage at 165° F	Nominal Wattage at 77° F
Hand Indication	16	13
Walking Man Indication	12	9
Countdown Indication	16	13

Note: Use a wattmeter having an accuracy of ±1% to measure the nominal wattage and maximum wattage of a pedestrian signal module. Power may also be derived from voltage, current and power factor measurements.

Provide 2-inch diameter pedestrian push-buttons with weather-tight housings fabricated from die-cast aluminum and threading in compliance with the NEC for rigid metal conduit. Provide a weep hole in the housing bottom and ensure that the unit is vandal resistant.

Provide push-button housings that are suitable for mounting on flat or curved surfaces and that will accept 1/2-inch conduit installed in the top. Provide units that have a heavy duty push-button assembly with a sturdy, momentary, normally-open switch. Have contacts that are electrically insulated from the housing and push-button. Ensure that the push-buttons are rated for a minimum of 5 mA at 24 volts DC and 250 mA at 12 volts AC.

Provide standard R10-3 signs with mounting hardware that comply with the MUTCD in effect on the date of advertisement. Provide R10-3E signs for countdown pedestrian heads and R10-3B for non-countdown pedestrian heads.

D. Signal Cable

Furnish 16-4 and 16-7 signal cable that complies with IMSA specification 20-1 except provide the following conductor insulation colors:

- For 16-4 cable: white, yellow, red, and green
- For 16-7 cable: white, yellow, red, green, yellow with black stripe tracer, red with black stripe tracer, and green with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern.

Provide a ripcord to allow the cable jacket to be opened without using a cutter. IMSA specification 19-1 will not be acceptable. Provide a cable jacket labeled with the IMSA specification number and provide conductors constructed of stranded copper.

4.3. CONSTRUCTION METHODS

A. General

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.

C. Pedestrian Signal Heads

Install signs with mounting hardware immediately above pedestrian push buttons.

Connect push button to controller cabinet using lead-in cable. Bond push button housing and all metal components to cabinet ground using cable ground.

Where new countdown pedestrian heads are called to be installed in the plans to replace existing pedestrian signal heads, remove the existing heads and replace sign with new countdown pedestrian sign (R10-3b).

D. Modify Existing Vehicle Signal Heads:

Modify existing vehicle signal heads by removing incandescent lamp hardware and replacing with new LED modules with all necessary hardware.

4.4. MEASUREMENT AND PAYMENT

Vehicle signal head (________) and *Pedestrian signal head (______)* will be measured and paid for as the actual number of signal heads of each type, size, and number of sections with mounting hardware furnished, installed, and accepted.

Modify existing vehicle signal head will be measured and paid for as the actual number of existing vehicle signal heads modified and accepted.

Signal Cable will be measured and paid for as actual linear feet of signal cable furnished, installed and accepted. Measurement will be point to point with no allowance for sag. Twenty five feet will be allowed for vertical segments up or down poles.

No measurement will be made of visors, wire entrance fittings, interconnecting brackets, mounting assemblies, pedestrian push buttons, and R10-3B pedestrian signal signs as these will be considered incidental to furnishing and installing signal heads. No measurement will be made for drip loops, coiled sections, or lashing wire as these will be considered incidental to furnishing and installing signal cable.

Payment will be made under:

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

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

Pedestrian Signal Head (16", 1 Section with Countdown) .... Each

Modify Existing Vehicle Signal Head .... Each

Signal Cable .... Linear Foot

5. SIGNAL PEDESTAL

5.1. DESCRIPTION

Furnish and install signal pedestal assemblies with foundations, grounding systems, and all necessary hardware.

5.2. MATERIAL

A. General

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

B. Pedestals

Provide aluminum pedestals with foundations that conform to AASHTO. Furnish Class B minimum concrete that conforms to the applicable parts of the Standard Specifications Section 1000 for Portland Cement Concrete Production and Delivery.

Provide reinforcing steel that conforms to the applicable parts of the Standard Specifications Section 1070 for Reinforcing Steel.

Provide caps and bases as part of pedestal assemblies. Unless otherwise required, furnish pedestals that provide the following heights:

To support traffic signal equipment cabinets – 30" above foundation.

To support signal heads, see Section 4 for required signal head height.

Provide pedestal caps fabricated from cast aluminum that meets Aluminum Association Alloy 356.0F. Provide stainless steel set screws as fasteners.

Provide either shoe-type or transformer-type pedestal bases made of aluminum that meets Aluminum Association Alloy 356.0 or equivalent, and designed to break upon impact in accordance with AASHTO requirements. For shoe-type bases, provide aluminum flange plate with four anchor boltholes, a hole to match the shaft, and a 4 x 8" hand hole with a reinforced frame located 8" above base. For transformer-type bases, provide overall dimensions of 15"(l) x 13"(w) x 13"(d) and an 8" x 8" hand hole with removable cover. Ensure bases are continuously welded to shafts or threaded to receive shafts. For use in grounding, provide a 1/2" minimum diameter, coarse thread stud located inside base at the handhold and oriented for easy access.

For each pedestal, provide four bolts with outside diameter of 3/4" and length of 18" each with leveling nut and washer. Ensure anchor bolts are hot-dipped galvanized in accordance with ASTM A 153 with completely galvanized nuts and washers.

5.3. CONSTRUCTION METHODS

Locate foundations, determine elevation, and submit findings. Obtain the Engineer's approval of foundation locations and elevations before constructing foundations.

Excavate in accordance with the Standard Specifications Section 410 for Foundation Excavation. If encountered, remove rock or boulders to a depth sufficient to obtain stability necessary to support the structure for design loads. Ensure ground is level before installing foundations.

Construct foundations in accordance with the Standard Specifications Section 825 for Incidental Concrete Construction. Cast concrete for pole foundations against undisturbed soil unless otherwise permitted. Provide forms with chamfer strips that measure one inch along diagonal face at all corners above ground level. Do not install foundations over uncompacted fill or muck. Install conduit in foundations.

Securely place, position, and align anchor bolts symmetrically about the center of foundation.

Give exposed vertical concrete surfaces an ordinary surface finish. Give exposed horizontal surfaces a float finish.

Level tops of concrete foundations. Do not allow tops to exceed 6 inches above adjacent ground surface. Pour and finish foundation to a level flush with surrounding sidewalk when possible.

Do not erect pedestals until concrete has attained a minimum compressive strength of 2500 psi as determined by cylinder breaks.

5.4. MEASUREMENT AND PAYMENT

Signal pedestal with foundation will be measured and paid as the actual number of signal pedestals with foundations furnished, installed, and accepted.

Payment will be made under:

Signal Pedestal with Foundation..Each

6. SIGNS INSTALLED FOR SIGNALS

6.1. DESCRIPTION

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

6.2. 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.

6.3. 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.

6.4. MEASUREMENT AND PAYMENT

Sign for Signals will be measured and paid as the actual number of signs for signals, regardless of mounting method, furnished, installed, and accepted.

Payment will be made under:

Sign for Signals..Each

7. MESSENGER CABLE

7.1. DESCRIPTION

Furnish and install messenger cable (spanwire) with cable clamps, machine bolts, eyebolts, 3 bolt clamps, eye nuts, split-bolt connectors, and all necessary hardware.

7.2. MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

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

Provide universal grade strandvises used for extra high strength steel messenger cable. Provide other pole line hardware constructed of hot-dipped galvanized steel. Provide machine bolts, eyebolts, and thimbleye bolts with minimum tensile strength of 12,400 lbs. Provide galvanized nuts, washers, and thimbleyelets.

7.3. CONSTRUCTION METHODS

Install guy assemblies before installing messenger cable.

Use 1/4-inch messenger cable for spans supporting only cables unless otherwise specified.

For permanent installation, install messenger cable in continuous lengths with no splices except where an insulator is required. With prior approval, existing messenger for temporary installations may be extended instead of installing new messenger cable.

Tension messenger cable to eliminate appreciable sag and to match the sag of surrounding utilities. Otherwise, allow 3 to 4 percent sag of the span length between poles. Use crossover clamps to maintain proper vertical and horizontal alignment of adjoining cable runs.

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 three bolt cable clamps with J-hooks in mid-runs and deadend strandvises at termination poles.

Maintain electrical continuity at all splices.

For messenger cable for communications cable attached to joint use poles, bond messenger cable to existing pole ground terminated with split bolt connectors or parallel groove clamps at ends and at 1300-foot intervals. If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3 for bonding messenger cable.

On multiple messenger cable arrangements, connect all messenger cable ends with #6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or parallel groove clamp at each end.

7.4. MEASUREMENT AND PAYMENT

Messenger cable (______) will be measured and paid for as actual horizontal linear feet of messenger cable furnished, installed, and accepted. Measurement will be point to point with no allowance for sag.

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.

Payment will be made under:

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

8. UNDERGROUND CONDUIT

8.1. DESCRIPTION

Furnish and install conduit for underground installation with tracer wire, miscellaneous fittings, all necessary hardware, marker tape, backfill, graded stone, paving materials, and seeding and mulching.

8.2. MATERIALS

A. General

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Refer to the following articles of the Standard Specifications:

- Backfill 1018-2
- Graded Stone 545-2 and 545-3

Use conduit bodies, boxes, and fittings that meet UL Standard 514B Conduit, Tubing, and Cable Fittings for electrical and communications installations.

B. Rigid Metallic Conduit

Provide rigid hot dipped galvanized steel conduit that meets UL Standard 6 Electrical Rigid Metal Conduit-Steel with rigid full weight sherardized or galvanized threaded fittings.

C. Polyvinyl Chloride (PVC)

Provide non-metallic conduit and duct including associated couplings, approved for above and below ground use with or without concrete encasement in accordance with UL Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit. Provide Schedule 40 conduit unless otherwise specified.

D. High Density Polyethylene Conduit (HDPE)

Provide HDPE conduit with an outer diameter to minimum wall thickness ratio that complies with ASTM D 3035, Standard Dimension Ratio (SDR) 13.6. Provide conduit that meets UL Standard 651B Continuous Length HDPE Conduit.

Provide conduit that meets the following:

ASTM D 638	Tensile Strength – 3,000 psi, min; Elongation – 400 percent, min

ASTM D 1238	Melt Index – 0.4 maximum
ASTM D 1505	Density – (0.941-0.955g/cc)
ASTM D 1693	Condition B – 20 percent failure, maximum
ASTM D 2444	Impact – NEMA Standards Publication Number TC7
ASTM D 3350	Cell Classification – 334420 or 344420

Ensure HDPE conduit 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. Furnish conduit with a coefficient of friction of 0.09 or less in accordance with Telcordia GR-356.

Furnish factory lubricated, low friction, coilable conduit constructed of HDPE. Furnish conduit with nominal diameter as required. Provide conduit with either a smooth or ribbed inner wall. Ensure 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.

E. Conduit Plugs, Sealing Putty, Pull Line, and Tracer Wire

Furnish duct plugs that provide a watertight barrier when installed in conduit. Furnish duct plugs sized in accordance with conduit. Ensure duct plug provides a means to secure a pull line to the end of the plug. Provide removable and reusable duct plugs.

Furnish mechanical sealing devices that provide a watertight barrier between conduit and cables in conduit. Furnish mechanical sealing devices sized in accordance with conduit and with appropriately sized holes to accommodate and seal cables. Provide removable and re-usable mechanical sealing devices.

Furnish moldable sealing putty that has the following characteristics:

- Comply with Subarticle 1400-2(H) Duct and Conduit Sealer of the Standard Specifications;
- Contains no asbestos;
- Designed for use with electrical and telecommunications cables house in conduits;
- Requires no mixing or additives (single-component) and requires no volatile solvents; and
- Can be applied by hand.

Furnish 1/2", pre-lubricated, woven polyester tape, pull line with minimum rated tensile strength of 2,500 lb.

Provide green insulated # 14 AWG, THW, stranded copper wire to serve as tracer wire.

Furnish non-detectable underground marker tape with the wording "WARNING – Fiber-Optic Cable" in all trenches containing one or more conduits that will house fiber-optic communications cable.

8.3. CONSTRUCTION METHODS

A. General

Except where the Plans call for a specific installation method or where the Engineer directs otherwise, underground conduit may be installed by either trenching, directional drilling or plowing at the option of the Contractor.

Install a minimum of two conduits for all underground communications cable routes unless shown otherwise on the Plans.

Install a minimum of two conduits for all directional drill installations beneath roadways, railroad rights-of-way or streams or which run longitudinally beneath a sidewalk.

Install junction boxes in underground conduit runs as shown on the Plans. Do not exceed 1500 feet between junction boxes in any underground conduit route that conveys communications cable without the prior approval the Engineer.

When two cables are being installed in conduit systems, both cables shall be installed in a single conduit.

Ensure conduit is free of moisture and debris before pulling cables.

Following installation of conduit where cable is not immediately installed, or conduit is for future use (spare), seal the ends of the conduit with a duct plug. Secure a pull line to the duct plug in such a manner that it will not interfere with installation of the duct plug and provides a watertight seal.

Extend ends of conduit 2 to 4 inches above concrete surfaces and 4 inches above crushed stone bases. For metallic conduit, install metallic bushings and bond conduits.

A.1. Conduit Entering Junction Boxes

Terminate conduits installed for communications cables in oversized junction boxes. Do not install other conduits in the oversized junction box unless otherwise specified.

Terminate conduits installed for signal wiring, including loop lead-in cable, in standard size junction boxes unless otherwise specified.

For all conduits entering junction boxes, seal spare conduits with approved duct plugs. Seal conduits containing fiber-optic communications cable with mechanical sealing devices or with moldable sealing putty. Seal conduits containing signal cable and loop lead-in wire with moldable sealing putty.

A.2. Tracer Wire

Install tracer wire in all conduits containing fiber-optic cable. Pull tracer wire simultaneously in a continuous length with the fiber-optic cable. Where multiple pulls of fiber-optic cable are required and conduit is placed in the same trench, only one tracer wire is required. Where multiple pulls of fiber optic cable are required and conduits may separate into individual trenches, install a tracer wire in each conduit run. Provide waterproof butt splices where tracer wire is spliced. Splicing is allowed only in cabinets and junction boxes. Label all tracer wires entering the equipment cabinet.

A.3. Plan of Record Drawings

Upon completion of the conduit system for communications, furnish the Engineer with a plan of record drawing detailing the horizontal and vertical locations of the conduit system.

B. Trenching

In certain cases the Contractor may use an alternate material other than HDPE and method of installation between trenching and plowing based on existing field conduits and preferences. Obtain approval before proceeding.

B.1. General

Install HDPE or rigid metallic conduit for all underground runs. Install rigid metallic conduit for all underground runs located inside railroad right-of-way. Clean existing underground conduit to be incorporated into a new system. Bond all metallic conduit.

If more than one conduit is required between the same points, install conduit in one common trench. Install non-detectable marker tape.

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

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

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.

Upon completion, restore surface to like-original condition within seven calendar days of occurrence of damage. Remove all rock and debris from backfill material. Remove excess material from site and compact area according to Article 300-7. Backfill with excavated material and compact to 95% of original density.

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

After installation of conduits and upon completion of tamping and backfilling, perform a mandrel test on each conduit to ensure 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. Ensure pull line is re-installed.

B.2. Paved Trenching

On concrete surfaces, replace the entire joint of concrete unless otherwise specified. On all other surfaces, neatly cut and replace the width of trench with like material.

Finish paved areas with materials matching damaged areas. For conduit installed under roadways, cut neatly and replace the width of paved area damaged by trenching. For conduit installed under sidewalks and walkways, remove entire section of slab from joint to joint and replace. Place graded stone material to temporarily maintain traffic where repairs cannot be performed immediately. Comply with Article 545-4.

B.3. Unpaved Trenching

Install conduit in all unpaved areas. Rake smooth the top 1 1/2 inches seed with same type of grass as surrounding area. Finish unpaved areas flush with surrounding natural ground.

C. Plowing (HDPE Conduit Only)

Direct plow HDPE ducts simultaneously using chute plow method. Direct plow ducts at a minimum depth so the top of the highest duct is 30 inches deep unless otherwise approved.

Provide sufficient personnel to feed chute, operate prime mover and equipment carrying reels (if separate equipment is used), observe chute feeding, observe plowing, and observe reel payout. Use chute with adequate dimensions to allow for passage of duct without damage. During plow operation, continuously check chute opening and path to be sure there are no obstructions and monitor payout reels to be sure reels are turning at a steady rate.

With prior approval, install a junction box at locations where splicing or coupling of the underground polyethylene conduits is necessary. Otherwise, splicing or joining of underground polyethylene conduit is prohibited.

D. Directional Drilling (HDPE Conduit Only)

D.1. Pre-Approvals and Minimum Depth Requirements

Obtain approval before beginning drilling operations.

At all points where HDPE conduit will traverse under roadways, driveways, sidewalks, or Controlled Access Areas including entrance/exit ramps, maintain 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/exit ramps maintain a minimum depth of 30 inches below finished grade. Maintain a minimum clearance of 30 inches below finished grade when crossing ditch lines. For the following structures, the minimum clearance requirements are:

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 equipment provided and have a minimum of one year experience operating the make and model of drill rig. Submit documentation of the operators' training and experience for review at least two weeks before start of 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 pedestrian walkways, driveways, and streets. Immediately remove all drilling fluids/slurry that are accidentally spilled.

D.2. 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 properly. Backfill pits and trenches to facilitate drilling operations immediately after drilling is completed.

Use drill head suitable for type of material being drilled and sized no more than 2 inches larger than the outer diameter of the conduit. Direct drill to obtain proper depth and desired destination. Pressure grout with an approved bentonite/polymer slurry mixture to fill all voids. Do not jet alone or wet bore with water.

During drilling operation, locate drill head every 10 feet along drill path and before traversing underground utilities or structures. Use digital walkover locating system to track drill head during directional drilling operation. Ensure locating system is capable of determining pitch, roll, heading, depth, and horizontal position of the drill head at any point.

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

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

Once installation of conduit has started, continue installation without interruption so as to prevent conduit from becoming firmly set. Apply bentonite/polymer slurry mixture during conduit installation.

Upon completion of conduit installation, perform a mandrel test on conduit system to ensure conduit has not been damaged. Furnish non-metallic mandrel with 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 and ensure that pull line is re-installed.

D.3. Drilling Fluids

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

Transport waste drilling fluid/slurry from site and dispose of in a method that complies with local, state and federal laws and regulations.

D.4. Conduit Splicing

With prior approval, install a junction box at locations where splicing or coupling of conduit is necessary. Otherwise, splicing or joining of HDPE conduit is prohibited.

8.4. MEASUREMENT AND PAYMENT

Tracer wire will be measured along the horizontal linear feet of tracer wire furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be made in linear feet. No payment will be made for excess tracer wire in junction boxes and/or cabinets.

Paved trenching (qty, size) will be measured in horizontal linear feet of trenching for underground conduit installation of each type furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet. No payment will be made for restoring surface to like-original conditions.

Unpaved trenching (qty, size) will be measured in horizontal linear feet of trenching for underground conduit installation of each type furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet. No payment will be made for restoring surface to like-original conditions.

Directional drill (qty, size) will be measured in horizontal linear feet of directional drill for underground conduit installation furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

No measurement will be made of vertical segments, sealing devices, backfill, graded stone, paved materials, miscellaneous fittings, pull lines, marker tape, mechanical sealing devices, duct plugs, conduit organizers, plan of record drawings, and seeding and mulching as these will be considered incidental to conduit installation.

Payment will be made under:

Tracer Wire	Linear Foot
Paved Trenching (1, 2")	Linear Foot
Paved Trenching (2, 2")	Linear Foot
Unpaved Trenching (1, 1")	Linear Foot
Unpaved Trenching (1, 2")	Linear Foot
Unpaved Trenching (2, 2")	Linear Foot
Directional Drill (1, 2")	Linear Foot
Directional Drill (2, 2")	Linear Foot

9. JUNCTION BOXES

9.1. DESCRIPTION

Furnish and install junction boxes (pull boxes) with covers, graded stone, grounding systems, and all necessary hardware.

Provide real world coordinates for all installed or reused junction boxes as required in Section 41.

9.2. MATERIALS

A. General

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Comply with Section 545 of the Standard Specifications for graded stone.

Comply with Article 1411-2 Electrical Junction Boxes except as follows:

- Provide junction box covers with standard *Traffic Signal* or *Fiber Optic* logos, pull slots, and stainless steel pins.
- Do not provide sealant compound between junction boxes and covers.

B. 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.

C. Oversized Heavy-Duty Junction Boxes

Provide oversized heavy-duty junction boxes and covers with minimum inside dimensions of 30"(l) x 15"(w) x 24"(d) that meet or exceed the Tier 15 requirements of ANSI/SCTE 77. Provide certification that testing methods are compliant with ANSI/SCTE 77.

D. Special Oversized Heavy-Duty Junction Boxes

Provide special oversized heavy-duty junction boxes and covers with minimum inside dimensions of 48"(l) x 48"(w) x 36"(d) that meet or exceed the Tier 15 requirements of ANSI/SCTE 77. Provide certification that testing methods are compliant with ANSI/SCTE 77.

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 standard 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.

At locations where an existing junction box is removed and replaced by a new junction box, the Contractor shall remove the junction box with minimal disruption to the surface of the surrounding area. The Contractor shall seal the existing conduit, protect any existing cables, and replace any surface materials in kind. The junction box should be disposed of by the Contractor in a manner approved by the Engineer.

At certain locations shown in the Plans, reuse existing pull boxes. Precaution shall be taken to prevent damage to the existing conduit or cables. Coil fifteen (15) feet of each new fiber optic cable entering each existing pull box unless otherwise noted. At locations where a new junction box or new conduit is to be connected to an existing junction box, use method to enter existing junction box as approved by the Engineer. Do not damage existing junction box or existing junction box contents. Junction boxes or cable damaged shall be replaced at the Contractor's expense. At locations where work is called for at manholes, follow all applicable City, State, and Federal requirements regarding work in enclosed spaces.

9.4. MEASUREMENT AND PAYMENT

Junction box (__________) will be measured and paid in actual number of junction boxes of each size and type furnished, installed, and accepted.

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

No measurement will be made for the removal and disposal of existing junction boxes as these will be considered incidental to furnishing and installing new junction boxes.

No measurement will be made for producing and submitting plan of record documentation, including real world coordinates, as this will be considered incidental to furnishing and installing new junction boxes.

Payment will be made under:

Junction Box (Standard Size)...Each

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

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

10. WOOD POLES

10.1. DESCRIPTION

Furnish and install wood poles with grounding systems and all necessary hardware.

10.2. MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Comply with Subarticles 1082-3(F) Treated Timber and Lumber – Poles and 1082-4(G) Preservative Treatment – Poles in the Standard Specifications.

Use treated wood poles meeting the requirements of Section 1082. Unless otherwise required by the contract, use Class 3 or better wood poles. For new wood poles that will have communication cable attachments, provide poles that have a minimum length of 40 feet and are of a sufficient length to maintain the minimum required clearances above the roadway, obstructions, and affected railroad tracks. For new wood poles that will have a CCTV camera attachment, provide poles of sufficient length to be properly installed and have the camera attached at the mounting height shown in the Summary of Work in the Plans for each location.

10.3. CONSTRUCTION METHODS

Mark final pole locations and receive approval before installing poles. Unless otherwise specified, 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 pole and to allow for compacting. Set pole at manufacturer's recommended depth, but at a minimum depth of 5 feet. Ensure the pole is within two degrees of vertical when fully loaded.

Backfill hole with pole installed and tamp backfill in 6 inch lifts with a mechanical tamp until compacted density is at least 95% of original density.

On new Department owned poles, install a grounding system consisting of #6 AWG solid bare copper wire that is exothermically welded to a single ground rod installed at base of pole or to the electrical service grounding electrode system located within 10 feet of the pole. Install ground wire so as to minimize damage from vandalism and environmental exposures. Install ground wire up pole to a point adjacent to the uppermost span. Use hot-dipped galvanized wire staples to secure ground wire to pole.

10.4. MEASUREMENT AND PAYMENT

Wood pole will be measured and paid as the actual number of wood poles for communications cable furnished, installed, and accepted.

CCTV wood pole (___) will be measured and paid as the actual number of wood poles for CCTV camera attachments 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.

Refer to the Summary of Work in the Plans for the desired mounting height of the CCTV camera at each location.

Payment will be made under:

Wood Pole..Each

CCTV Wood Pole (Mt. Hght. 30-35')..Each

CCTV Wood Pole (Mt. Hght. 45-60')..Each

11. GUY ASSEMBLIES

11.1. DESCRIPTION

Furnish and install guy assemblies with all necessary hardware.

11.2. 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 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 anchor assembly size is adequate for site conditions. Provide rods constructed of hot-dipped galvanized steel sized according to the soil bearing conditions in the area. Provide tripleye guy attachments constructed of hot-dipped galvanized steel. Anchor assemblies with double-strand eyes may be used in lieu of those with the tripleye feature when only one guy cable is to be attached. Ensure anchor assemblies are 7 feet minimum in length.

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 3-bolt clamp fabricated from galvanized steel with minimum length of 5 3/4". Ensure clamp has parallel grooves (one on each side of bolt holes) for cable placement. Provide three 1/2" diameter galvanized bolts and nuts to tighten the clamp around the messenger cable. Ensure clamp fits 1/4" to 3/8" messenger cable.

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. Comply with Section 7 of these Project Special Provisions.

11.3. CONSTRUCTION METHODS

A. Guy Assemblies for Signal Heads

Install guy assemblies with guy cable, guy guards, anchors, three-bolt clamps and associated fittings. Use two-bolt attachment method where there is adequate room on the pole to comply with the NESC. Attach guy assembly and guy cable to two separate bolts with one bolt for span and one bolt for guy cable.

Where adequate spacing is not available and a violation of the NESC would occur with the two-bolt attachment method, use approved one-bolt attachment method for attaching messenger cable and guy assembly.

Bond guy assembly to new pole grounding system as described in Section 1710-3.

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

Anchors used in guy assemblies are not to be used as grounding electrodes.

B. Guy Assemblies for Communications Cable or Loop Lead-in Cable

When installing messenger cable for supporting only communications cable or loop lead-in cable, use approved one-bolt attachment method for attaching messenger cable and guy assembly. Install mid-span guys in accord with telecommunication standards and as approved by the Engineer.

Bond guy assembly to existing pole ground using appropriate clamps. If existing poles do not have a grounding system, install new grounding system for bonding guy assembly that complies with Article 1720-3.

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

11.4. MEASUREMENT AND PAYMENT

Guy assembly will be measured and paid as the actual number of guy assemblies furnished, installed, and accepted.

No measurement will be made of guy cable, guy guards, anchors, clamps, strandvises, galvanized pipe, pole plates, fittings, or grounding systems as this will be considered incidental to furnishing and installing guy assemblies.

Payment will be made under:

Guy Assembly..Each

12. RISER ASSEMBLIES

12.1. DESCRIPTION

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

12.2. MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Provide rigid metallic conduit for risers as called for in these Project Special Provisions.

12.3. CONSTRUCTION METHODS

A. New Installations

Install risers with required weatherheads or heat shrink tubing on poles using pole attachment fittings. Maintain a 10" minimum and 18" maximum offset from signal messenger to the top of riser for all risers. On utility-owned poles, maintain a 40" offset from electrical utility's power conductors to top of riser and riser attachment fittings.

Use approved heat shrink tubing retrofit kits when installing new fiber-optic or coaxial cable into exiting risers that contain existing fiber-optic or coaxial cables.

Install heat shrink tubing retrofit kits in existing risers as specified.

Use separate 1" riser with weatherhead for electrical service.

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

Install condulets on risers for lead-in cable, railroad preempt interconnection cables and signal pedestals.

Use separate 2" riser with heat shrink tubing for fiber-optic communications cables and coaxial cable. Install risers with heat shrink tubing so that cable can be installed without violating its minimum bending radius. Install cable so it does not share a riser with any other cable.

Install heat shrink tubing in accordance with manufacturer's recommendations. Provide tubing a minimum of 5" in length with a minimum of 2.5" extended over cables and 2.5" extended over risers after heat has been applied. Use nylon filler rods with UV protection or equivalent and sealing spacer clips to separate cables where multiple cables enter a riser. Ensure sealing spacer clips have a heat activated sealing compound with the sealing compound fully encapsulating the space between cables. Ensure heat shrink tubing provides a watertight fit around individual cables and outer walls of risers. Do not use cut sections of cable or any other devices instead of filler rods. Use aluminum tape around cables to prevent damage from sealing chemicals. Use a heat source that will provide even heat distribution around tubing. Ensure no damage occurs to any cables.

Bond new risers, a minimum of 10 ft above grade, to the pole ground using a #6 AWG minimum solid bare copper wire and an approved pipe clamp, a split bolt connector or parallel groove clamp. On pole mounted cabinets where the riser are connected to the cabinet, bond risers in the cabinet using ground bushings with a #6 AWG minimum solid bare copper wire to the cabinet ground bus.

If a pole ground exists on the joint use pole, bond new riser to existing pole ground using #6 AWG minimum solid bare copper wire terminated with split bolt connectors or parallel groove clamp.

If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3 for bonding messenger cable.

Transition from rigid galvanized steel risers to underground PVC conduits using an approved rigid galvanized steel sweeping elbow with PVC female adaptor.

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. If installing fiber optic cable in existing riser with existing heat shrink tubing, replace with new heat shrink tubing following installation.

12.4. MEASUREMENT AND PAYMENT

__" Riser with ___________ will be measured and paid as the actual number of risers of each type and size furnished, installed, and accepted. No measurement will be made of weatherheads, heat shrink tubing or pole attachment fittings as these will be incidental to furnishing and installing risers.

Heat shrink tubing retrofit kit will be measured and paid for as the actual number of heat shrink tubing retrofit kits furnished, installed, and accepted. No measurement will be made for removing existing communications cable.

Payment will be made under:

2" Riser with Weatherhead ....Each

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

Heat Shrink Tubing Retrofit Kit ....Each

13. INDUCTIVE DETECTION LOOPS

13.1. DESCRIPTION

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

13.2. MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

A. Loop Sealant

Provide loop slot sealant that completely encapsulates loop wire when installed according to manufacturer's instructions. Provide loop sealant that does not generate temperatures greater than 220 degrees F. Ensure sealant bonds with asphalt and concrete pavement saw slots so sealant and encapsulated loop wire do not come out of slot. Ensure sealant is self-leveling, but with sufficient viscosity to prevent exit from 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 saw slot, and is resistant to traffic, water, gasoline, chemical and chemical fumes, mild alkalis, oils, and mild acids. Ensure sealant will not be affected by water and sealant does not chemically interact with pavement and loop wire insulation.

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

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

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

B. Loop Wire

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

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

Provide insulating compound that is cross-linked thermosetting black polyethylene (ASTM D 2655). Ensure insulation is applied concentrically about conductor. Provide insulation thickness not less than 0.026" at any point and minimum average thickness of 0.030" as measured by UL Standard 62.

Ensure insulation of finished conductor will withstand application of a 60 Hertz or 3000 Hertz, 7500 volt (RMS) essentially sinusoidal spark test potential as specified in UL Standard 83.

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

- Encasing tube fabricated of polyethylene compound conforming to ASTM D 1248 for Type I, Class C, Grade E5.
- Minimum inside diameter of 0.150"
- Wall thickness of 0.040" +/- 0.010"
- Outside diameter of 0.240" +/- 0.010"

C. Conduit

Comply with Section 8 of these Project Special Provisions for non-metallic conduit.

13.3. CONSTRUCTION METHODS

All work performed in this section shall be done in the presence of the Engineer.

Notify Engineer one week before installing inductive detection loops.

Coordinate sawcutting and loop placement with pavement markings. For new construction or for resurfacing, install inductive detection loops before placing final layer of surface course. On unmarked pavement, pre-mark locations of stop lines and lane lines before locating inductive detection loops.

Loop locations are shown on the Plans with the distance to the closest stopline in the direction of travel noted. This measurement is an approximation. Before sawcutting, pre-mark inductive detection loop locations and receive approval.

Sawcut pavement at approved pre-marked locations. Do not allow vehicles to travel over unsealed loop slots.

Install 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 bottom of saw slot without damaging loop wire.

Before sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megohms. For each location with inductive loops, submit a completed Inductive Detection Loop & Grounding Test Results form and place copy in controller cabinet. Ensure all loops are included on form. The form shown here and is also located on the Department's website.

http://www.ncdot.gov/doh/preconstruct/traffic/ITSS/ws/signal_data.xls

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*)

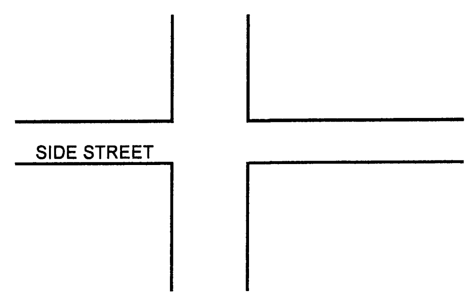
How are the ground rods installed? ☐ Individually ☐ Stacked

Ohm Reading? __________

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

Ground Rod Location

(Draw in cabinet & locate ground rods)



NOTES:

- **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**
- **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.**

Embed loop conductors in saw slot with loop sealant. Seal saw slot and dispose of excess sealant in an environmentally safe manner. Provide Engineer with Material Safety Data Sheet and manufacturer's test data.

Between where loop conductor pairs leave saw cut in pavement 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.

Sawcutting shall comply with the detail drawings in the Plans.

13.4. MEASUREMENT AND PAYMENT

Inductive loop sawcut will be measured and paid as the actual linear feet of inductive loop sawcut furnished, installed, and accepted.

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

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.

14.2. MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Furnish lead-in cable with two conductors of number 14 AWG fabricated from stranded tinned copper that complies with IMSA Specification 50-2 except as follows:

Ensure conductor is twisted with a maximum lay of 2.0 inches, resulting in a minimum of 6 turns per foot.

Provide a ripcord to allow cable jacket to be opened without using a cutter.

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

14.3. CONSTRUCTION METHODS

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, install lead-in cable from the signal controller cabinet to 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. Splicing shall be as called for in the Standard Specifications and as shown in the Roadway Standard Drawings.

Test each complete loop system from the controller cabinet by using a megger to verify that impedance from the loop system to the ground is at least 50 megohms. Record and report results utilizing "Inductive Loop and Grounding Test Results" form in Section 13 of these Project Special Provisions. Maintain a single source binder or binders of all results, kept in order by intersection number. 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. MEASUREMENT AND PAYMENT

Lead-in cable (____) will be measured and paid as the actual linear feet of lead-in cable furnished, installed, and accepted. Measurement will be made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all cables before determining length of cable run.

If markings are not visible, measurement will be point to point with no allowance for sag. Twenty-five feet will be allowed for vertical segments up or down poles.

Payment will be made under:

Lead-In Cable (14-2)..Linear Foot

15. FIBER OPTIC CABLE

15.1. DESCRIPTION

Furnish and install single mode fiber-optic (SMFO) communications cable and drop cable, fiber-optic cable storage racks (snow shoes), communications cable identification markers, lashing wire, and all necessary hardware.

All fiber optic cables furnished under this project shall be from the same manufacturer.

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. Provide exactly 12 fibers per buffer tube, regardless of the total number of fibers in the cable. Use single mode fiber in 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 minimum of one ripcord under sheath for easy sheath removal and with shipping, storage, installation, and operating temperature of at least -40 to 160 degrees F with a dual layered, UV cured acrylate fiber coating applied by cable manufacturer that may be stripped mechanically or chemically without damaging 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 that meets 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 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 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 to provide communications links between aerial splice enclosures and cabinet interconnect centers. Furnish drop cable containing six individual fibers.

Furnish drop cable that comply with RUS-CFR 1755.900 and have a minimum bend radius of 5.0 inches for a 6-fiber cable. Ensure drop cables have the same operating characteristics as the SMFO cable it is to be coupled with.

On one end of cable, furnish six ST-PC connectors for termination on the connector panel in equipment cabinet. Provide either factory assembled drop cables with ST-PC connectors or field installed connectors. No connectors are required for drop cables running from one splice enclosures directly to another splice enclosure.

Ensure attenuation of drop cable at 1310 nm does not exceed 0.5 dB/km. Ensure attenuation loss for complete drop cable assembly does 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 exposure to UV light and weather does not affect the markers natural coiling effect or deteriorate performance.

Furnish cable wraps containing the following text in black:

WARNING **CITY OF JACKSONVILLE TRAFFIC FIBER OPTIC CABLE** **CONTACT TELEPHONE NUMBER: 910-938-5200** **WARNING** **CITY OF JACKSONVILLE TRAFFIC FIBER OPTIC CABLE**

WARNING **CITY OF JACKSONVILLE IT FIBER OPTIC CABLE** **CONTACT TELEPHONE NUMBER: 910-938-5200** **WARNING** **CITY OF JACKSONVILLE IT FIBER OPTIC CABLE**

Overall Marker Dimensions: 7"(l) x 4"(w)
Lettering Height: 3/8 inch for *WARNING*, ¼" 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 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 prior to installation, in a format approved and accepted by the Engineer.

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

Comply with manufacturer's recommendations. Install communications cable on signal poles, utility poles, 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 outer sheath for termination. Measure slack cable by extending cable straight out of 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 risers with heat shrink tubing or conduits. All conduits that contain fiber optic cable and enter the bottom of a pole mounted cabinet shall be rigid metallic conduit. Do not share risers or conduits containing fiber-optic cable 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 or the amount shown on the Plans. This shall be for each fiber optic cable lashed to the messenger cable or overlashed to existing communications 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 fiber optic cables for different owners 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 recommended by the fiber-optic cable manufacturer. If more than one cable is being installed in multi-duct conduit banks, install all cables in one conduit and leave other conduit as a spare.

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 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 or manhole.

D. Installation of Drop Cable

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

At aerial splice enclosures, store 100 feet (or quantity shown on the Plans) of slack for each cable on cable storage racks. At below ground splice enclosures, coil 30 feet (or quantity shown on the Plans) of slack for each cable in manhole or junction box where enclosure is located.

At equipment cabinet end of the drop cable, terminate all fibers with ST-PC connectors to the connector panel. Label all connectors, pigtails, 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 for Future Use

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.

As shown on the plans, store cable at the end of cable routes. If not terminating fibers, cap and seal cable as directed on the Plans and in these Project Special Provisions.

F. Reuse of Existing Fiber Optic Cable

Existing fiber optic cable owned by NCDOT is called for reuse under this project. Prior to splicing, reconnecting at patch panels, or performing any activity that would otherwise modify the operation of the existing cable, the Contractor shall notify the Engineer in writing of the location of the affected cable, and the duration for which the cable will be affected. The Contractor shall be responsible for testing existing optical fibers intended for reuse from the nearest accessible terminated end to the location points the cable is intended for reuse. The Contractor shall report in writing to the Engineer any fibers proposed for reuse that do not meet the operating standards called for in these Project Special Provisions. The Contractor shall verify prior to disruption of any service the nature and character of the use of all optical fibers and report these uses to the Engineer. The Contractor shall not perform work that removes any existing communications or devices from service during the week day commute hours (7AM to 9AM and 4PM to 6PM Monday through Friday) nor during planned special events or other events or activities as called for by the Engineer unless approved by the Engineer.

G. Removal of Existing Communications Cable

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.

Do not reuse any removed communications cable, messenger cable, 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, or pole attachment hardware is to be returned to the Engineer, it will be so noted on the plans.

Removal of existing communications cable from risers noted in the Plans will be considered incidental to the heat shrink tubing retrofit kit pay item.

15.4. MEASUREMENT AND PAYMENT

Communications cable (____fiber) will be measured and paid as the actual linear feet of fiber-optic cable of each fiber count furnished, installed, and accepted in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 60 day observation period). Measurement will be made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all fibers before determining length of cable run.

Drop cable (____fiber) will be measured and paid as linear feet of fiber-optic drop cable furnished, installed, and accepted in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 60 day observation period). Sag and vertical segments will not be paid for as these distances are considered incidental to the installation of drop cable.

No measurement will be made for terminating, splicing, and testing of the new and existing fiber-optic cable, communications cable identification markers, fiber-optic cable storage racks, and grounding of messenger cable, as these will be considered incidental to the installation of the fiber optic cable.

No measurement will be made for the removal of existing messenger cable, existing communications cable, or existing pole attachment hardware as this will be considered incidental to the installation of new communications cable.

Payment will be made under:

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

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

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

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

Drop Cable (6 Fiber)..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. Provide aerial splice enclosures that are suitable for aerial, pedestal, buried, junction box, and/or manhole installations.

Check splice details before doing any work at splicing centers and enclosures. Do not cut entire cable when express fibers are present.

16.2. MATERIALS

A. General

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

B. Interconnect Center

Furnish compact, modular interconnect centers designed to mount inside equipment cabinets. Furnish interconnect centers with 12-position modules. Furnish interconnect centers that are rack-mountable. 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 secure fibers inside 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 that are a maximum of 6 feet in length with the appropriate type of factory assembled 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 the appropriate type of factory assembled connectors on each end. Ensure that SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

C. Splice Enclosure

Furnish splice enclosures that are re-enterable using a mechanical dome-to-base seal with a flash test valve, and are impervious to the entry of foreign material (water, dust, etc.). Ensure 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 with a minimum of four round ports (for single cables) that will accommodate all cables entering enclosure. Provide heat shrink cable shields with enclosure to ensure weather tight seal where each cable enters enclosure.

Within enclosures, provide enough 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 expressed through the enclosure. Ensure 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.

16.3. CONSTRUCTION METHODS

A. General (Workmanship Identification Information)

Include on the cover of each splice tray in a legible format the following information:

- Splice location reference # or identification information (i.e. 03-0098 tray 1 of 3, 03-0098 tray 2 of 3, etc.)
- Date the splice was made
- Company name of individual performing the splicing
- Name of individual performing the splicing

B. Workmanship

Upon cutting the cable and removing the outer jacketing material down to the individual buffer tubes, secure the central strength member to the enclosure so that no tensile force is applied to the fibers. Secure the individual buffer tubes to the splice trays by a method recommended by the manufacturer. Determine the length of each buffer tube needed to ensure the buffer tube can be looped a minimum of two times around the inside of the splice tray. Upon determining the length of buffer tube needed, remove the buffer tube to expose the individual fibers for fusion splicing. Adjust individual fiber lengths as necessary to ensure that once the fusion splicing process is completed that the finished splices will align with the "splice block organizer: supplied within the splice tray. Ensure the splice block organizer has individual fusion splice space holders for each fiber splice.

While prepping the individual fibers for splicing install the heat shrink protecting tube over the fiber and then perform the splicing operations, following the manufacturer's instructions. Verify the newly formed splice does not exceed 0.05 dB of attenuation. If the attenuation is more than 0.05 dB then remake the splice until it meeting the 0.05 dB or less requirement. Finish the splicing operation by sliding the heat shrink tube over the splice and applying heat to activate the heat shrink tubing. Secure the finished splice in the splice block organizer. Ensure each splice is properly secured in a space holder in the splice block organizer. Multiple splices secured to the same space holder are unacceptable.

Ensure all buffer tubes are contained within splice trays so no bare fibers are outside the tray and do not damage the fiber or violate the minimum bending radius of the fiber.

Prior to installing the cover over the splice tray and placing it in its final resting location, take a MANDATORY digital photograph of the splice tray that shows the final workmanship. Ensure the photograph shows the "Workmanship Identification Information" as well as the workmanship associated with installing and terminating the fiber. Include digital copies of each photograph on a computer disk as part of the OTDR Test Results submittal.

C. Termination and Splicing within Interconnect Center

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

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 fiber-optic connector labeling method.

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

For all cut fibers designated to pass through interconnect center, fusion splice fibers.

For all buffer tubes designated to pass through interconnect center, neatly coil the excess tubing inside the interconnect center.

D. Termination and Splicing within Splice Enclosure

Install 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 all fibers including fibers designated to be coupled with fibers from a drop cable assembly and cut fibers designated to pass through splice enclosure.

For all buffer tubes designated to pass through splice enclosure without splicing (expressed), neatly coil the excess tubing inside basket provided with enclosure. Do not cut pass-through (expressed) buffer tubes.

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

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

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

Install enclosures with enough slack cable to allow enclosure to be lowered to ground level and extended into a splicing vehicle.

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.

E. Testing

Provide written notification a minimum of ten days before beginning OTDR tests.

After splicing is completed, perform bi-directional OTDR test on each fiber, including unused fibers. Install 1000 foot pre-tested launch cable between the OTDR and fiber optic to be tested.

Ensure fusion splice losses do not exceed 0.05 dB and connectors have a loss of 0.5 dB or less. If any fiber exceeds maximum allowable attenuation or if fiber properties of the cable have been impaired, take appropriate actions up to and including replacement of the fiber cable. Corrective action will be at no additional cost to the Department.

Clearly label each OTDR trace identifying a starting and ending point for all fibers being tested. Record the attenuation level of each fiber and clearly indicate OTDR trace results in report format. Furnish one hard copy of each of the OTDR trace results and electronic copies of all trace results along with digital photographs showing workmanship for each splice on a compact disk. Furnish the manufacturer's make, model number, and software version of the OTDR used for testing.

F. Modify Existing Interconnect Center or Splice Enclosure

At locations shown in the Plans, the Contractor shall reuse an existing cabinet interconnect center or an existing splice enclosure to facilitate the splicing of an additional communications cable. The Contractor shall ensure that all existing, unmodified splices are functional and operating in their same condition after performing any work in an existing splice enclosure or cabinet. The Contractor shall also ensure that any modifications do not cause downtime of the terminating communication cables during normal business hours. All existing fibers shall be tested according to the requirements above.

16.4. MEASUREMENT AND PAYMENT

Interconnect center will be measured and paid as the actual number of fiber-optic interconnect centers furnished, installed, and accepted.

Interconnect centers to be located in equipment racks in buildings are included in the Fiber Optic Termination pay items in Section 20 of these Project Special Provisions.

Splice enclosure will be measured and paid as the 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.

Modify existing interconnect center or splice enclosure will be measured and paid as the actual number of existing splice enclosures or cabinets modified and accepted.

No measurement will be made of splice trays, pigtails, jumpers, connector panels, splice enclosures, and testing, as these will be considered incidental to furnishing and installing interconnect centers, splice enclosures, and modifying existing interconnect centers or splice enclosures.

Payment will be made under:

Interconnect Center..Each

Splice Enclosure..Each

Modify Existing Interconnect Center or Splice Enclosure ....Each

17. DELINEATOR MARKERS

17.1. DESCRIPTION

Furnish and install delineator markers with all necessary hardware.

17.2. MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Furnish tubular delineator markers, 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 orange delineators posts.

Provide text, including the contact number, 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 text visible from all directions approaching the assembly:

WARNING	**FIBER OPTIC CABLES**
BEFORE EXCAVATING OR IN AN EMERGENCY CALL 910-938-5200	
CITY OF JACKSONVILLE	

17.3. CONSTRUCTION METHODS

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

17.4. MEASUREMENT AND PAYMENT

Delineator marker will be paid for by the actual number furnished, installed, and accepted.

Payment will be made under:

Delineator Marker .... Each

18. CABLE TRANSFERS

18.1. DESCRIPTION

Remove and reinstall communications cable for pole relocations.

18.2. CONSTRUCTION METHODS

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

18.3. MEASUREMENT AND PAYMENT

Cable transfer will be measured and paid as the actual number of cable transfers with attachment hardware to new poles furnished, installed, and accepted.

Payment will be made under:

Cable Transfer..Each

19. ETHERNET CABLE (OUTDOOR RATED)

19.1. DESCRIPTION

Furnish and install Ethernet cable to serve as interconnect between Ethernet switches and/or field devices routed in outdoor conduit and/or lashed to messenger cable and existing cables.

19.2. MATERIALS

Furnish CAT5E Ethernet cable that is suitable for outdoor installation and meets or exceeds the following standards:

- 4-pair shielded twisted pair cable
- 24AWG (minimum) solid bare copper conductor
- Meets or exceeds CAT5E specifications
- High-density polyethylene insulation, PVC jacket
- Compliant with EIA/TIA standards
- UL/CSA listed
- UV Stabilized PE Jacket
- Gel Filled
- Meets TIA/EIA 568B.2 Networking Standard
- Supports 10/100/1000/10,000Mbps
- Mean Power Sum for Equal Level Fare End Crosstalk (ELFEXT): 45dB/kft (minimum) at 772kHz
- Worst Pair Power Sum for ELFEXT: 40dB/kft (minimum) at 772kHz
- Mean Power Sum for Near-end Crosstalk (NEXT): 42dB/kft (minimum) at 772 kHz
- Operating Temperature: Rated from -10 to +60 Celsius
- Average mutual capacitance: 90nf/mile (maximum)

Have the manufacturer factory test the Ethernet cable on reels for each pair's mutual capacitance, crosstalk loss, insulation resistance, and conductor resistance. Furnish the Engineer with a certified report for each reel showing compliance with these Project Special Provisions, the factory test results, and the manufactured date of the cable. The contractor shall not use Ethernet cable manufactured more than one year before the date of installation.

Cables where both ends will terminate in an RJ-45 connector, both ends should be installed with punchdown female jacks at both ends of the factory-manufactured cable, to be connected at both ends with short 3-6' patch cables.

Cable length with end patch connectors shall not exceed 295 feet.

19.3. CONSTRUCTION METHODS

A. General

Install Ethernet cable on new or existing messenger cable and in conduits at locations shown in the Plans. Allow a minimum of 10 feet (3 meters) of cable slack.

Ethernet cables shall not be spliced.

All cables shall be labeled with water proof, smear resistant labels that denote the equipment cabinets or housing they are run from and the device and identifier for that device they are connected to (e.g. CCTV Cabinet 31; CODEC at CCTV Cabinet 31).

B. Aerial Installation

Double lash the Ethernet cable to the messenger cable where installed aerially.

Wrap the Ethernet cable to the messenger cable using aluminum ribbon wraps where the wire supports other cables.

C. Underground Installation

Install underground Ethernet cable in conduit described in these Special Provisions and as shown in the Plans.

The contractor shall not exceed 80 percent of the manufacturer's maximum pulling tension when installing underground Ethernet cable. Use a clutch device (dynamometer) so as not to exceed the 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 the pulling line at the start of each pull. Do not release the tension in the cable if the pulling operation is halted. Restart the pulling operation by gradually increasing the tension until the cable is in motion.

19.4. MEASUREMENT AND PAYMENT

Ethernet cable (outdoor rated) will be measured and paid as linear feet of outdoor rated Ethernet cable furnished, installed, and accepted. Sag and vertical segments will not be paid for as these distances are considered incidental to the installation of the cable.

Ethernet cabling installed within equipment cabinets, within rooms, and within buildings are incidental and will not be paid for under this item.

No measurement will be made for terminating and testing of the cable, connectors, cable identification markers, and grounding, as these will be considered incidental to the installation of the Ethernet cable.

Payment will be made under:

Ethernet Cable (Outdoor Rated) .... Linear Feet

20. IN-BUILDING CABLE ROUTING AND FIBER OPTIC CABLE TERMINATION

20.1. 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.

All construction to reach a building (including up to installing a new junction box at an exterior wall) is paid for using other pay items in these Project Special Provisions. All construction to enter a building (including all work from integrating with an existing entrance) and making internal provisions for terminating cables are covered under these fiber optic cable termination pay items.

20.2. MATERIALS

A. General

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

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.

The Owner of each facility will be providing any furniture noted in the Plans.

B. Interconnect Center

Furnish compact, modular interconnect centers designed to be rack mounted in a standard 19" rack cabinet. Furnish interconnect centers with 12-position modules. Design and size interconnect centers to accommodate all fibers entering interconnect centers with additional 50% spare capacity for future splicing and terminations.

Provide splice trays that hold, protect, and organize optical fibers, and secure fibers inside 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 that are a maximum of 6 feet in length with the appropriate type of factory assembled 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 the appropriate type of factory assembled connectors on each end. Ensure that SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

20.3. CONSTRUCTION METHODS

A. General

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

Whenever possible, use existing 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.

Where applicable, install firestop around new conduit when penetrating walls.

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

Install interconnect centers in existing rack cabinets installed and maintained by the City of Jacksonville.

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

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

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

20.4. MEASUREMENT AND PAYMENT

Fiber optic cable termination will be measured and paid as a lump sum price.

This item 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, and cable routing within building as this will be considered incidental to building modifications.

No separate measurement will be made for computer hardware, video head-end equipment, and rack cabinets, as these will be measured and paid for elsewhere in these Project Special Provisions.

Payment will be made under:

Public Safety Complex Fiber Optic Cable Termination .... Lump Sum

Public Services Complex Fiber Optic Cable Termination .... Lump Sum

21. SIGNAL CABINET FOUNDATIONS

21.1. DESCRIPTION

Furnish and install signal cabinet foundations and all necessary hardware.

Furnish either poured concrete foundations or preformed cabinet pad foundations and all necessary hardware. Obtain approval of foundation type.

Where approved by the Engineer, install conduit entrances into existing foundations in accordance with the plans and specifications.

Modify existing foundations in accordance with the Plans and Project Special Provisions. At locations with where sidewalk, decorative brick pavers, or surface treatments or landscaping treatments are removed or damaged as part of the cabinet foundation installation, replace and restore to pre-construction condition using same material.

21.2. MATERIALS

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

Comply with Article 1000-4 Portland Cement Concrete.

Provide foundations with a minimum pad area that extends 24" from front and back of cabinet and 3" from sides of cabinet.

Furnish cabinet foundations with chamfered top edges. Provide minimum Class B concrete.

Provide preformed cabinet pad foundations with 7"(l) x 18"(w) minimum opening for the entrance of conduits. For precast signal cabinet foundations, include steel reinforcement to ensure structural integrity during shipment and placing of item. Include four 3/4" coil thread inserts for lifting. Comply with Article 1077-16.

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

Replacement sidewalk where required to restore locations to preconstruction condition shall be replaced in whole panels and shall meet the requirements of Section 848 of the Standard Specifications.

Replacement brick pavers where required to restore locations to preconstruction condition shall be of the same color and materials of the damaged or modified items

Replacement of other special pavement treatments or landscaping required to restore locations to preconstruction condition shall be the same materials of the damaged or modified items

21.3. CONSTRUCTION METHODS

A. General

Comply with Section 825 of the 2006 Standard Specifications for Roads and Structures regarding Incidental Concrete Construction.

Obtain approval for final cabinet foundation locations before pouring the concrete base. Locate new cabinets so as not to obstruct sight distance of vehicles turning on red or create any ADA violations or pedestrian conflicts.

Do not install foundations over uncompacted fill or muck.

Use procedures, equipment, and hardware as follows:

- Hand tamp soil before placing the concrete.
- Maintain 12 inches minimum from service pole to the closest point on foundation unless otherwise approved.
- Use a minimum of four 1/2 inch diameter expanding type anchor bolts to secure the cabinet to foundation.
- Install minimum 4 inches above and 4 inches below finished grade.
- Locate external stubbed out conduit at the cabinet foundation so conduit is in middle of cabinet. Provide service conduit as the rightmost conduit coming into cabinet. Provide two spare conduits stubbed out; one pointed toward service pole and the other toward direction of lead-in cable. Inscribe an identification arrow in foundation indicating direction of spare conduits.
- Give cabinet foundation a broom finish.
- Seal space between cabinet base and foundation with permanent, flexible, waterproof sealing material.
- If using preformed cabinet pad, ensure ground is level before installation.

B. Install Conduit Entrance into Existing Foundation

Install Conduit Entrances into existing cabinet foundations by core drilling foundations to install additional conduit. Ensure an IMSA Level II certified Technician is present during core drilling operations.

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.

If new metallic conduit is used, bond conduit to the cabinet grounding system.

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

C. 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.

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.

D. Generator Anchor

At locations shown in the Plans, modify existing foundations for the installation of an eye bolt in the side of the foundation to serve as an anchor for emergency generators being used by the City. Provide a forged machinery eye bolt with shoulder with a minimum 7/8" diameter that is a hot dipped galvanized steel material to prevent corrosion. Install the eye bolt a minimum of 4" below grade on any side of the existing foundation. Extract surrounding soil if necessary. Core drill new hole into the existing foundation and epoxy anchor in hole.

21.4. MEASUREMENT AND PAYMENT

Signal cabinet foundation will be measured and paid as the actual number furnished, installed, and accepted.

No separate payment will be made for removing existing signal cabinet foundations, as this will be considered incidental to the installation of new foundations.

Conduit entrance into existing foundation will be measured and paid as the actual number installed and accepted.

Modify foundation for controller cabinet will be measured and paid as the actual number installed and accepted.

Generator anchor into existing foundation will be measured and paid as the actual number installed and accepted.

4" concrete sidewalk will be measured and paid as the actual square yards of concrete installed and accepted.

Brick pavers will be measured and paid as the actual square footage of pavers installed and accepted.

Payment will be made under:

Signal Cabinet Foundation....................Each

Conduit Entrance into Existing Foundation....................Each

Modify Foundation for Controller Cabinet...Each

Generator Anchor into Existing Foundation..Each

4" Concrete Sidewalk .... Square Yard

Brick Pavers .... Square Foot

22. CABINET BASE ADAPTER/EXTENDER

22.1. DESCRIPTION

Furnish and install cabinet base adapters and extenders with all necessary hardware.

22.2. MATERIALS

Fabricate base adapters and extenders from the same materials and with the same finish as cabinet housing. Fabricate base adapter and extender in the same manner as controller cabinets, meeting all applicable specifications called for in the CALTRANS *Transportation Electrical Equipment Specifications* (TEES) (dated August 16, 2002, plus Errata 1 dated October 27, 2003 and Errata 2 dated June 8, 2004). Provide base adapters and extenders a minimum height of 12 inches.

22.3. CONSTRUCTION METHODS

Install cabinet base adapter at locations requiring a new Model 332 cabinet on existing/modified foundation.

Install cabinet base extender at locations of a new Model 332 cabinet on new foundation, unless a cabinet adapter has been called for.

Where Model 336 cabinet is used as base mount cabinet, install adapter or extender, as required.

Use permanent, flexible waterproof sealing material to:

- Seal between cabinet base and cabinet base adapter/extender,
- Seal two-piece cabinet base adapter/extender seams, and
- Seal space between cabinet base adapter/extender and foundation.

22.4. MEASUREMENT AND PAYMENT

Cabinet base adapters will be measured and paid as the actual number furnished, installed, and accepted.

Cabinet base extenders will be measured and paid as the actual number furnished, installed, and accepted.

Payment will be made under:

Cabinet Base Adapter ....Each

Cabinet Base Extender...Each

23. CONTROLLERS WITH CABINETS

23.1. DESCRIPTION

Furnish and install controllers with cabinets and all necessary hardware. Furnish all pole or foundation mounting hardware, 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.

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 cabinet assemblies as called for in Section 44 of these Project Special Provisions.

Provide real world coordinates for all installed or reused controller cabinets as required in Section 41.

23.2. 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.

B. Cabinet Prototype

The Contractor shall develop cabinet prototypes for each configuration of controller and equipment cabinet to show how all hardware (controller, detectors, field Ethernet switches, etc.) and associated cabling called for in these Project Special Provisions will be installed and configured in the field. The cabinet prototypes shall be approved by the Engineer prior to the installation of that cabinet configuration.

C. Type 2070L Controllers

Conform to CALTRANS *Transportation Electrical Equipment Specifications* (TEES) (dated August 16, 2002, plus Errata 1 dated October 27, 2003 and Errata 2 dated June 8, 2004) except as required herein.

Furnish Model 2070L controllers. Ensure that removal of the CPU 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 before needing software. Program software provided by the Department.

Provide model 2070L controllers with the latest version of OS9 operating software and device drivers, 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.

D. General Cabinets

Provide a moisture resistant coating on all circuit boards.

Provide one V150LA20 MOV or equal protection on each load switch field terminal.

Provide a power line surge protector that is a two-stage device that will allow connection of the radio frequency interference filter between the stages of the device. Ensure that a maximum continuous current is at least 10A at 120V. Ensure that the device can withstand a minimum of 20 peak surge current occurrences at 20,000A for an 8x20 microsecond waveform. Provide a maximum clamp voltage of 280V at 20,000A with a nominal series inductance of 200μh. Ensure that the voltage does not exceed 280V. Provide devices that comply with the following:

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

E. Type 170E Cabinets

E.1. General

Conform to CALTRANS *Transportation Electrical Equipment Specifications* (TEES) (dated August 16, 2002, plus Errata 1 dated October 27, 2003 and Errata 2 dated June 8, 2004) except as required herein.

Furnish CALTRANS Model 336S cabinets configured for 8 vehicle phases with power distribution assemblies (PDAs) # 2, and 4 pedestrian phases or overlaps.

Furnish CALTRANS Model 332 base mounted cabinets with PDAs #2 and configured for 8 vehicle phases, 2 pedestrian phases, or 2 overlaps. When overlaps are required, provide auxiliary output files for the overlaps. Do not reassign load switches to accommodate overlaps unless shown on electrical details.

E.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.

All AC+ power is subject to radio frequency signal suppression.

If additional surge protected power outlets are needed to accommodate shelf mounted equipment, 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.

Connect detector test switches for cabinets as follows:

336S Cabinet		**332 Cabinet**	
Detector Call Switches	**Terminals**	**Detector Call Switches**	**Terminals**
Phase 1	I1-F	Phase 1	I1-W
Phase 2	I2-F	Phase 2	I4-W
Phase 3	I3-F	Phase 3	I5-W
Phase 4	I4-F	Phase 4	I8-W
Phase 5	I5-F	Phase 5	J1-W
Phase 6	I6-F	Phase 6	J4-W
Phase 7	I7-F	Phase 7	J5-W
Phase 8	I8-F	Phase 8	J8-W

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 on-state clamping voltage is 30V. Provide a maximum response time less than 5 nanoseconds. Ensure that off-state leakage current is less than 10 µA. Provide a nominal capacitance less than 220pf 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 1500pf and a series resistance less than 15 Ω.

Provide surge suppression on each DC input channel in the cabinet. Ensure that the DC input channel surge suppresser can withstand a peak surge current of at least 10,000 amperes in the form of an 8x20 microsecond waveform and at least 100 occurrences of an 8x20 microsecond wave form at 2000 A. Ensure that the maximum clamping voltage is 30V. Provide a maximum response time less than 1 nanosecond and a series resistance less than 15 Ω per line.

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 cord.

Provide detector test 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.

Equip 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 [illegible] 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 2010 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".

Terminate ribbon cable at the P20 connector and terminal assembly. Ensure the P20 connector and mating ribbon cable connector is keyed to prevent cable from being improperly installed. Wire the P20 connector to the traffic signal red displays to provide inputs to 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 and Model 204 flashers.

E.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.

i) 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.

ii) 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 terminals so that each pair of inputs is next to each other. Ensure 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 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 fiber optic interconnect center (when applicable). Ensure 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 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 the assembly can support the 2070 controller plus 15 pounds of additional weight. Ensure shelf has a locking mechanism to secure it in the fully extended position and does not inhibit the removal of the 2070 controller or removal of cards inside the controller when fully extended. Provide a locking mechanism that is easily released when the shelf is to be returned to its non-use position directly under the controller.

E.4. Model 2010 Enhanced Conflict Monitor

Furnish Model 2010 Enhanced Conflict Monitors that provide monitoring of 16 channels. Ensure each channel consists of a green, yellow, and red field signal input. Ensure that the conflict monitor meets or exceeds CALTRANS Transportation Electrical Equipment Specifications dated August 16, 2002 with Erratum 1 and 2 (hereafter referred to as CALTRANS's 2002 TEES) for a model 210 monitor unit and other requirements stated in this specification.

Ensure the conflict monitor is provided with a 16 channel conflict programming card. Pin 16 and Pin T of the programming card shall be connected together. Ensure that the absence of the conflict programming card will cause the conflict monitor to trigger (enter into fault mode), and remain in the triggered state until the programming card is properly inserted and the conflict monitor is reset.

Provide a conflict monitor that incorporates LED indicators into the front panel to dynamically display the status of the monitor under normal conditions and to provide a comprehensive review of field inputs with monitor status under fault conditions. Ensure that the monitor indicates the channels that were active during a conflict conditions and the channels that experienced a failure for all other per channel fault conditions detected. Ensure that these indications and the status of each channel are retained until the Conflict Monitor is reset. Furnish LED indications for the following:

- AC Power

- VDC Failed
- WDT Error
- Conflict
- Red Fail
- Dual Indication
- Short Yellow/Sequence Failure
- Program Card/PC Ajar
- Monitor Fail/Diagnostic Failure
- Channel Indicators (One indicator for each green, yellow, and red field signal input for each channel)

In addition to the connectors required by CALTRANS's 2002 TEES, provide the conflict monitor with a red interface connector mounted on the front of the monitor (3M-3428-5302 or equivalent with polarizing keys) which ensures proper mating with a 20 pin cable connector that conducts the signals from the P20 connector on the cabinet assembly. Keying of the connector shall be between pins 3 and 5, and between 17 and 19. The odd numbered pins are on one side, and the even pins on the other. Provide connector pins on the monitor with the following functions:

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

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

Provide Special Function 1 and Special Function 2 inputs to the unit which shall disable only Red Fail Monitoring when either input is sensed active. A Special Function input shall be sensed active when the input voltage exceeds 70 Vrms with a minimum duration of 550 ms. A Special Function input shall be sensed not active when the input voltage is less than 50 Vrms or the duration is less than 250 ms. A Special Function input is undefined by these specifications and may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms or the duration is between 250 ms and 550 ms.

Ensure the conflict monitor recognizes field signal inputs for each channel that meet the following requirements:

- consider a Red input greater than 70 Vrms and with a duration of at least 500 ms as an "on" condition;
- consider a Red input less than 50 Vrms or with a duration of less than 200 ms as an "off" condition (no valid signal);
- consider a Red input between 50 Vrms and 70 Vrms or with a duration between 200 ms and 500 ms to be undefined by these specifications;
- consider a Green or Yellow input greater than 25 Vrms and with a duration of at least 500 ms as an "on" condition;
- consider a Green or Yellow input less than 15 Vrms or with a duration of less than 200 ms as an "off" condition; and
- consider a Green or Yellow input between 15 Vrms and 25 Vrms or with a duration between 200 ms and 500 ms to be undefined by these specifications.

Provide a conflict monitor that recognizes the faults specified by CALTRANS's 2002 TEES and the following additional faults. Ensure monitor will trigger upon detection of a fault and will remain in the triggered (in fault mode) state until unit is reset at the front panel or through the external remote reset input for the following failures:

1. **Red Monitoring or Absence of Any Indication (Red Failure):** A condition in which no "on" 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 1000 ms when used with a 170 controller and 1500 ms when used with a 2070L controller, ensure monitor will trigger and put the intersection into flash. If the absence of any indication condition lasts less that 750 ms when used with a 170 controller and 1200 ms when used with a 2070L controller, ensure conflict monitor will not trigger. Have red monitoring occur when both the following input conditions are in effect:
a) 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 and 70 Vrms), and
b) neither Special Function 1 nor Special Function 2 inputs are active.

2. **Short/Missing Yellow Indication Error (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 for a minimum of 2.7 seconds (± 0.1 second) following the detection of an "on" signal at a Green input for that channel, ensure that the monitor triggers and generates a sequence/short yellow error fault indication. This fault shall not occur when the channel is programmed for Yellow Inhibit or when the Red Enable signal is inactive.
3. **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.
4. **Configuration Settings Change:** The configuration settings are comprised of (as a minimum) the permissive diode matrix, dual indication switches, yellow disable jumpers, any option switches, any option jumpers, and the Watchdog Enable switch. Ensure the conflict monitor compares the current configuration settings with the previous stored configuration settings on power-up, on reset, and periodically during operation. If any of the configuration settings are changes, ensure that the conflict monitor triggers and causes the program card indicator to flash. Ensure that configuration change faults are only reset be depressing and holding the front panel reset button for five second. Ensure the external remote reset input does not reset configuration change faults.

Ensure the conflict monitor will trigger and the AC Power indicator will flash at a rate of 2 Hz ± 20% with a 50% duty cycle when the AC Line voltage falls below the "drop-out" level. Ensure the conflict monitor will resume normal operation when the AC Line voltage returns above the "restore" level. Ensure the AC Power indicator will remain illuminated when the AC voltage returns above the "restore" level. The "drop-out" level is at 98 Vrms and the "restore" level is at 103 Vrms with timing at 400 ms. Should an AC Line power interruption occur while the monitor is in the fault mode, then upon restoration of AC Line power, the monitor will remain in the fault mode and the correct fault and channel indicators will be displayed.

Provide a flash interval of at least 6 seconds and at most 10 seconds in duration following a power-up, and AC Line interruption, or a brownout restore. Ensure the conflict monitor will suspend all fault monitoring functions, close the Output relay contacts, and flash the AC indicator at a rate of 4 Hz ± 20% with a 50% duty cycle during this interval. Ensure the termination of the flash interval after at least 6 seconds if the Watchdog input has made 5 transitions between the True and False state and the AC Line voltage is greater than the "restore" level. If the watchdog input has not made 5 transitions between the True and False state within 10 ± 0.5 seconds, the monitor shall enter a WDT error fault condition.

Ensure to monitor an intersection with up to four approaches using the four-section Flashing Yellow Arrow (FYA) vehicle traffic signal as outlines by the NCHRP 3-54 research project for protected-permissive left turn signal displays. Ensure the conflict monitor will operate in the FYA mode and FYAc (Compact) mode as specified below to monitor each channel for the following fault conditions: Conflict, Red Fail, Dual Indication, and Clearance. Provide a switch to select between the FYA and FYAc mode. Provide a switch to select each FYA phase movement for monitoring:

FYA mode

FYA Signal Head	Phase 1	Phase 3	Phase 5	Phase 7
Red Arrow	Channel 9 Red	Channel 10 Red	Channel 11 Red	Channel 12 Red
Yellow Arrow	Channel 9 Yellow	Channel 10 Yellow	Channel 11 Yellow	Channel 12 Yellow
Flashing Yellow Arrow	Channel 9 Green	Channel 10 Green	Channel 11 Green	Channel 12 Green
Green Arrow	Channel 1 Green	Channel 3 Green	Channel 5 Green	Channel 7 Green

FYAc mode

FYA Signal Head	Phase 1	Phase 3	Phase 5	Phase 7
Red Arrow	Channel 1 Red	Channel 3 Red	Channel 5 Red	Channel 7 Red
Yellow Arrow	Channel 1 Yellow	Channel 3 Yellow	Channel 5 Yellow	Channel 7 Yellow
Flashing Yellow Arrow	Channel 1 Green	Channel 3 Green	Channel 5 Green	Channel 7 Green
Green Arrow	Channel 9 Green	Channel 9 Yellow	Channel 10 Green	Channel 10 Yellow

Ensure that the conflict monitor will log at least nine of the most recent events detected by the monitor in non-volatile EEPROM memory (or equivalent). For each event, record at a minimum the time, date, type of event, status of each field signal indication with RMS voltage, and specific channels involved with the event. Ensure the conflict monitor will log the following events: monitor reset, configuration, previous fault, and AC line. Furnish the signal sequence log that shows all channel states (Greens, Yellows, and Reds) and the Red Enable State for a minimum of 2 seconds prior to the current fault trigger point. Ensure the display resolution of the inputs for the signal sequence log is not greater than 50 ms.

Provide a RS-232C/D compliant port (DB-9 female connector) on the front panel of the conflict monitor in order to provide communications from the conflict monitor to the 170/2070L controller or to a Department-furnished laptop computer. Electrically isolate the port interface electronics from all monitor electronics, excluding Chassis Ground. Ensure that the controller can receive all event log information through a controller Asynchronous Communications Interface Adapter (Type 170E) or Async Serial Comm Module (2070L). Provide a Windows based graphical user interface software to communicate directly through the same monitor RS-232C/D compliant port to retrieve and view all event log information to a Department-furnished laptop computer. The RS-232C/D compliant port on the monitor shall allow the monitor to function as a DCE device with pin connections as follows:

Conflict Monitor RS-232C/D (DB-9 Female) Pinout		
Pin Number	**Function**	**I/O**
1	DCD	O
2	TX Data	O
3	RX Data	I
4	DTR	I
5	Ground	-
6	DSR	O
7	CTS	I
8	RTS	O
9	NC	-

E.5. Model 222 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 loop detector sensor units.

E.6. Auxiliary Output Files

Furnish auxiliary output file units that comply with Chapter 3 Section 8 of the CALTRANS Specifications (2002 TEES) and the requirements for Model 214 ITS Auxiliary Monitor Units (AMU).

E.7. Cabinet Finish

Cabinet finish shall be an anodized silver aluminum finish.

F. Terminal Splice Box

Furnish terminal splice boxes to splice and extend signal conductors, loop lead-in cables, and existing twisted pair interconnect cables where present. 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, loop lead-ins, and twisted pair cables, as the splicing of all existing signal conductors, loop lead-ins, and twisted pair cables 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, loop lead-in, and twisted pair cable shall be of the same size and type of the existing wires and cables. 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 banded attachments and screws and other attachment hardware as approved by the Engineer. 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.

23.3. CONSTRUCTION METHODS

A. General

Remove existing controllers and cabinets as shown in the Plans. 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, auxiliary output files, and hardware that provide the required phasing, color sequence, flash sequence, interconnection, railroad clearance and preemption, and emergency vehicle clearance and preemption as shown on the signal plan electrical drawings. At locations with preemption (emergency vehicle, railroad, or transit vehicle), submit a completed Preemption Test Procedure Checklist for approval by the Engineer. The latest checklist can be found at:

http://www.ncdot.org/doh/preconstruct/traffic/ITSS/ws/preemption.pdf

Stencil signal inventory number on cabinet side facing 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. When field conditions require deviation from the plans, notify the Engineer.

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. Ensure all signal heads for same approach flash concurrently during flashing operation.

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

Install pole mounted cabinets so height to cabinet middle is 4 feet. Install new conduit and riser entrances in bottom of pole mounted cabinets to accommodate the number of entering cables as shown in the Plans.

Activate controllers with proposed phasing and timing.

At locations with existing school flasher outputs, integrate school flasher outputs with new controller and cabinet to preserve all existing functionality.

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.

B. Terminal Splice Box

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

C. Emergency Vehicle Preemption

Comply with the emergency vehicle preemption requirements detailed in Section 1 of these Specifications for new installations and reuse of existing emergency vehicle preemption. Coordinate emergency vehicle preemption work with the proper operating authority. Contact the proper operating authority and schedule installation of all equipment. Reuse existing hardware, harnesses, and wires to interface with new signal controller and cabinet.

D. Emergency Generator Provisions

Comply with the emergency generator provisions detailed in Section 1 of these Specifications for new installations and reuse of existing emergency generator provisions. Reuse existing hardware, harnesses, and wires to interface with new signal controller and cabinet.

E. Flashing Yellow Arrow Locations

At locations shown on the Plans where new flashing yellow arrow signal heads will be installed, replace the existing conflict monitor with a new Model 2010 Enhanced Conflict Monitor as described above. Program the Model 2010 Enhanced Conflict Monitor as shown on the electrical plans.

23.4. MEASUREMENT AND PAYMENT

Controllers with cabinets (____) will be measured and paid as the actual number of each type of controllers with cabinets furnished, installed, and accepted in accord with the following conditions: 90% of the payment will be made upon acceptance of the installed unit; 10% of the payment will be made following final acceptance of the integrated system (including completion of the 60 day observation period).

No measurement of payment will be made for removing existing cabinets and controllers, as this will be considered incidental to the installation of new controllers with cabinets.

No measurement will be made for conduits nipples, fittings, signal cable, service wire, locknuts and bushings or other material necessary to replace a pole mounted cabinet.

Conflict monitor will be measured and paid for as the actual number furnished, installed, and accepted in conjunction with the installation of new flashing yellow arrow signal heads. No measurement will be made for the reuse of existing conflict monitors. No measurement will be made for conflict monitors furnished and installed with new cabinets.

Detector card (____) will be measured and paid as the actual number furnished, installed, and accepted.

Auxiliary output files will be measured and paid as the actual number furnished, installed, and accepted.

Terminal splice box will be measured and paid as the actual number furnished, installed, and accepted. No measurement or payment will be made of new riser assemblies and conduit needed to complete terminal splice boxes.

Emergency generator provisions will be measured and paid as the actual number furnished, installed, and accepted.

No measurement or payment will be made of conflict monitors, grounding systems, AC/DC isolators, reuse of existing preemption systems, reuse of existing emergency generator provisions and all associated hardware, entrances for pole mounted cabinet configurations, and painting of cabinets, as these will be considered incidental to furnishing and installing controllers with cabinets. New installations of emergency vehicle preemption systems will be paid for under Section 24.

No measurement or payment will be made of new riser assemblies and conduit needed to complete terminal splice boxes.

No measurement or payment will be made for developing cabinet prototypes, as that will be considered incidental to the installation of new cabinets.

No measurement will be made for producing and submitting plan of record documentation, including real world coordinates, as this will be considered incidental to furnishing and installing new cabinets.

Payment will be made under:

Controller with Cabinet (Type 2070L, 332 Base Mounted) .... Each

Controller with Cabinet (Type 2070L, 332 Base Mounted with Aux File) .... Each

Controller with Cabinet (Type 2070L, 336S Pole Mounted) .... Each

Conflict Monitor .... Each

Detector Card (Model 222) .... Each

Auxiliary Output File .... Each

Terminal Splice Box .... Each

Emergency Generator Provisions .... Each

24. EMERGENCY VEHICLE INITIATED PREEMPTION SYSTEMS

24.1. DESCRIPTION

Furnish and install new emergency vehicle initiated preemption systems (hereafter referred to as preemption systems) with all necessary hardware and software in accordance with the plans and specifications. Ensure the preemption systems consist of both a means to place a preemption call and a receiver/processor to receive the call that will properly initiate the desired signal preemption and is compatible with the existing preemption system. Ensure the preemption systems comply with all applicable FCC regulations and conform to NEMA TS2-2003 Section 2, "Environmental Requirements."

24.2. MATERIALS

Furnish preemption systems that are compatible with 170/2070 signal controller equipment. Ensure the equipment is compatible for use in a Caltrans 332/336 input file. Ensure the operation of the preemption systems are not affected by the following conditions:

- Snow
- Rain
- Ambient light conditions such as bright sunlight, twilight, shadows, vehicle headlights, etc.
- Fog which can be penetrated by traffic signal indications
- Ambient noise levels below 70 db
- Ambient electromagnetic interference

Provide preemption systems that will log and retain a minimum of 1,000 preemption occurrences that include the direction of preemption, time, and date. Ensure that it is impossible to delete a logged preemption event manually using equipment switches or other manual input and controls. Furnish the ability to upload and download all data and operating parameters using a DB-9 communication port or Department approved alternative. Ensure the logged data is maintained in memory until the data is downloaded. When the maximum number of occurrences is recorded, ensure preemption systems retain data from the most recent event and lose data from the oldest event as new preemption calls occur.

Furnish preemption systems with a time clock that utilize the following features:

- provide time clock to adjust the time for the transition between Daylight Saving Time and Standard Time,
- provide time clock with the option to record and report occurrences using a 24 hour clock time stamp,
- provide internal battery or capacitor backup power source to continue the operation of the time clock and memory during a power outage. Ensure the backup power source will supply power for a single outage for a minimum of 48 hours and automatically recharge within 24 hours after power is resumed.

Provide preemption systems with a minimum of four separate preemption inputs and outputs or as specified by the bid list or plans. Ensure preemption system receivers differentiate between any two approaches as the source of a call signal if those approaches intersect at an angle greater than 20 degrees. Furnish preemption systems that will detect a preempt call at distances between 250 feet to 1,500 feet. Ensure ambient signal sources will not cause the preemption system to place the intersection in the preemption mode. Also, provide the means to prevent false calls resulting from emergency vehicles passing through nearby locations or nearby intersections such as at cross streets near the signal.

Provide preemption systems to automatically select the programmed output call to the traffic signal controller based on the approach of the emergency vehicle placing the call. Provide a call extension timer that will hold the preempt call for a user selectable time after the preempt call terminates. Furnish preemption systems to display indications for the receipt of a call for each approach to allow a servicing technician to determine proper or improper operation. Ensure the indications last as long as that call is being received by the system. Provide a test switch or push-button for each channel on the control unit to manually place a preemption call to the traffic signal controller.

Provide all necessary software to the Department for the operation of the preemption systems. Ensure the software can operate on a personal computer and is compatible with Windows 7. Furnish software that is licensed for use by the City of Jacksonville, State personnel, and personnel of other agencies that are responsible for maintaining State signals. Ensure the State is licensed to duplicate and distribute the software as necessary for design and maintenance support. Furnish software to have the programming of all user application functions to be displayed in a menu format and show like parameters, functions, or data in a group to provide a coherent order.

Provide preemption systems that have control circuitry of solid-state construction. Ensure active devices for logic, timing, and control functions are solid state and sufficiently rated to have no material shortening of life under conditions of maximum power dissipation at maximum ambient temperature. Furnish timing functions using digital devices. Ensure the memory for event data and program data is stored in an electronically erasable memory device which has 100,000 write cycles (minimum) and is designed to retain data for 10 years. Furnish memory that is not required to have an external battery backup to retain data or other programmed entries unless otherwise specified. Ensure each system component unit requires input power by either 120 VAC from the controller cabinet or separate equipment power supply that is powered by the 120 VAC from the controller cabinet.

Ensure the components of the preemption systems do not exceed the dimension and weight as specified below:

- Control Unit - 8" (203mm) width x 10" (254mm) height x 10" (254mm) depth, 10 lbs. (4.5kg)
- Detector Unit or Antenna - 15 lbs. (6.8kg)

Ensure all equipment of the preemption systems which are exposed to weather be weatherproof and suitable for operation in wet locations. Provide moisture resistant coating on all circuit boards.

Provide all required mounting hardware to install the preemption systems that are suitable for use with wood pole or metal structure application. Ensure the mounting hardware provides a secure position to prevent shifting after the initial alignment of the preemption systems.

24.3. CONSTRUCTION METHODS

Test at the Contractor's workshop all emergency vehicle initiated preemption before installation at the intersection. Connect and program the preemption system as shown on the plans. Receive approval from the Engineer for the correct operation of the emergency vehicle initiated preemption system. Clearly label each unit and associated cables and wiring.

Place into operation emergency vehicle initiated preemption systems. Configure emergency vehicle initiated preemption systems to achieve required activation by emergency vehicles within required ranges.

Install the necessary processing and communications equipment in the signal controller cabinet. Make all necessary modifications to install equipment, cabling harnesses, and phase selector with surge suppression.

Install the necessary cables from each optical detector to the signal controller cabinet along signal cabling routes. Install surge protection where required and terminate all cable conductors.

24.4. MEASUREMENT AND PAYMENT

Optical preemption detectors will be measured and paid as the actual number furnished, installed, and accepted.

Optical preemption phase selectors will be measured and paid as the actual number furnished, installed, and accepted.

Payment will be made under:

Optical Preemption Detector..Each

Optical Preemption Phase Selector..Each

25. FIBER OPTIC TRANSMITTER AND RECEIVER UNIT WITH CONTACT CLOSURE

25.1. DESCRIPTION

Furnish and install 8 channel contact closure, and fiber-optic transmitter and receiver unit with contact closure to provide queue detection at locations shown on the plans.

25.2. MATERIALS

A. General

The fiber optic transmitter and receiver unit shall provide the ability to transmit eight input and output channels simultaneously over one optical fiber. The transmitter and receiver devices shall operate with single-mode fiber. Provide devices that are shelf or DIN rail mounted, modular-designed, and with all necessary hardware that is compatible with the system equipment. Provide transmitter and receiver devices from the same manufacturer.

B. Transmitter and Receiver Unit

Provide transmitter and receiver unit that meets the following minimum requirements:

- Input Power: 120 VAC or 120 VAC pluggable power supply cube with secondary DC voltage range of 12 to 36 VDC.
- Operating Distance: 5 miles, minimum
- Operating Wavelength: 1310 or 1550 nm
- Optical Connector: ST
- Temperature Range: 0 to 150 degrees F
- Support Single Mode fiber
- Terminal Block with screw clamp for power and data
- 8 Input/Output Channels
- Contacts: 100 VDC, 0.5 amp, 12 watts, normally open

25.3. CONSTRUCTION METHODS

Install fiber-optic fiber optic transmitter and receiver unit in the traffic signal controller cabinet at locations shown on the plans. Comply with the manufacturer's installation instructions.

Program traffic signal controllers, connect wiring, relays and resistors as shown in the plans. Test unit in workshop before installing in the field. Receive approval from Engineer before installing cabinets. Clearly label each unit and associated cables and wiring.

25.4. MEASUREMENT AND PAYMENT

Fiber Optic transmitter and receiver unit will be measured and paid for as the actual number installed, integrated, and accepted. A unit is defined as consisting of a single transmitter device and a single matching receiver device. No measurement will be made for testing, relays, cable, wiring, fiber optic jumpers, DC isolators and other items necessary for installation.

No measurement will be made for terminating, splicing, and testing of the fiber-optic cable identified to be used for the queue detection system.

Payment will be made under:

Fiber-optic Transmitter and Receiver Unit .... Each

26. ELECTRICAL SERVICE

26.1. DESCRIPTION

Install new electrical service where required by the plans. Coordinate all work involving electrical service with the appropriate electrical utility company.

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.

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 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 listed as meeting UL Standard UL-489 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. Provide ground bus and neutral bus with a minimum of four terminals with minimum wire capacity range of number 14 through number 4.

Furnish NEMA Type 3R meter base rated 100 Ampere minimum that meets the requirements of the local utility. Provide meter base with sockets' ampere rating based on sockets being wired with minimum of 167 degrees F insulated wire. Furnish 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

- With or without horn bypass
- Made of galvanized steel
- Listed as meeting UL Standard UL-414
- Overhead or underground service entrance as specified

Ensure meter bases have electrostatically applied dry powder paint finish, light gray in color, with minimum thickness of 2.4 mils.

Furnish 1" 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 marked as being suitable for use as service equipment. Ensure combination meter and disconnect mounted in a pedestal for underground service is listed as meeting UL Standard UL-231. Otherwise, ensure combination meter and disconnect is listed as meeting UL Standard UL-67.

26.3. 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 required by 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 Division 17 of the Standard Specifications and Standard Drawings.

Furnish and install new external service disconnect (breaker box) of the type shown in the plans. Route the electrical service through the meter base and service disconnect to the controller cabinet to form a complete electrical service assembly as shown in the plans. Ensure that the existing grounding system for the existing service with the new service disconnect complies with the grounding requirements of these provisions and Division 17 of 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.

If required, furnish and install new external service disconnect (breaker box) of the type shown in the plans. Route the electrical service through the meter base and service disconnect to the controller cabinet to form a complete electrical service assembly as shown in the plans. Ensure that the existing grounding system for the existing service with the new service disconnect complies with the grounding requirements of these provisions and Division 17 of the Standard Specifications and Standard Drawings.

C. Power from Existing Electrical Service

For locations shown in the plans where an existing electrical service is being provided to both a traffic signal controller cabinet and a CCTV cabinet (i.e., two separate circuits from a single electrical service), ensure the existing electrical service has two circuit breakers in the service disconnect. One (1) 50 amp circuit breaker for the signal controller cabinet and one (1) 15 amp circuit breaker for the CCTV cabinet. Circuit breaker(s) must be compatible with existing disconnect. Install new 1" underground conduit between the service disconnect and the CCTV cabinet. Use 1" rigid galvanized short risers from bottom of disconnect and CCTV cabinet to connect the underground conduit. Route the new conductors (3 number 12 THWN conductors) from the 15 amp circuit breaker to the CCTV cabinet through the new underground conduit and short risers. Permanently label the circuit breakers to identify which circuit servers the signal controller cabinet and which servers the CCTV cabinet.

26.4. MEASUREMENT AND PAYMENT

New electrical service will be measured and paid as actual number furnished, installed and tested. No measurement will be made for 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 as these are considered incidental to installing a new electrical service.

Modify existing electrical service will be measured and paid as actual number of modified electrical services, including service disconnects, furnished, installed, and integrated into an existing service to form a complete electrical service. Any electrical service conductors, remaining hardware and conduit to connect the electrical service to the cabinet are considered incidental to the service disconnects. No separate payment will be made for extending or replacing electrical service cable and conduits.

Power from existing electrical service will be measured and paid as actual number furnish, installed, and tested. No measurement will be made for circuit breakers, conductors, conduit fittings, bonding, and any remaining hardware to provide power from the existing electrical service to the cabinet as these are considered incidental. Conduit will be measured separately and paid for under Section 8 of these Project Special Provisions.

Payment will be made under:

New Electrical Service..Each

Modify Existing Electrical Service..Each

Power From Existing Electrical Service...Each

27. SOLAR POWER ASSEMBLY

27.1. DESCRIPTION

At locations shown in the Plans, furnish and install Solar Power Assembly equipment with equipment cabinets and all necessary hardware in accordance with these Special Provisions and the Plans. Comply with the provisions of Section 1700 of the Standard Specifications.

27.2. MATERIAL

A. General

Furnish and install a Solar Power Assembly at locations shown in the Plans consisting of the following:

- Solar Array
- Solar Charge Controller
- Batteries
- Assembly Cabinet

B. Solar Array

Furnish solar modules made in North America and have a minimum 20 year factory warranty. The solar array should have a minimum peak output of 100W. Solar modules must be UL listed, FM Class I, Div II, Group C&D approved. For the solar array, power wiring should be 10-2, stranded copper, double insulated, sunlight resistant, 600V 90C rated cable. The array mount will attach to the side of the CCTV pole with stainless steel fasteners. The array mount must be aluminum alloy or stainless steel. The array must be capable of withstanding 130 mph winds (per NCDOT Wind Zone 2).

C. Solar Charge Controller

The solar charge controller must be UL listed, minimum 45A with solid state, low voltage disconnect. The solar charge regulator must be sealed with internal temperature compensation, lightning protection, reverse polarity protection, and LED indicators. Furnish controllers with the capability of 3 functions: battery charging, load control, or diversion regulation. Controllers must be furnished with fully adjustable DIP switches and RS-232 communications port to adjust the unit's operational modes. The solar charge regulator should be FM Class I, Div. II, Groups ABCD and have the CE mark.

D. Batteries

Provide 12V gel electrolyte, non-spillable, maintenance free batteries. Batteries should be able to provide power for 10 days without being charged by the Solar Array and Solar Charge Controller. Furnish batteries with a minimum operating temperature of -76° F to 140° F.

E. Solar Power Assembly Cabinet

The solar power assembly cabinet should be constructed of 0.125" aluminum with stainless steel hardware. There must be separate compartments for the batteries and the electronics. The enclosures must be NEMA 3R rated and large enough to contain all solar equipment and incidental components, including 20% spare space. The cabinet should be pad mounted.

27.3. CONSTRUCTION METHOD

Furnish and install new Solar Power Assemblies. Install solar power equipment on 60 foot wood poles. Provide wiring, disconnects, and all other equipment as required by Article 690 of the NEC.

Install solar panel collectors on pole at a height that will prohibit theft and/or vandalism, and at a minimum of 25 feet from ground level. Installation of multiple collector panels shall be approved by the Engineer prior to installation.

Ensure that the 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 the test requirements.

27.4. MEASUREMENT AND PAYMENT

Solar Power Assembly will be measured and paid as the actual number of solar power assemblies furnished, installed and accepted.

No separate payment will be made for solar arrays, solar power assembly equipment cabinet, installing breakers, inverters, temperature sensors, mounting system, grounding system, conduits, risers, wiring, and hardware as these will be considered incidental to furnishing and installing the solar power assembly.

Payment will be made under:

Solar Power Assembly .... Each

28. WIRELESS BROADBAND ETHERNET RADIO SYSTEM

28.1. DESCRIPTION

Furnish and install a wireless broadband Ethernet radio system with all necessary hardware in accordance with the plans and specifications to provide a video and data link between a CCTV camera and a fiber access point. Provide a radio system with a bi-directional communications channel between two “line-of-sight” antennas using license free technology operating in the 2.4 / 5.8 GHz frequency band.

Furnish material and workmanship conforming to the National Electrical Code (NEC), the National Electrical Safety Code (NESC), Underwriter’s Laboratories (UL) or a third-party listing agency accredited by the North Carolina Department of Insurance, and all local safety codes in effect on the date of advertisement. Comply with all regulations and codes imposed by the owner of affected utility poles.

28.2. MATERIALS

A. General

Furnish a point to point & point to multi-point wireless broadband Ethernet data radio system. 5.8 GHz is to be used for broadband connectivity applications with an inbuilt 2.4 GHz for 802.11 WiFi connection. The system may consist of connectorized radios and/or radios with integrated panel antennas.

Furnish a dual 2.4 & 5.8 GHz wireless broadband system with the following minimum general operating characteristics:

Frequency	5.2 GHz UNII & 5.8 GHz ISM Dynamic Frequency Selection (DFS) and 2.4 - 2.4835 GHz ISM Dynamic Frequency Selection (DFS)
Wireless Technology	E-OFDM and DSSS
Operating Mode	Point-to-point, point to multipoint
Range	>20 Miles (LOS)
Bandwidth	Up to 54 Mbps

Compliance	SWRI tested, FCC & Industry Canada, RSS-210 approved.
Weatherproof Outdoor Unit	IP67 rated with either a connectorized unit (2 n-male ports) or with integrated 23 dB panel antenna & one 2.4 GHz n-male antenna port

B. Radio

Furnish a radio with the following minimum general operating characteristics:

Multiple Frequency Bands	5.2 GHz UNII 5.8 GHz ISM Non-overlapping Channels: 40 x 5 MHz 20 x 10 MHz, 10 x 20 MHz, 5 x 40 MHz 2.4 GHz ISM Non-overlapping Channels: 16 x 5 MHz 8 x 10 MHz, 4 x 20 MHz, 2 x 40 MHz
Radio Type	E-Orthogonal Frequency Division Multiplexing (E-OFDM)
Standards Compliance	802.3, 802.11i, 802.11a hardware with proprietary bridging extensions
Radio Output Power	Max radio output power 26dB
Date Rate	Up to 54 Mbps
Receiver Sensitivity (dBm)	-70 to -93
Modulation	64QAM, 16QAM, QPSK, BPSK
Wireless Operating Modes	Point to Multipoint, Backhaul (point to point), Repeater, and Hotspot
Remote Power System	Power-over-Ethernet remote power to IP67 rated outdoor unit. Input: 100-240 AC, 50-60 Hz, Output: 18V, .4A. c/w inline surge suppressor
Security	AES-256/WEP 152-bit data encryption options, VPN support for Ethernet tagged frames (802.1q, 802.1p)
Firmware Upgrades	Web Based downloadable – configurable over the air
Antenna Alignment	Built-in Spectrum Analyzer, Real-time RSSI (Signal Strength) monitor; link optimization and throughput maximization utility

Indoor LED Status Indicator	Indoor remote power indicator
Real-Time Link Monitoring	Secure Management Interface- Real-time signal strength, authentication data, system uptime, data rate, and channel selection

Furnish a radio with the following minimum general mechanical and environmental characteristics:

Radio Dimensions	12" x 12" x 0.6" (Integrated Antenna) or 0.8" x 0.7" x 0.2" (Connectorized)
POE Dimensions	3" x 2" x 1.5"
Radio Operating Temperature	-22°F to 140°F. Outdoor units are weather protected (IP67)
Radio Operating Humidity	Max. 95% non-condensing
Outdoor Antenna	-50°F to +140°F
Wind Survivability	125 Mph

Furnish a radio with the following minimum certifications:

EMC	FCC Part 15, Industry Canada RSS-210, Mexico, ETSI
Safety	UL-Canada, USA, CE
Radio	FCC 15.407 (UNII, ISM), Industry Canada RSS-210, ETSI (w/TPC & DFS), MII SRRC, TXDOT and SWRI Tested.

C. 2.4/5.8 GHz Wireless Ethernet Repeater Standalone Radio System

C.1. General

Furnish an operational 2.4/5.8 GHz wireless broadband Ethernet repeater radio system installed in a NEMA Type 3R enclosure for pole mounting. As a minimum, ensure the repeater radio meets the specifications provided above.

C.2. Cabinet

Furnish the cabinet shell constructed from unpainted, natural aluminum. Ensure that all non-aluminum hardware on the cabinet is stainless steel or an approved non-corrosive alternate. Ensure that each exterior cabinet plane surface is constructed of a single sheet of aluminum and is seamless. Provide continuous welds made from the inside wherever possible. On the exterior, provide joints that are smooth and flush. Ensure that no screws, bolts, or rivets protrude to the outside of the cabinet shell.

Ensure that all components are arranged for easy access during servicing.

Provide sufficient size so the installed equipment will not occupy more than 60 percent of the total cabinet volume.

Provide a handle and three point latching mechanism designed to be disassembled using hand tools. Provide a shaft connecting the latching plate to the door handle by passing through the door within a bushing, bearing, or equivalent device. Provide a latching plate at least 1/8 inch thick and that mates securely with the lock bolt. Provide a lock bolt with a flat end (no bevel) and that has at least 1/4 inch of length in contact with the latching plate.

Ensure that the handle and lock are positioned so that the lock does not lie in the path of the rotating handle as the door is unlatched and that the handle points down in the latched position.

Provide a main door opening that encompasses the full frontal area of the cabinet shell. Ensure that the cabinet shell is sturdy and does not exhibit noticeable flexing, bending or distortion under normal conditions, except that a minor amount of flexing is permitted in the main door when the cabinet is open. In such case, the flexing must not result in permanent deformation of the door.

A police panel door is not required for this cabinet.

Provide a roof with a slope from front to back at a minimum ratio of 1 inch drop per 2 feet. Ensure the cabinet is vented at the top and in the door. Supply a cabinet door assembly with a louvered air vent and standard-sized fiberglass air filter.

Provide one equipment shelf in the cabinet that extends the practical width of the cabinet. Ensure that the shelf can be moved up and down within the cabinet. Do not locate permanently mounted equipment in such a way that will restrict access to terminals.

C.3. Cabinet Electrical

Furnish a cabinet with two 15 Amp, single pole circuit breakers for power distribution. Ensure one 15 Amp auxiliary breaker provides the electrical circuit to accommodate a thermostatically controlled cabinet exhaust fan, door activated fluorescent light, and one GFCI convenience receptacle.

Ensure the second 15 Amp equipment breaker provides the electrical circuit to accommodate the electrical equipment installed in the cabinet with a minimum of two duplex receptacles.

Provide a two-stage power line surge protector between the electrical equipment receptacles and the 15 Amp equipment breaker. Ensure a maximum continuous current of at least 10A at 120V. Ensure that the device can withstand a minimum of 20 peak surge current occurrences at 20,000A for an 8x20 microsecond waveform. Provide a maximum clamp voltage of 280V at 20,000A with a nominal series inductance of 200µh. Ensure that the voltage does not exceed 280V. Provide devices that comply with the following:

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

Ensure the two-stage power line surge protector will allow connection of a radio frequency interference filter between the two stages of the device. Ensure the radio frequency interference filter minimizes interference generated in the cabinet in both the broadcast and aircraft frequencies. Ensure the filter(s) provide attenuation of at least 50 decibels over a frequency range of 200 kilohertz to 75 megahertz. Furnish a filter that is hermetically sealed in an insulated metal case. Ensure the filter is rated at least at the rated current of the main circuit breaker, 125-volts, 60Hz.

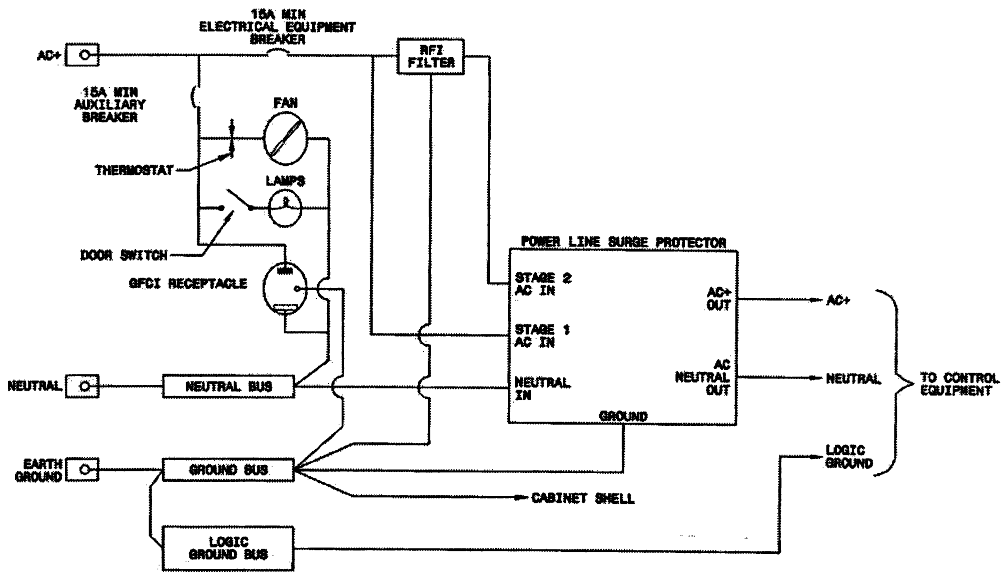
Furnish a fluorescent fixture with lamps mounted above the shelf to light the equipment area.

Fasten all wiring and harness supports to the cabinet with screws or other removable mechanical means. Do not use adhesives.

Do not locate terminals on the underside of the shelf or at other places where they are not readily visible and accessible, or where they may be a hazard to personnel. Provide a clear plastic guard for exposed 120-volt AC terminals on the power panel.

Provide a neutral that is not connected to the earth ground or the logic ground anywhere within the cabinet. Ensure that the earth ground bus and the neutral ground bus each have ten compression type terminals each of which can accommodate wires ranging from number 14 through number 4.

Furnish a cabinet wiring schematic to be placed in the cabinet. Reference the cabinet wiring schematic below for additional details:



D. Software

Furnish units with a 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 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 all industry standard CCTV cameras.

E. Panel Antenna

For 2.4 / 5.8 GHz radio systems, furnish a 23 dBd Gain panel antenna that will allow the system to function as designed.

All antennas furnished shall meet the following minimum specifications:

Frequency Range	5.2 GHz UNII 5.85 GHz ISM
Gain	23 dBi
3 dB Beam width	10.5deg/ 50deg
Polarization	Single linear, vertical
Dimensions	305mm x 305mm x 15mm (diamond shape)
VSWR	<1.9:1
Front to Back Ratio	>35dB
Cross Polarization	>24 dB
Power rating	10 Watts
Impedance	50 Ohms
Lightning Protection	DC ground
Weight	1.7lb
Radome	UV stabilized plastic
Wind Survivability	125 Mph (201 kph)
Wind Load	1.23 ft2
Operating Temp.	-45C to +75C
Weatherproof	IP67 Rating

F. Antenna Mounting Hardware Kit

Furnish an antenna mounting kit to support the antenna when attached to a metal pole, mast arm, or wood pole as recommended by the manufacturer of the antenna and as approved by the Engineer.

G. Lightning Arrestor:

Furnish a lightning arrestor installed in line between each antenna and its designated radio modem inside the equipment cabinet. Furnish a lightning arrestor that meets the following minimum specifications:

- Filter Type – DC Block (None gas tube design)

- Surge: 20kA, 800MHz to 2.0GHz < 1.1 : 1 VSWR
  18kA, 800MHz to 2.3GHz < 1.1 : 1 VSWR
  700MHz to 2.7GHz < 1.2 : 1 VSWR
- Insertion Loss: ≤ 0.1 dB over frequency range
- Max Power: 500 w @ 920MHz (750 W @ at 122□ F)
- RF Power: 300 Watts
- Let Through Voltage: ≤+/- 3 Volts for 3kA @ 8/20 μs Waveform
- Throughput energy: ≤ 0.5 μJ for 3kA @ 8/20 μs Waveform
- Temperature: -40 to 185 ° F Storage/Operating 122° F
- Vibration: 1G at 5 Hz up to 100Hz
- Unit Impedance: 50Ω
- VSWR: 1.1:1
- Frequency Range: 800 MHz to 2200 MHz
- 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

H. Disconnect Switch

Furnish a double pole, single throw snap switch in a weatherproof outlet box with cover, suitable for use in wet locations. Ensure outlet box and cover supports a lockout tag device. Ensure outlet box includes one ½-inch hole in back of box. Furnish mounting hardware, sealing gaskets and lockout tag. (NOTE: On NCDOT owned poles the "Disconnect Switch" can be omitted.)

I. Warning Signs(s) and Decal(s)

Furnish Warning Sign and Decal at locations called for in the plans. Furnish mounting hardware to secure the Sign to either metal or wood poles. Secure the sign to the pole using 'Band-It' brackets or a method approved by the engineer. (NOTE: On NCDOT owned poles the "Warning Sign" is required, however, the "Decal" may be omitted.)

28.3. CONSTRUCTION METHODS

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 a coaxial cable – power divider, antenna splitter cable and additional antenna 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 NESC) and as specified in the antenna manufacturer's recommendations. Secure the antenna mounting hardware to the pole. 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.

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 the power supply for the radio system is NOT connected to the GFCI receptacle circuit 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. Repeater Cabinets

Do not obstruct the sight distance of vehicles when locating and installing cabinets.

Install the pole-mounted cabinet approximately five feet from the ground line to the top of the cabinet. Secure the cabinet to the pole using 'Band-It' brackets or a method approved by the Engineer. Leave the RS-232 data interface cable in the cabinet.

C. Disconnect Switch

At all locations, where the antenna is mounted on a joint use pole, install a double pole, snap switch to remove power from the spread spectrum wireless radio system. Do not mount weatherproof box on the field equipment cabinet door. Drill a hole in the side of the field equipment cabinet. Mount the outlet box over the hole using a ½-inch chase nipple and bushings. Ensure sealing gaskets are in place and no water can enter the cabinet. Securely mount the weatherproof outlet box with additional mounting screws. Bond the outlet box to the equipment ground bus. See plans for approximate mounting height. Run the power supply cord of the spread spectrum radio unit into the outlet box and connect to switch. Securely attach power supply cord to equipment rack. Install disconnect switch with lockout tag cover.

Do not install power supply for the radio in a GFCI protected outlet.

D. Warning Sign(s) and Decal(s)

At all locations, where the antenna is mounted on a joint use pole, secure a Warning Sign to pole. Mount Warning Sign(s) at locations called for on the plans. Ensure there are no conflicts between the warning sign and surrounding utilities. Mount Warning Sign to be easily viewed. Do not mount Warning Sign under pole grounds or conduit.

Clean and remove any dirt or oil on traffic cabinet before placing Decal. Place decal adjacent to the disconnect switch located on the outside of traffic cabinet. If the antenna is mounted on an NCDOT owned pole the Decal and Switch may be omitted.

28.4. WARRANTY

Provide a minimum two-year warranty with each radio and antenna assembly to ensure the products are free of manufacturing defects in material and workmanship. The warranty commences on the date the radio system is accepted by the Engineer.

28.5. MEASUREMENT AND PAYMENT

Actual number of *2.4/5.8 GHz wireless ethernet radio systems* furnished, installed and accepted.

This item includes the appropriate sized antenna(s), radio, power supplies, disconnect/snap switch, signs, decals, data interface cable/serial cable, lightning arrestor, labeling and any integration between the wireless radio system and a fiber optic network if necessary, installation materials and configuration software necessary to complete this work, including the radio path Site Survey test and warranties, will be incidental.

Actual number of *2.4/5.8 GHz wireless Ethernet repeater standalone radio systems* furnished, installed and accepted.

This item includes the appropriate sized NEMA 3R cabinet, antenna(s), radio, power supplies, disconnect/snap switch, signs, decals, data interface cable/serial cable, lightning arrestor, labeling and any integration, installation materials and configuration software necessary to complete this work, including the radio path Site Survey test and warranties, will be incidental.

Payment will be made under:

2.4/5.8 GHz Wireless Ethernet Radio System .... Each

2.4/5.8 GHz Wireless Ethernet Repeater Standalone Radio System .... Each

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29. CELLULAR MODEMS

29.1. DESCRIPTION

As shown in the Plans, some DMS controllers will not be integrated with the fiber optic communications network, but will utilize dial-up communications over a commercial cellular network.

29.2. MATERIALS

A. Modem

Furnish cellular modems for field (to connect to the DMS controller) communications. Furnish modems that meet the following specifications at a minimum:

- CDMA EV-DO Revision A with fallback to:
  - CDMA 1x EV-DO (Revision 0)
  - CDMA 1xRTT
  - CDMA IS-95
- 800 MHz Cellular, 1900 MHz PCS
- Ethernet Interface: 10/100 Mbps with RJ-45 port
- Serial Interface: RS-232 with DB-9 port
- Antenna Interface: 50 Ohm SMA
- Application Interfaces: TCP/IP, UDP/IP, DHCP, HTTP, SNMP. SMTP, SMS, MSCI
- Security and Intelligence: Ipsec VPN, GRE Tunneling
- LED Indicators: Network, Signal, Activity, Service, Power
- Operating Temperature: -20° F to 160° F
- Power Consumption: maximum 270 mA at 12V DC
- Dimensions: maximum 6" x 2" x 4"
- Environmentally hardened enclosure suitable for installation in field equipment cabinets

All modems furnished shall not be manufacturer activated for service on the Verizon Wireless network. The Contractor shall procure service through Verizon in the Department's name and maintain until final acceptance of the project.

Furnish cellular modems that are compatible with the existing cellular modems being used by NCDOT Division 3 for remote communications to DMS controllers.

B. Application Software

Furnish user application software and all applicable device drivers from the same manufacturer as the cellular modems. Software shall be Microsoft 7 compatible while operating in a client/server environment. Software shall support over-the-air programming of field modems and operate seamlessly with local DMS controller and central DMS software packages.

29.3. CONSTRUCTION METHODS

At locations shown in the Plans, furnish and install a cellular modem for DMS controller communications. Fully integrate with DMS controller and cabinet power supply. Provide grounding and surge suppression according to manufacturer recommendations.

Install application software on the DMS server as shown in the Plans and all workstations and notebook computer being installed under this Project. Integrate software to form a fully functional DMS system where users can seamlessly access all DMS using cellular communications or Ethernet communications using the fiber optic network.

Vendor representative, or other manufacturer trained installer, shall be present during setup and configuration of central cellular modem.

29.4. MEASUREMENT AND PAYMENT

Cellular Modem (____) will be measured and paid for as the actual number of assemblies furnished, installed, integrated, and accepted. No measurement or payment will be made for the application software as this will be considered incidental to the Cellular Modem pay item.

Payment will be made under:

Cellular Modem ....Each

30. CCTV FIELD EQUIPMENT

30.1. DESCRIPTION

Furnish and install new CCTV cameras, camera control equipment, and pole mounted cabinets at locations shown in the Plans.

Provide real world coordinates for all installed CCTV assemblies as required in Section 41.

30.2. 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, camera cabling, and 336S pole mounted equipment cabinet.

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", 35X optical zoom, 12X 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 "go-to" 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. CCTV Test Panel

Equip each CCTV equipment cabinet with CCTV unit test panel with a null modem adaptor. The test panel shall have a BNC port and a serial port. The BNC port shall allows for a test monitor to be plugged into the panel and NTSC video from the CCTV unit to be viewed from a monitor with a standard coaxial video cable. The serial port shall be equipped with a null modem adapter such that a notebook computer with CCTV unit vendor provided CCTV control software or a CCTV vendor provided joystick may be plugged into it and all CCTV control functionality available in the unit may be performed in the same fashion as if the user were located at the CCTV video head end in the TOC.

G. CCTV Unified Cable

Furnish cable for connection to CCTV unit that contains CCTV serial wires and cables, CCTV coaxial video cable, and CCTV power wire and cable in a signal cable jacket that is rated for outdoor use. Furnish cable that is rated to meet outdoor temperature, water blocking, ultraviolet and insulation characteristics of Belden CM FT1 family of Cables, part number 5339W5. Furnish cable that prevents cross-talk and RFI/EFI between conductors. Furnish cable that uses standard connections on both ends that are compatible with the equipment to which it will be connected. Furnish coaxial cable that meets or exceeds Belden part number 5339W5 (RG-6 type, AWG 18). Furnish serial connections and power connections of the conductor size that operate with voltage drop and signal loss characteristics required for the equipment being connected.

H. 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 130 miles per hour (mph) (per NCDOT Wind Zone 2) with a 30 percent gust factor and can support a minimum camera unit dead load of 45 pounds.

I. 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.

J. Pole Mounted CCTV Cabinet

Furnish pole mounted 336S stretch cabinet as initially described in Section 23 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 23.

K. Field Video CODEC Unit

Furnish a field-hardened video encoder designed for unheated/uncooled "outdoor" applications such as roadside control cabinets. The video encoder shall be installed in equipment cabinet and shall allow for the encoding and transmission of analog NTSC video signals from new CCTV units that will be provided under this Project.

Furnish a shelf-mountable, field-hardened video encoder to convert analog NTSC video signals into two digital video streams that can be transported over Ethernet. The video encoder shall allow for the simultaneous encoding and transmission of the two digital video streams - one in MPEG-2 or

MPEG-4 format (high-resolution) and one in MPEG-4 format (low-resolution). High resolution streams shall allow video bit rates from 1 to 4 Mbps and the low resolution stream shall allow video bit rates from 64 kbps to 2 Mbps. The Contractor shall configure these formats for 2 Mbps and 384kbps, respectively. The video encoder shall also transmit pan-tilt-zoom control data from all CCTV control points to the CCTV camera via a serial connection to the CCTV camera resident on the CODEC.

The video encoder shall support the following digital transport standards at a minimum: RTP/IP, UDP/IP, TCP/IP, and unicast/multicast IP. The Contractor shall use UDP/IP for video transport and TCP/IP for camera control transport unless otherwise approved by the Engineer.

The video shall support resolutions of CIF (352 (H) x 240 (V)), 1/2 D1 (352 (H) x 480 (V)), and D1 (720 (H) x 480 (V)) at a minimum. The video encoder units shall provide a display showing diagnostic data such as data rate, quality level, frame rate, and video status on the front panel. All supporting user interface software shall be provided with each encoder unit.

The video encoder shall be equipped with at least one NTSC video input, two RS-232/422 serial ports and one 10/100BaseTX Ethernet port. The 10/100BaseTX port shall support half-duplex or full-duplex and provide auto negotiation, and shall be configured for full-duplex.

The video encoder shall be remotely manageable using standard network applications such as telnet, SNMP monitors, and/or web interface administration. The video encoder shall be equipped with LED or other approved indicators for the following functions:

- Power
- Link
- Activity

K.1. Electrical Requirements

The video encoder shall operate from 115 VAC (+/-10%) power at 60 Hz. The Contractor shall furnish any external step down transformers, power converters, and/or regulation equipment needed to operate the video encoder.

K.2. Physical and Environmental Requirements

The video encoder enclosure shall be constructed of high-strength galvanized steel. For Contractor-supplied cameras, the video encoder shall be installed in equipment cabinets and secured to the cabinet in a manner that is approved by the Engineer. The video encoder enclosure, including adapters/connectors, shall fit neatly within the confines of the equipment cabinet. All necessary mounting hardware shall be provided by the Contractor.

The video encoder shall meet or exceed NEMA TS-2 requirements for shock, temperature, humidity, and vibration. The video encoder shall operate at ambient temperatures from -40° to 185° F (-40° to 85° C) and ambient relative humidity from 0% to 90% (non-condensing). No cooling airflow shall be required.

K.3. Communication Interface Requirements

The video encoder shall comply with the 10/100BaseTX standard and have at least one standard RJ-45 interface. The 10/100BaseTX port shall operate as half-duplex or full-duplex and provide auto negotiation.

The video encoder shall have at least one video input that supports composite NTSC format compatible with the CCTV video interface cables. Interconnection with the NTSC video input shall be made with a surge protector that provides an external electrical ground bonding capability and does not require an electrical receptacle. The CCTV coaxial surge protector shall provide a clamping voltage no greater than 30 volts.

The video encoder shall have at least two serial ports – one for pan-tilt-zoom camera control and the other for local maintenance or data transport. The two serial ports shall support RS-232 and RS-422 data transmission and shall be transparent to the central system using TCP/IP network access methods. Interconnection with camera control receivers with or without adapters or converters (i.e. RS-422/232 for compatibility with CCTVs) shall provide opto-isolated surge suppression. The optical isolation shall provide an isolation of no greater than 2000 VAC for data signals and ground.

K.4. Cables and Connectors

The Contractor shall furnish and install all cables and connectors necessary for video encoder installation. This shall include at a minimum CAT 5E cables with RJ-45 connectors to connect the Video Encoder to the Field Ethernet Switch in the equipment cabinet or traffic controller cabinet and standard serial data cables to connect the Video Encoder to the CCTV camera for pan-tilt-zoom functions and local configuration administration.

30.3. CONSTRUCTION METHODS

A. General

Install CCTV assemblies at locations as shown in the Plans.

Mount CCTV camera units at heights according to the Plans.

Mount CCTV camera on side of pole nearest intended field of view and avoid 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.

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.

C. Pole Mounted CCTV Equipment 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. All conduits that contain fiber optic cable or Ethernet cable and enter the bottom of a pole mounted cabinet shall be rigid metallic conduit.

At each new CCTV cabinet where fiber optic cable or Ethernet cable is routed, coil a minimum of 20 feet of fiber optic cable in the cabinet as shown in the Plans.

D. Field Video CODEC Unit

At locations where the field Video CODEC unit is called for installation into new equipment cabinet, integrate field CODEC with Ethernet switch, CCTV assembly, CCTV test panel, power distribution assembly, and surge protection. Ground and provide electrical transient protection to the CODEC in accord with these Project Special Provisions and the CODEC manufactures requirements.

30.4. MEASUREMENT AND PAYMENT

CCTV Camera Assembly will be measured and paid for as the actual number of assemblies furnished, installed, integrated, and accepted. The assembly includes the CCTV Camera unit, housing, pan and tilt unit, controller/receiver unit, CCTV Test Panel, pole mounted equipment cabinet, and all associated cabling, configuration, integration and labor to furnish and install the assembly. CCTV poles for mounting of CCTV assemblies shall be paid for separately. No separate measurement will be made for cabling, connectors, CCTV camera attachment assemblies, vertical risers, conduit, condulets, grounding equipment, CCTV camera enclosures, surge protectors, or any other equipment or labor required to install the CCTV assembly. All work to mount assembly on pole shall be incidental.

No measurement will be made for producing and submitting plan of record documentation, including real world coordinates, as this will be considered incidental to furnishing and installing new CCTV camera assemblies.

Field Video CODEC Unit will be measured and paid for as the actual number of units, furnished, installed, integrated, and accepted. All cabling and patch cables, integration, and configuration required to install the field video CODEC unit shall be incidental and not be paid for separately.

Payment will be made under:

CCTV Camera Assembly ....Each

Field Video CODEC Unit...Each

31. DYNAMIC MESSAGE SIGN (DMS)

31.1. DESCRIPTION

DMSs used on the State Highway System shall be preapproved on the current NCDOT ITS & Signals Qualified Products List (QPL) by the date of installation. DMSs not preapproved will not be allowed for use on the project. To ensure compatibility with the existing DMS Control Software deployed in the State, furnish NTCIP compliant DMSs that are fully compatible with Daktronics, Inc. Vanguard software (also referred to as the "Control Software." The QPL is available on the Department's website. The QPL website is:

http://www.ncdot.org/doh/preconstruct/traffic/ITSS/SMS/qpl/

Furnish and install DMSs compliant with UL standards 48, 50, 879, and 1433.

Add and configure the new DMSs in the system using the Control Software and computer system. Furnish, install, test, integrate and make fully operational the new DMSs at locations shown in the Plans.

Furnish operating DMS systems consisting of, but not limited to, the following:

- Full Matrix, 27 pixels high and 60 pixels wide Front Access LED DMS (also referred to as a Small DMS)
- Full Matrix, 27 pixels high and 90 pixels wide Walk-In LED DMS (also referred to as a Large DMS)
- Pedestal type DMS support structure and mounting hardware
- DMS controllers, Uninterruptible Power Supplies (UPS), cabinets and accessories with interconnect and power cabling and conduit
- Electrical service and related equipment
- All other equipment and incidentals required for furnishing, installing, and testing the DMS system and system components

Use only UL listed and approved electronic and electrical components in the DMS system.

Provide real world coordinates for all installed DMS as required in Section 41.

31.2. MATERIALS

A. Environmental Requirements

Construct the DMS and DMS controller cabinet so the equipment within is protected against moisture, dust, corrosion, and vandalism.

Design the DMS system to comply with the requirements of NEMA TS 4-2005 in Section 2.1 (Environmental and Operating Standards) and Section 3 (Sign Mechanical Construction) as it applies to front access enclosures.

B. Full Matrix LED Dynamic Message Sign (DMS)

Construct the DMS to display at least three lines of text that, when installed, are clearly visible and legible to a person with 20/20 corrected vision from a distance of 900 feet in advance of the DMS at an eye height of 3.5 feet along the axis.

For 27x90 DMS (walk-in), each line must display at least 15 equally spaced and equally sized alphanumeric individual characters when displaying three lines. Each character must be at least 18 inches in height and composed from a luminous dot matrix. Provide an entire LED matrix that is a minimum of 27 pixels high and 90 pixels wide.

For 27x60 DMS (front access), each line must display at least 10 equally spaced and equally sized alphanumeric individual characters when displaying three lines. Each character must be at least 18 inches in height and composed from a luminous dot matrix. Provide an entire LED matrix that is a minimum of 27 pixels high and 60 pixels wide.

B.1. DMS Enclosure

Comply with the requirements of Section 3 (Sign Mechanical Construction) of NEMA TS 4-2005. The following requirements complement TS 4-2005.

Construct the Large DMS with a metal walk-in enclosure excluding the face. Provide an aluminum walking platform inside the enclosure that is at least 28 inches wide. Ensure the width of the walking platform is free of obstructions to a height of 7 feet. Construct the enclosure of welded aluminum type 6061-T6, 5052 H38, 5052-H34, or of an Engineer approved alternate at least 1/8-inch thick. Perform all welding of aluminum and aluminum alloys in accordance with the latest edition of AWS D1.2, Structural Welding Code - Aluminum. Continuously weld the seams using Gas Metal Arc Welding (GMAW).

Provide all exterior and interior DMS enclosure surfaces with natural, mill-finish aluminum. Remove all grind marks and discoloration from the surfaces.

Provide corrosion resistant nuts, bolts, washers, and other mounting and bonding parts and components used on the exterior of the DMS enclosure and ensure they are sealed against water intrusion.

Provide one key lockable, hinged, gasket-sealed inspection door for service and maintenance along each side of the enclosure for Large DMS units. Install one appropriately sized fire extinguisher within 12 inches of each maintenance door. Equip the DMS enclosure with internal fluorescent lighting controlled by timers installed close to each inspection door. Make certain no light emitted from the fluorescent tubes or any other light source inside the enclosure not comprising the display is leaked to the outside of the enclosure. Equip the door with a door-hold-open device. Install GFCI duplex utility receptacles every 6 feet along the width of the DMS in convenient locations for powered service tools.

For 27x60 DMS, provide one front access door for each 10 to 15 pixel wide section of the sign enclosure. Vertically hinge the doors and design to swing out from the face to provide access to the enclosure interior. Extend each door the full height of the display matrix.

Provide a retaining latch mechanism for each door to hold the door open at a 90-degree angle.

Each door will form the face panel for a section of the sign. Mount the LED modules to the door such that they can be removed from the door when in the open position. Other sign components can be located inside the sign enclosure and be accessible through the door opening.

Provide for each door a minimum of two (2) screw-type captive latches to lock them in the closed position and pull the door tight and compress a gasket located around the perimeter of each door. Install the gasket around the doors to prevent water from entering the cabinet.

Provide all exterior and interior DMS enclosure surfaces with natural, mill-finish aluminum. Remove all grind marks and discoloration from the surfaces.

Provide corrosion resistant nuts, bolts, washers, and other mounting and bonding parts and components used on the exterior of the DMS enclosure and ensure they are sealed against water intrusion.

Furnish the sign face, excluding the front, panel with a flat black, UV treated, colorfast material. Prepare all surfaces for application according to the sheeting manufacturer's recommendations prior to applying the sheeting. Construct UV-treated, colorfast border with a minimum width of 18 inches.

Do not place a manufacturer name, logo, or other information on the front face of the DMS or shield visible to the motorist.

Provide power supply monitoring circuitry to detect power failure in the DMS and to automatically report this fault to the Control Software. This requirement is in addition to reporting power failure at the controller cabinet.

Do not paint the stainless steel bolts on the Z-bar assemblies used for mounting the enclosure.

B.2. DMS Interior Environment Control for Walk-In Enclosures

Design the local field controller to monitor and control the interior DMS environment. Design environmental control to maintain the internal DMS temperature within +/- 10° F of the outdoor ambient temperature. Provide the DMS environmental control system with four primary subsystems as follows:

B.2.1. Internal Temperature Sensors

Provide the DMS with two internally mounted temperature sensors which are equipped with external thermocouples and which the field controller continuously monitors. Design the field controller to use this temperature information to determine when to activate and deactivate the environmental control systems described herein. Locate sensors on opposite ends of the upper 1/3 of the LED display matrix with their external thermocouples attached to and making contact with an LED pixel circuit board. Design the thermocouple and LED board to be easily detachable, in the event that one of the units requires removal and replacement. Provide sensors capable of measuring temperatures from -40° F to +185° F. Design the field controller to automatically shut down the LED display whenever one or both sensors indicate that LED board temperature has exceeded +140° F, and to automatically restart the LED display whenever the temperature falls below +130° F. Design both shutdown and re-start temperature thresholds to be user-programmable. Design the field controller to report sensor temperatures and DMS shutdown/re-start events to the DMS Control Software.

B.2.2. Housing Cooling System

Provide the DMS housing with a cooling system that circulates outside air into the DMS housing whenever the LED board temperature exceeds a user-programmable threshold. Provide this system with enough ventilation fans to exchange the internal DMS housing air volume at a minimum rate of 2 times per minute. Provide steel ball-bearing type fans. Mount fans in a line across the upper rear wall of the DMS housing to direct air out of the cabinet. Provide one filtered air intake port for each exhaust fan. Locate intake ports in a line across the lower rear wall of the DMS housing. Provide intake ports with a removable filter that will remove airborne particles measuring 500 microns in diameter and larger. Provide a filter that is of a size and style that is commercially readily available. Program the field controller to activate the DMS housing cooling system whenever the LED board temperature exceeds +90° F and to turn the cooling system off whenever LED board temperature falls below +85° F. On the DMS housing rear exterior wall, cover all air intake and exhaust ports on their top, front, and sides by an aluminum shroud fabricated from 0.090-inch aluminum sheeting. Taper the shrouds at the top. Securely fasten shrouds to the DMS housing, and provide gaskets at the interface to prevent water from entering the DMS. Design all air filters and fans to be removable from inside the DMS housing. Provide the DMS housing cooling system with an adjustable timer that will turn fans off after the set time has expired. Provide a timer that is adjustable to at least 4 hours, and locate it just inside the DMS housing door, within easy reach of a maintenance technician standing outside the DMS doorway.

B.2.3. LED Display Cooling System

Provide the DMS with an LED display cooling system which directs air across the LED display modules whenever LED board temperature exceeds a user-programmable threshold. Direct fan-forced air vertically across the backside of the entire LED display matrix using multiple ball-bearing fans. Program the field controller to activate the LED cooling fan system whenever LED board temperature exceeds +90° F and to deactivate the system whenever LED board temperature falls to +85° F. Locate cooling fans so as not to hinder removal of LED display modules and driver boards.

B.2.4. Front Face Panel Defog/Defrost System

Provide the DMS with a defog/defrost system which circulates warm, fan-forced air across the inside of the polycarbonate front face whenever LED board temperature falls below a user-programmable threshold. Provide multiple steel ball-bearing fans that provide uniform airflow across the face panel. Program the field controller to activate the defog/defrost system whenever LED board temperature falls below +40° F and to deactivate the defog/defrost system whenever LED board temperature exceeds +106° F. Mount a 100-watt pencil-style heating element in front of each defog/defrost fan to warm the air directed across the DMS face. Design heating elements to be on only when the defog/defrost fans are on.

Install additional fans and/or heaters as needed to maintain the temperature inside the DMS enclosure within the operating temperature range of the equipment within the DMS enclosure as recommended by the equipment manufacturer(s).

B.3. DMS Interior Environment Control for Front Access Enclosures

Install a minimum of one (1) temperature sensor that is mounted near the top of the DMS interior. The sensor(s) will measure the temperature of the air in the enclosure over a minimum range of -40°F to +176°F. Ensure the DMS controller will continuously monitor the internal temperature sensor output and report to the DMS control software upon request.

Design the DMS with systems for enclosure ventilation, face panel fog and frost prevention, and safe over-temperature shutdown.

Design the DMS ventilation system to be thermostatically controlled and to keep the internal DMS air temperature lower than +140°F, when the outdoor ambient temperature is +115°F or less.

The ventilation system will consist of two or more air intake ports located near the bottom of the DMS rear wall. Cover each intake port with a filter that removes airborne particles measuring 500 microns in diameter and larger. Mount one or more ball bearing-type fans at each intake port. These fans will positively pressure the DMS enclosure.

Design the fans and air filters to be removable and replaceable from inside the DMS housing. To ease serviceability, mount the fans no more than four (4) feet from the floor of the DMS enclosure.

Provide each ventilation fan with a sensor to monitor its rotational speed, measured in revolutions per minute and report this speed to the sign controller upon request.

The ventilation system will move air across the rear of the LED modules in a manner such that heat is dissipated from the LED's. Design the airflow system to move air from the bottom of the enclosure towards the top to work with natural convection to move heat away from the modules.

Install each exhaust port near the top of the rear DMS wall. Provide one exhaust port for each air intake port. Screen all exhaust port openings to prevent the entrance of insects and small animals.

Cover each air intake and exhaust port with an aluminum hood attached to the rear wall of the DMS. Thoroughly seal all intakes and exhaust hoods to prevent water from entering the DMS.

Provide a thermostat near the top of the DMS interior to control the activation of the ventilation system.

The DMS shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal enclosure air temperature exceeds a maximum threshold temperature. The threshold temperature shall be configurable and shall have a default factory setting of 140°F.

B.4. Front Panel

Protect the DMS face with contiguous, weather-tight, removable panels. Manufacture these panels of sheets of polycarbonate, methacrylate that are ultraviolet protected, have an antireflection coating, and are a minimum of 1/8- inch thick. For substitutes, submit one 12" x 12" sample of the proposed material together with a description of the material attributes to the Engineer for review and approval. Install a .09" aluminum mask on the front of the panel (facing the motorists) that contains a circular opening for each LED pixel. Prime and coat the front side of the aluminum mask, which faces the viewing motorists, with automotive-grade flat black acrylic enamel paint or an approved equivalent. Guarantee all painted surfaces provide a minimum outdoor service life of 20 years.

Design the panels so they will not warp nor reduce the legibility of the characters. Differential expansion of the DMS housing and the front panel must not cause damage to any DMS component or allow openings for moisture or dust. Glare from sunlight, roadway lighting, commercial lighting, or vehicle headlights must not reduce the legibility or visibility of the DMS. Install the panels so that a maintenance person can easily remove or open them for cleaning.

For front access DMS enclosures, securely attach a single 1/8-inch thick polycarbonate sheet to cover all of the pixel openings to the inside of each aluminum door panel. Seal the polycarbonate to prevent water and other elements from entering the DMS. Mount the LED display modules to the inside of the DMS front face door panels. Ensure common hand tools can be used for removal and replacement.

B.5. Display Modules

Manufacture each display module with a standard number of pixels, not to exceed an array of 9 x 5, which can be easily removed. Assemble the modules onto the DMS assemblies contiguously to form a continuous matrix to display the required number of lines, characters, and character height.

Design display modules that are interchangeable and replaceable without using special tools. Provide plug-in type power and communication cables to connect to a display module.

Construct each display module as a rectangular array of 5 horizontal pixels by 7 to 9 vertical pixels. Provide the module with an equal vertical and horizontal pitch between pixels, and columns that are perpendicular to the rows (i.e., no slant). Design each module to display:

- All upper and lower case letters.
- All punctuation marks.
- All numerals 0 to 9.
- Special user-created characters.

Display upper-case letters and numerals over the complete height of the module. Optimize the LED grouping and mounting angle within a pixel for maximum readability.

B.6. Discrete LEDs

Provide LEDs that are untinted, non-diffused, high output solid state lamps utilizing indium gallium aluminum phosphide (InGaAlP) technology manufactured by Toshiba or Hewlett-Packard.

No substitutions will be allowed. Provide T1 ¾, 0.2 inch size LEDs that emit a true amber color at a wavelength of 590 ± 5 nm.

Provide LEDs with a MTBF (Mean Time Before Failure) of at least 100,000 hours of permanent use at an operating point of 140° F or below at a specific forward current of 20mA. Discrete LED failure is defined as the point at which the LED's luminous intensity has degraded to 50% or less of its original level.

Provide discrete LEDs with a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Make certain the viewing cone tolerances are as specified in the LED manufacturer's product specifications and do not exceed +/- 3 degrees half-power viewing angle of 15 degrees.

Obtain the LEDs used in the display from a single LED manufacturer that have a single part number. Obtain them from batches sorted for luminous output, where the highest luminosity LED is not more than fifty percent more luminous than the lowest luminosity LED when the LEDs are driven at the same forward current. Do not use more than two successive and overlapping batches in the LED display. Document the procedure to be used to comply with this requirement as part of the material submittal.

Individually mount the LEDs on circuit boards that are at least 1/16"thick FR-4 fiberglass, flat black printed circuit board in a manner that promotes cooling. Protect all exposed metal on both sides of the LED pixel board (except the power connector) from water and humidity exposure by a thorough application of acrylic conformal coating. Design the boards so bench level repairs to individual pixels, including discrete LED replacement and conformal coating repair is possible.

Operate the LED display at a low internal DC voltage not to exceed 24 Volts.

Design the LED display operating range to be –20° F to +140° F at 95% relative humidity, non-condensing.

Supply the LED manufacturer's technical specification sheet with the material submittals.

B.7. LED Power Supplies

Power the LED Display by means of multiple regulated switching DC power supplies that operate from 120 volts AC input power and have an output of 48 volts DC or less. Wire the supplies in a redundant parallel configuration that uses multiple power supplies per display. Provide the supplies with current sharing capability that allows equal amounts of current to their portion of the LED display. Provide power supplies rated such that if one supply fails the remaining supplies will be able to operate their portion of the display under full load conditions (i.e. all pixels on at maximum brightness) and at a temperature of 140° F.

Provide power supplies to operate within a minimum input voltage range of +90 to +135 volts AC and within a temperature range of –22° F to 140° F. Power supply output at 140° F must not deteriorate to less than 65% of its specified output at 70° F. Provide power supplies that are overload protected by means of circuit breakers, that have an efficiency rating of at least 75%, a power factor rating of at least .95, and are UL listed. Provide all power supplies from the same manufacturer and with the same model number. Design the power driver circuitry to minimize power consumption.

Design the field controller to monitor the operational status (normal or failed) of each individual power supply and be able to display this information on the Client Computer screen.

B.8. LED Pixels

A pixel is defined as the smallest programmable portion of a display module that consists of a cluster of closely spaced discrete LEDs. Design each pixel to be a maximum of 2 inches in diameter.

Construct the pixels with two strings of LEDs. It is the manufacturer's responsibility to determine the number of LEDs in each string to produce the candela requirement as stated herein.

Ensure each pixel produces a luminous intensity of 40 Cd when driven with an LED drive current of 20 mA per string.

Power the LEDs in each pixel in strings. Use a redundant design so that the failure of an LED in one string does not affect the operation of any other string within the pixel. Provide the sign controller with the ability to detect the failure of any LED string and identify which LED string has failed. Submit a complete schematic of the LED power and driver circuits with the material submittals.

B.9. Character Display

Design display modules to be easily removable without the use of tools. Position cooling fans so they do not prevent removal of an LED pixel board or driver board.

Use continuous current to drive the LEDs at the maximum brightness level. Design the light levels to be adjustable for each DMS / controller so the Engineer may set levels to match the luminance requirements at each installation site.

Design the controller to automatically detect failed LED strings or drivers and initiate a report of the event to the Control Software. Design the controller to be able to read the internal temperature of the DMS enclosure and the ambient temperature outside the DMS enclosure and report these to the Control Software.

B.10. Display Capabilities

Design the DMS with at least the following message displays:

- Static display
- Flashing display with Dynamic flash rates
- At least two alternating Static and / or Flashing sequences (multi page messages)

B.11. DMS Mini Controller

Furnish and install a mini controller inside the DMSs that is interconnected with the main controller using a fiber optic cable, CAT-5 cable, or an approved alternate. The mini controller will enable a technician to perform all functions available from the main controller. Provide the mini controller with an LCD/keypad interface. Size the LCD display screen to allow preview of an entire one-page message on one screen. Provide a 4 X 4 keypad.

Alternatively, install an EIA/TIA-232E port inside the DMS enclosure to enable a maintenance technician to communicate with the DMS main controller and obtain access to and perform all functions of the main controller using a laptop computer.

C. DMS Enclosure Structure Mounting

Mount the DMS enclosure and interconnect system securely to the supporting structures of the type specified in the Plans. Design the DMS enclosure supports and structure to allow full access to the DMS enclosure inspection door.

Furnish and install U-bolt connections of hanger beams to overhead assembly truss chords with a double nut at each end of the U-bolt. Bring the double nuts tight against each other by the use of two wrenches.

Submit plans for the DMS enclosure, structure, mounting description and calculations to the Engineer for approval. Have such calculations and drawings approved by a Professional Engineer registered in the state of North Carolina, and bear his signature, seal, and date of acceptance.

Provide removable lifting eyes or the equivalent on the DMS enclosure rated for its total weight to facilitate handling and mounting the DMS enclosure.

Design the DMS structure to conform to the applicable requirements of the *Standard Specifications for Structural Supports for Highway Signs, Luminaires,* and the section titled "DMS

Assemblies" of these Project Special Provisions.

D. DMS / DMS Controller Interconnect

Furnish and install all necessary cabling, conduit, and terminal blocks to connect the DMS and the DMS controller. Use approved manufacturer's specifications and the Plans for cable and conduit types and sizes. Use fiber optic cable to interconnect sign and controller. Install fiber optic interconnect centers in the sign enclosure and cabinet to securely install and terminate the fiber optic cable. Submit material submittal cut sheets for the interconnect center.

Furnish and install one IP-based DMS controller with accessories per DMS in a protective cabinet. Mount the controller cabinet on the DMS support structure. Install cabinet so that the height to the middle of the cabinet is 4 feet. Ensure a minimum of 3 feet level working surface under each cabinet that provides maintenance technicians with a safe working environment.

Provide the DMS controller as a software oriented microprocessor and with resident software stored in non volatile memory. The Control Software, controller and communications must comply with the NTCIP Standards identified in these Project Special Provisions. Provide sufficient non-volatile memory to allow storage of at least 500 multi page messages and a test pattern program.

Furnish the controller cabinet with, but not limited to, the following:

- Power supply and distribution assemblies
- Power line filtering hybrid surge protectors
- Radio Interference Suppressor
- Communications surge protection devices
- Industrial-Grade UPS system and local disconnect
- Microprocessor based controller
- Display driver and control system (unless integral to the DMS)
- Serial interface port for local laptop computer
- Local user interface
- Interior lighting and duplex receptacle
- Adjustable shelves as required for components
- Temperature control system
- All interconnect harnesses, connectors, and terminal blocks

- All necessary installation and mounting hardware

Furnish the DMS controller and associated equipment completely housed in a NEMA 3R cabinet made from 5052 H32 sheet aluminum at least 1/8" thick. Use natural aluminum cabinets. Perform all welding of aluminum and aluminum alloys in accordance with the latest edition of AWS D1.2, Structural Welding Code - Aluminum. Continuously weld the seams using Gas Metal Arc Welding (GMAW).

Slant the cabinet roof away from the front of the cabinet to prevent water from collecting on it.

Do not place a manufacturer name, logo, or other information on the faces of the controller cabinet visible to the motorist.

Provide cabinets capable of housing the components and sized to fit space requirement. Design the cabinet layout for ease of maintenance and operation, with all components easily accessible. Submit a cabinet layout plan for approval by the Engineer.

Locate louvered vents with filters in the cabinet to direct airflow over the controller and auxiliary equipment, and in a manner that prevents rain from entering the cabinet. Fit the inside of the cabinet, directly behind the vents, with a replaceable, standard size, commercially available air filter of sufficient size to cover the entire vented area.

Provide a torsionally rigid door with a continuous stainless steel hinge on the side that permits complete access to the cabinet interior. Provide a gasket as a permanent and weather resistant seal at the cabinet door and at the edges of the fan / exhaust openings. Use a non-absorbent gasket material that will maintain its resiliency after long term exposure to the outdoor environment. Construct the doors so that they fit firmly and evenly against the gasket material when closed. Provide the cabinet door with louvered vents and air filters near the bottom as described in the paragraph above.

Provide a Plexiglas rack of appropriate size at a convenient location on the inside of the door to store the cabinet wiring diagrams and other related cabinet drawings. Provide a Corbin #2 main door lock made of non ferrous or stainless steel material. Key all locks on the project alike, and provide 10 keys to the Engineer. In addition, design the handle to permit pad-locking.

Provide the interior of the cabinet with ample space for housing the controller and all associated equipment and wiring; use no more than 75% of the useable space in the cabinet. Provide ample space in the bottom of the cabinet for the entrance and exit of all power, communications, and grounding conductors and conduit.

Arrange the equipment so as to permit easy installation of the cabling through the conduit so that they will not interfere with the operation, inspection, or maintenance of the unit. Provide adjustable metal shelves, brackets, or other support for the controller unit and auxiliary equipment. Leave a 3 inch minimum clearance from the bottom of the cabinet to all equipment, terminals, and bus bars.

Provide power supply monitoring circuitry to detect power failure and to automatically report the occurrence to the Control Software.

Install two 15 watt fluorescent light strips with shields, one in the top of the cabinet and the other under the bottom shelf. Design both lights to automatically turn on when the cabinet door is opened and turn off when the door closes.

Mount and wire a 120V (+10%) GFCI duplex receptacle of the 3 wire grounding type in the cabinet in a location that presents no electrical hazard when used by service personnel for the operation of power tools and work lights.

No cabinet resident equipment may utilize the GFCI receptacle. Furnish one spare non-GFCI receptacle for future equipment.

Mount a bug-proof and weatherproof thermostatically controlled fan and safety shield in the top of the cabinet. Size the fan to provide at least for two air exchanges per minute. Fuse the fan at 125% of the capacity of the motor. The magnetic field of the fan motor must not affect the performance of the control equipment. Use a fan thermostat that is manually adjustable to turn on between 80°F and 160°F with a differential of not more than 10°F between automatic turn on and turn off. Mount it in an easily accessible location, but not within 6 inches of the fan.

Install additional fans and/or heaters as needed to maintain the temperature inside the cabinet within the operating temperature range of the equipment within the cabinet as recommended by equipment manufacturer(s).

D.1. Wiring

The requirements stated herein apply wherever electrical wiring is needed for any DMS system assemblies and subassemblies such as controller cabinet, DMS enclosure, electrical panel boards and etc.

Neatly arrange and secure the wiring inside the cabinet. Where cable wires are clamped to the walls of the control cabinet, provide clamps made of nylon, metal, plastic with rubber or neoprene protectors, or similar. Lace and jacket all harnesses, or tie them with nylon tie wraps spaced at 6 inches maximum to prevent separation of the individual conductors.

Individually and uniquely label all conductors. Ensure all conductor labels are clearly visible without moving the conductor. Connect all terminal conductors to the terminal strip in right angles.

Remove excess conductor before termination of the conductor. Mold the conductor in such a fashion as to retain its relative position to the terminal strip if removed from the strip. Do not run a conductor across a work surface with the exception of connecting to that work surface. No conductor bundles can be support by fasteners that support work surfaces. Install all connectors, devices and conductors in accordance to manufactures guidelines. Comply with the latest NEC guideline in effect during installation. No conductor or conductor bundle may hang loose or create a snag hazard. Protect all conductors from damage. Ensure all solder joints are completed using industry accepted practices and will not fail due to vibration or movement. Protect lamps and control boards from damage.

No splicing will be allowed for feeder conductors and communication cables from the equipment cabinet to the DMS enclosure.

Insulate all conductors and live terminals so they are not hazardous to maintenance personnel.

Route and bundle all wiring containing line voltage AC and / or shield it from all low voltage control circuits. Install safety covers to prevent accidental contact with all live AC terminals located inside the cabinet.

Use industry standard, keyed type connectors with a retaining feature for connections to the controller.

Label all equipment and equipment controls clearly.

Supply each cabinet with one complete set of wiring diagrams that identify the color-coding or wire tagging used in all connections. Furnish a water-resistant packet adequate for storing wiring diagrams, operating instructions, and maintenance manuals with each cabinet.

D.2. Power Supply and Circuit Protection

Design the DMS and controller for use on a system with a line voltage of 120V + 10% at a frequency of 60 Hz + 3 Hz. Under normal operation, do not allow the voltage drop between no load and full load of the DMS and its controller to exceed 3% of the nominal voltage.

Blackout, brownout, line noise, chronic over-voltage, sag, spike, surge, and transient effects are considered typical AC voltage defects. Protect the DMS system equipment so that these defects do not damage the DMS equipment or interrupt their operation. Equip all cabinets with devices to protect the equipment in the cabinet from damage due to lightning and external circuit power and current surges.

D.3. Circuit Breakers

Protect the DMS controller, accessories, and cabinet utilities with thermal magnetic circuit breakers. Provide the controller cabinet with a main circuit breaker sized according to the NEC. Use appropriately sized branch circuit breakers to protect the controller and accessories and for servicing DMS equipment and cabinet utilities.

D.4. Surge Suppressor

Install and clearly label filtering hybrid power line surge protectors on the load side of the branch circuit breakers in a manner that permits easy servicing. Ground and electrically bond the surge protector to the cabinet within 2 inches.

Provide power line surge protector that meets the following requirements:

Peak surge current occurrences	20 minimum
Peak surge current for an 8 x 20 microsecond waveshape	50,000 amperes
Energy Absorption	> 500 Joules
Clamp voltage	240 volts
Response time	<1 nanosecond
Minimum current for filtered output	15 amperes for 120VAC*
Temperature range	-40°F to +158°F

*Capable of handling the continuous current to the equipment

D.5. Radio Interference Suppressor

Provide each controller cabinet with sufficient electrical and electronic noise suppression to enable all equipment in it to function properly. Provide one or more radio interference suppressors (RIS) connected between the stages of the power line surge suppressor that minimize interference generated in the cabinet in both the broadcast and the aircraft frequencies. Each RIS must provide a minimum attenuation of 50 decibels over a frequency range of 200 KHz to 75 MHz. Clearly label the suppressor(s) and size them at least at the rated current of the main circuit breaker but not less than 50 amperes.

Provide RIS that are hermetically sealed in a substantial metal case which is filled with a suitable insulating compound and have nickel plated 10/24 brass stud terminals of sufficient external length to provide space to connect #8 AWG wires. Mount them so that the studs cannot be turned in the case. Properly insulate ungrounded terminals from each other, and maintain a surface linkage distance of not less than ¼" between any exposed current conductor and any other metallic parts.

The terminals must have an insulation factor of 100 200 MΩ, dependent on external circuit conditions. Use RIS designed for 120 VAC + 10%, 60Hz, and which meet the standards of UL and the Radio Manufacturers Association.

D.6. Communications Surge Protector

Equip the cabinet with properly labeled hybrid data line surge protectors that meet the following general requirements:

Surge current occurrences at 2000 ampere, 8 x 20 microsecond waveform	> 80
Surge current occurrences at 400 ampere, 10x700 microsecond waveform	> 80
Peak surge current for 8 x 20 microsecond waveform	10,000 A (2500 A/line)
Peak surge current for 10x700 microsecond waveform	500 A/line
Response time	< 1 nanosecond
Series resistance	< 15 Ω
Average capacitance	1500 pF
Temperature range	-10°F to 150°F
Clamp Voltage	As required to match equipment in application

D.7. Lightning Arrester

Protect the system with an UL approved lightning arrester installed at the main service disconnect that meets the following requirements:

Type of design	Silicon Oxide Varistor
Voltage	120/240 Single phase, 3 wires
Maximum current	100,000 amps
Maximum energy	3000 joules per pole
Maximum number of surges	Unlimited
Response time one milliamp test	5 nanoseconds

Response time to clamp 10,000 amps	10 nanoseconds
Response time to clamp 50,000 amps	25 nanoseconds
Leak current at double the rated voltage	None
Ground Wire	Separate

D.8. Uninterruptible Power Supply (UPS)

Provide the cabinet with an industrial grade power conditioning UPS unit to supply continuous power to operate the equipment connected to it if the primary power fails. The UPS must detect a power failure and provide backup power within 20 milliseconds. Transition to the UPS source from primary power must not cause loss of data or damage to the equipment being supplied with backup power. Provide an UPS with at least three outlets for supplying conditioned AC voltage to the DMS controller and modem. Provide a unit to meet the following requirements:

Input Voltage Range:	120VAC +12%, -25%
Power Rating:	1000 VA, 700 Watts
Input Frequency:	45 to 65 Hz
Input Current:	7.2A
Output Voltage:	120VAC +/- 3%
Output Frequency:	50/60 +/-1 Hz
Output Current:	8.3A
Output Crest Factor Ration:	@50% Load Up to 4.8:1 @75% Load Up to 3.2:1 @100% Load Up to 2.4:1
Output THD:	3% Max. (Linear) 5% Max. (Non-Linear)
Output Overload:	110% for 10 min; 200% for 0.05 sec.
Output Dynamic Response:	+/- 4% for 100% Step Load Change 0.5 ms Recovery Time.
Output Efficiency:	@ 100% Load:90% (Normal Mode)
Operating Temperature:	-40 °F to +165 °F

Humidity:	0% to 95% Non-condensing
Remote Monitoring Interface:	RS-232
Protection:	Input/Output Short Circuit Input/Output Overload Excessive Battery Discharge
Specifications:	UL1778, FCC Class A, IEEE 587

Provide the UPS unit capable of supplying 30 minutes of continuous backup power to the equipment connected to it when the equipment is operating at full load.

D.9. Controller Communications Interface

Provide the controller with the following interface ports:

- An EIA/TIA-232E port for remote communication using NTCIP
- An 10/100 Ethernet port for remote communication using NTCIP
- An EIA/TIA-232E port for onsite access using a laptop
- An EIA/TIA-232E auxiliary port for communication with a field device such as a UPS
- Fiber Optic ports for communication with the sign
- RJ45 ports for communication with the sign using CAT-5 cable
- RJ45 ports for communication with mini-controller located inside the sign enclosure

D.10. Controller Local User Interface

Provide the controller with a Local User Interface (LUI) for at least the following functions:

- On / Off Switch: controls power to the controller.
- Control Mode Switch: for setting the controller operation mode to either remote or local mode.
- LCD Display and Keypad: Allow user to navigate through the controller menu for configuration (display, communications parameter, etc) running diagnostics, viewing peripherals status, message creation, message preview, message activation, and etc. Furnish a LCD display with a minimum size of 240x64 dots with LED back light.

D.11. Controller Address

Assign each DMS controller a unique address. Preface all commands from the Control Software with a particular DMS controller address. The DMS controller compares its address with the address transmitted; if the addresses match, then the controller processes the accompanying data.

D.12. Controller Functions

Design the DMS controller to continuously control and monitor the DMS independent of the Control Software. Design the controller to display a message on the sign sent by the Control Software, a message stored in the sign controller memory, or a message created on site by an operator using the controller keypad.

Provide the DMS controller with a watchdog timer to detect controller failures and to reset the microprocessor, and with a battery backed up clock to maintain an accurate time and date reference. Set the clock through an external command from the Control Software or the Local User Interface.

D.13. DMS Controller Memory

Furnish each DMS controller with non-volatile memory. Use the non-volatile memory to store and reprogram at least one test pattern sequence and 500 messages containing a minimum of two pages of 45 characters per page. The Control Software can upload messages into and download messages from each controller's non-volatile memory remotely.

Messages uploaded and stored in the controller's non-volatile memory may be erased and edited using the Control Software and the controller. New messages may be uploaded to and stored in the controller's non-volatile memory using the Control Software and the controller.

E. Photo-Electric Sensors

Install three photoelectric sensors with ½ inch minimum diameter photosensitive lens inside the DMS enclosure. Use sensors that will operate normally despite continual exposure to direct sunlight. Place the sensors so they are accessible and field adjustable. Point one sensor north or bottom of the sign. Place the other two, one on the back wall and one on the front wall of the sign enclosure. Alternate designs maybe accepted, provided the sensor assemblies are accessible and serviceable from inside the sign enclosure.

Provide controls so that the Engineer can field adjust the following:

- The light level emitted by the pixels elements in each Light Level Mode.
- The ambient light level at which each Light Level Mode is activated.

F. Equipment List

Provide a general description of all equipment and all information necessary to describe the basic use or function of the major system components. Include a general "block diagram" presentation.

Include tabular charts listing auxiliary equipment, if any is required. Include the nomenclature, physical and electrical characteristics, and functions of the auxiliary equipment unless such information is contained in an associated manual; in this case include a reference to the location of the information. Include an itemized list of equipment costs.

Include a table itemizing the estimated average and maximum power consumption for each major piece of equipment.

G. Physical Description

Provide a detailed physical description of size, weight, center of gravity, special mounting requirements, electrical connections, and all other pertinent information necessary for proper installation and operation of the equipment.

H. Parts List

Provide a parts list that contains all information needed to describe the characteristics of the individual parts, as required for identification. Include a list of all equipment within a group and a list of all assemblies, sub assemblies, and replacement parts of all units. Arrange this data in a table, in alpha numerical order of the schematic reference symbols, which gives the associated description, manufacturer's name, and part number, as well as alternate manufacturers and part numbers. Provide a table of contents or other appropriate grouping to identify major components, assemblies, etc.

I. Character Set Submittal

Submit an engineering drawing of the DMS character set including 26 upper case and lower case letters, 10 numerals, an asterisk (*), a dash, a plus sign (+), a designated lane diamond, a slash, an ampersand, and arrows at 0, 45, 90, 135, 180, 225, 270, and 315 degrees.

J. Wiring Diagrams

Provide a wiring diagram for each DMS and each controller cabinet, as well as interconnection wiring diagrams for the system as a whole.

Provide complete and detailed schematic diagrams to component level for all DMS assemblies and subassemblies such as driver boards, control boards, DMS controller, power supplies, and etc. Ensure that each schematic enables an electronics technician to successfully identify any component on a board or assemblies and trace its incoming and outgoing signals.

K. Routine of Operation

Describe the operational routine, from necessary preparations for placing the equipment into operation to securing the equipment after operation. Show appropriate illustrations with the sequence of operations presented in tabular form wherever applicable. Include in this section a total list of the test instruments, aids and tools required to perform necessary measurements and measurement techniques for each component, as well as set up, test, and calibration procedures.

L. Maintenance Procedures

Specify the recommended preventative maintenance procedures and checks at pre operation, monthly, quarterly, semi-annual, annual, and "as required" periods to assure equipment operates reliably. List specifications (including tolerances) for all electrical, mechanical, and other applicable measurements and / or adjustments.

M. Repair Procedures

Include in this section all data and step by step procedures necessary to isolate and repair failures or malfunctions, assuming the maintenance technicians are capable of analytical reasoning using the information provided in the section titled "Wiring Diagrams and Theory of Operation."

Describe accuracy, limits, and tolerances for all electrical, physical, or other applicable measurements. Include instructions for disassemblies, overhaul, and re-assemblies, with shop specifications and performance requirements.

Give detailed instructions only where failure to follow special procedures would result in damage to equipment, improper operation, danger to operating or maintenance personnel, etc. Include such instructions and specifications only for maintenance that specialized technicians and engineers in a modern electromechanical shop would perform. Describe special test set up, component fabrication, and the use of special tools, jigs, and test equipment.

N. Field Trial

At the request of the Engineer, supply a three character demonstration module with characters of the size and type specified for the project, an appropriate control device and power supply to allow character display within 30 working days of the request. Perform a field trial on this module at a time and location selected by the Engineer.

This trial will allow the Engineer or his selected representatives to test the readability of the DMS at the maximum distance required for specified character size. Test the module with the sun directly above the DMS, and near the horizon in front of and behind the DMS (washout and back-lit conditions).

31.3. CONSTRUCTION METHODS

A. Description

This article establishes practices and procedures and gives minimum standards and requirements for the installation of Dynamic Message Sign systems, auxiliary equipment and the construction of related structures.

Provide electrical equipment described in this specification that conforms to the standards of NEMA, UL, or Electronic Industries Association (EIA), wherever applicable. Provide connections between controllers and electric utilities that conform to NEC standards. Express wire sizes according to the American Wire Gauge (AWG).

Provide stainless steel screws, nuts, and locking washers in all external locations. Do not use self tapping screws unless specifically approved by the Engineer. Use parts made of corrosion resistant materials, such as plastic, stainless steel, brass, or aluminum. Use construction materials that resist fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

B. Layout

The Engineer will establish the actual location of each Dynamic Message Sign assemblies. It is the Contractor's responsibility to ensure proper elevation, offset, and orientation of all DMS assemblies. The location of service poles as well as conduit lengths shown in the Plans, are approximate based on available project data. Make actual field measurements to place conduit and equipment at the required location. Submit a drawing showing all underground conduits and cables dimensioned from fixed objects or station marks.

C. Construction Submittal

When the work is complete, submit "as built" plans, inventory sheets, and any other data required by the Engineer to show the details of actual construction and installation and any modifications made during installation.

The "as built" plans will show: the DMS, controller, and service pole locations; DMS enclosure and controller cabinet wiring layouts; and wire and conduit routing. Include detailed drawings that identify the routing of all conductors in the system by cable type, color code, and function. Clearly label all equipment in the DMS system, controller cabinet, and DMS enclosure.

D. Conduit

Install the conduit system in accordance with section 1097 of Standard Specification and NEC requirements for an approved watertight raceway.

Flexible conduit will only be allowed when the conduits transition from the horizontal structure segment to the horizontal truss segment and from the horizontal truss segment to the rear entrance of the DMS when installing the DMS communications and feeder cables. The maximum length of flexible conduit allowed at each transition point will be 5 feet.

Make bends in the conduit so as not to damage it or change its internal diameter. Install watertight and continuous conduit with as few couplings as standard lengths permit.

Clean conduit before, during, and after installation. Install conduit in such a manner that temperature changes will not cause elongation or contraction that might damage the system.

Attach the conduit system to and install along the structural components of the DMS structure assemblies with beam clamps or stainless steel strapping. Install strapping according to the strapping manufacturer's recommendations. Do not use welding or drilling to fasten conduit to structural components. Space the fasteners at no more than 4 feet for conduit 1.5 inches and larger or 6 feet for conduit smaller than 1.25 inches. Place fasteners no more than 3 feet from the center of bends, fittings, boxes, switches, and devices.

Locate underground conduit as shown in the Plans in a manner consistent with these Project Special Provisions.

Do not exceed the appropriate fill ratio on all cable installed in conduit as specified in the NEC.

E. Wiring Methods

Do not pull permanent wire through a conduit system until the system is complete and has been cleaned.

Color-code all conductors per the NEC. Use approved marking tape, paint, sleeves or continuous colored conductors for No.8 AWG and larger. Do not mark a white conductor in a cable assemblies any other color.

Bury underground circuits at the depth shown in the Plans and surround it with at least 3 inches of sand or earth back fill free of rocks and debris. Compact backfill in 6 inch layers. Do not splice underground circuits unless specifically noted in the Plans.

F. Equipment and Cabinet Mounting

Mount equipment securely at the locations shown in the Plans, in conformance with the dimensions shown. Install fasteners as recommended by the manufacturer and space them evenly. Use all mounting holes and attachment points for attaching DMS enclosures and controller cabinets to the structures.

Drill holes for expansion anchors of the size recommended by the manufacturer of the anchors and thoroughly clean them of all debris.

Provide one key-operated, pin tumbler, dead bolt padlock, with brass or bronze shackle and case, conforming to Military Specification MIL P 17802E (Grade I, Class 2, Size 2, Style A) for each electrical panel and switch on the project. Key all padlocks alike, and provide 10 keys to the Engineer.

Provide cabinets with all mounting plates, anchor bolts, and any other necessary mounting hardware in accordance with these Project Special Provisions and the Plans.

Seal all unused conduit installed in cabinets at both ends to prevent water and dirt from entering the conduit and cabinet with approved sealing material.

Install a ground bushing attached inside the cabinet on all metal conduits entering the cabinet. Connect these ground bushings to the cabinet ground bus.

G. Work Site Clean-Up

Clean the site of all debris, excess excavation, waste packing material, wire, etc. Clean and clear the work site at the end of each workday. Do not throw waste material in storm drains or sewers.

31.4. MEASUREMENT AND PAYMENT

Walk-In Enclosure DMS will be measured and paid as the actual number of DMS furnished, installed, and accepted.

Each DMS consists of a LED Dynamic Message Sign, communications equipment, strapping hardware, controller, UPS, controller cabinet, conduit, fittings, couplings, sweeps, conduit bodies, wire, flexible conduit, power conductors and communications cable between the controller cabinet and the DMS enclosure, connectors, circuit protection equipment, photo-electric sensors, tools, materials, all related testing, cost of labor, cost of transportation, incidentals, and all other equipment necessary to furnish and install the DMS system.

Front Access Enclosure DMS will be measured and paid as the actual number of DMS furnished, installed, and accepted.

Each DMS consists of a LED Dynamic Message Sign, communications equipment, strapping hardware, controller, UPS, controller cabinet, conduit, fittings, couplings, sweeps, conduit bodies, wire, flexible conduit, power conductors and communications cable between the controller cabinet and the DMS enclosure, connectors, circuit protection equipment, photo-electric sensors, tools, materials, all related testing, cost of labor, cost of transportation, incidentals, and all other equipment necessary to furnish and install the DMS system.

Payment will be made under:

Walk-In Enclosure DMS..Each

Front Access Enclosure DMS..Each

32. NTCIP REQUIREMENTS

This section defines the detailed NTCIP requirements for the DMSs covered by these Project Special Provisions and Plans.

32.1. REFERENCES

This specification references several standards through their NTCIP designated names. The following list provides the full reference to the current version of each of these standards.

Implement the most recent version of the standard including any and all Approved or Recommended Amendments to these standards for each NTCIP Component covered by these project specifications.

Table 1: NTCIP Standards

Abbreviated Number	Full Number	Title
NTCIP 1101	NTCIP 1101:1997	Simple Transportation Management Framework
NTCIP 1201	NTCIP 1201:1997	Global Object Definitions
NTCIP 1203	NTCIP 1203:1997	Object Definitions for Dynamic Message Signs
NTCIP 2001	NTCIP 2001:1997	Class B Profile
NTCIP 2101	NTCIP 2101	SP-PMPP/232 Subnet Profile for PMPP over RS-232
NTCIP 2102	NTCIP 2102	SP-PMPP/FSK Subnet Profile for PMPP over FSK Modem
NTCIP 2103	NTCIP 2103	SP-PPP/232 Subnetwork Profile for PPP over RS232 (Dial Up)
NTCIP 2104	NTCIP 2104	SP-Ethernet Subnet Profile for Ethernet
NTCIP 2201	NTCIP 2201	TP-Null Transport Profile

NTCIP 2202	NTCIP 2202	TP-Internet Internet Transport Profile (TCP/IP and UDP/IP)
NTCIP 2301	NTCIP 2301	AP-STMF AP for Simple Transportation Management Framework

A. General Requirements

A.1. Subnet Level

Ensure each serial port on each NTCIP Component supports NTCIP 2103 over a dial-up connection with a contractor provided external modem with data rates of 28.8 kbps, 19.2 kbps, 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps. Enable the NTCIP Component to make outgoing and receive incoming calls as necessary and support the following modem command sets:

- Hayes AT - Command Set
- MNP5
- MNP10
- V.42bis

Ensure each serial port on each NTCIP Component supports NTCIP 2103 over a null-modem connection with data rates of 19.2 kbps, 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps.

Ensure each serial port on each NTCIP Component supports NTCIP 2101 with data rates of 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps.

Ensure NTCIP components support NTCIP 2102 and NTCIP 2104.

NTCIP Components may support additional Subnet Profiles at the manufacturer's option. At any one time, make certain only one Subnet Profile is active on a given serial port of the NTCIP Component. Ensure the NTCIP Component can be configured to allow the field technician to activate the desired Subnet Profile and provide a visual indication of the currently selected Subnet Profile.

A.2. Transport Level

Ensure each NTCIP Component complies with NTCIP 2201 and 2202.

NTCIP Components may support additional Transport Profiles at the manufacturer's option. Ensure Response datagrams use the same Transport Profile used in the request. Ensure each NTCIP Component supports the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

A.3. Application Level

Ensure each NTCIP Component complies with NTCIP 1101 and 2301 and meets the requirements for Conformance Level 1 (NOTE - See Amendment to standard).

Ensure each NTCIP Component supports SNMP traps. An NTCIP Component may support additional Application Profiles at the manufacturer's option. Ensure Responses use the same Application Profile used by the request. Ensure each NTCIP Component supports the receipt of Application data packets at any time allowed by the subject standards.

A.4. Information Level

Guarantee each NTCIP Component provides Full, Standardized Object Range Support of all objects required by these Special Provisions unless otherwise indicated below. Make certain the maximum Response Time for any object or group of objects is 200 mililiseconds.

Design the DMS to support all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1201 and NTCIP 1203. Table 2 indicates the modified object requirements for these mandatory objects.

Table 2: Modified Object Ranges for Mandatory Objects

Object	Reference	Project Requirement
ModuleTableEntry	NTCIP 1201 Clause 2.2.3	Contains at least one row with moduleType equal to 3 (software). The moduleMake specifies the name of the manufacturer, the moduleModel specifies the manufacturer's name of the component and the modelVersion indicates the model version number of the component.

MaxGroupAddresses	NTCIP 1201 Clause 2.7.1	At least 1
CommunityNamesMax	NTCIP 1201 Clause 2.8.2	At least 3
DmsNumPermanentMsg	NTCIP 1203 Clause 2.6.1.1.1.1	At least 1*
DmsMaxChangeableMsg	NTCIP 1203 Clause 2.6.1.1.1.3	At least 21
DmsFreeChangeableMemory	NTCIP 1203 Clause 2.6.1.1.1.4	At least 20 when no messages are stored.
DmsMessageMultiString	NTCIP 1203 Clause 2.6.1.1.1.8.3	The DMS supports any valid MULTI string containing any subset of those MULTI tags listed in Table 4
DmsControlMode	NTCIP 1203 Clause 2.7.1.1.1.1	Support at least the following modes: Local, External, Central, CentralOverride

* Ensure the Permanent Messages display the content shown in Table 3.

Ensure the sign blanks if a command to display a message contains an invalid Message CRC value for the desired message.

Table 3: Content of Permanent Messages

Perm. Msg. Num.	**Description**
1	Permanent Message #1 blanks the display (i.e., consist of an empty MULTI string). It has a run-time priority of one (1).

Table 4: Required MULTI Tags

Code	**Feature**
f1	field 1 - time (12hr)
f2	field 2 - time (24hr)
f8	field 8 – day of month

f9	field 9 – month
f10	field 10 - 2 digit year
f11	field 11 - 4 digit year
fl (and /fl)	flashing text on a line by line basis with flash rates controllable in 0.5 second increments.
fo	Font
jl2	Justification – line – left
jl3	Justification – line – center
jl4	Justification – line – right
jl5	Justification – line – full
jp2	Justification – page – top
jp3	Justification – page – middle
jp4	Justification – page – bottom
Mv	moving text
Nl	new line
Np	new page, up to 2 instances in a message (i.e., up to 3 pages/frames in a message counting first page)
Pt	page times controllable in 0.5 second increments.

The NTCIP Component implements all mandatory and optional objects of the following optional conformance groups with FSORS.

A.5. Test Heading

A.5.1. Time Management

As defined in NTCIP 1201

A.5.2. Timebase Event Schedule

As defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.

Table 5: Modified Object Ranges for the Timebase Event Schedule Conformance Group

Object	Reference	Project Requirement
MaxTimeBaseScheduleEntries	NTCIP 1201 Clause 2.4.3.1	At least 28
maxDayPlans	NTCIP 1201 Clause 2.4.4.1	At least 14
maxDayPlanEvents	NTCIP 1201 Clause 2.4.4.2	At least 10

A.5.3. Report

As defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.

Table 6: Modified Object Ranges for the Report Conformance Group

Object	Reference	Project Requirement
maxEventLogConfigs	NTCIP 1201 Clause 2.5.1	At least 50
eventConfigurationMode	NTCIP 1201 Clause 2.4.3.1	The NTCIP Component supports the following Event Configuration Modes: onChange, greaterThanValue, smallerThanValue
MaxEventLogSize	NTCIP 1201 Clause 2.5.3	At least 200
MaxEventClasses	NTCIP 1201 Clause 2.5.5	At least 16

A.5.4. PMPP

A.5.5. Font Configuration

As defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 7: Modified Object Ranges for the Font Configuration Conformance Group

Object	Reference	Project Requirement
NumFonts	NTCIP 1203 Clause 2.4.1.1.1.1	At least 4*
MaxFontCharacters	NTCIP 1203 Clause 2.4.1.1.1.3	At least 127**

*Upon delivery, the first font is a standard 18" font. The second font is a double-stroke 18" font. The third font is a 28" font. The fourth font is empty.

**Upon delivery, the first three font sets are configured in accordance with the ASCII character set for the following characters:

- "A" thru "Z"- All upper case letters.
- "0" thru "9"- All decimal digits.
- Space (i.e., ASCII code 0x20).
- Punctuation marks shown in brackets [. , ! ? - ' ' " " / ( )]
- Special characters shown in brackets [# & * +< >]

A.5.6. DMS Configuration

As defined in NTCIP 1203.

A.5.7. MULTI Configuration

As defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 8: Modified Object Ranges for the MULTI Configuration Conformance Group

Object	**Reference**	**Project Requirement**
DefaultBackgroundColor	NTCIP 1203 Clause 2.5.1.1.1.1	The DMS supports the following background colors: black
DefaultForegroundColor	NTCIP 1203 Clause 2.5.1.1.1.2	The DMS supports the following foreground colors: amber
DefaultJustificationLine	NTCIP 1203 Clause 2.5.1.1.1.6	The DMS supports the following forms of line justification: left, center, right, full
defaultJustificationPage	NTCIP 1203 Clause 2.5.1.1.1.7	The DMS supports the following forms of page justification: top, middle,

		bottom
defaultPageOnTime	NTCIP 1203 Clause 2.5.1.1.1.8	The DMS supports the full range of these objects with step sizes no larger than 0.5 seconds
defaultPageOffTime	NTCIP 1203 Clause 2.5.1.1.1.9	The DMS supports the full range of these objects with step sizes no larger than 0.5 seconds
defaultCharacterSet	NTCIP 1203 Clause 2.5.1.1.1.10	The DMS supports the following character sets: eightBit

A.5.8. Default Message Control

As defined in NTCIP 1203

A.5.9. Pixel Service Control

As defined in NTCIP 1203

A.5.10. MULTI Error Control

As defined in NTCIP 1203

A.5.11. Illumination/Brightness Control

As defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 9: Modified Object Ranges for the Illumination/Brightness Control Conformance Group

Object	Reference	Project Requirement
dmsIllumControl	NTCIP 1203 Clause 2.8.1.1.1.1	The DMS supports the following illumination control modes: photocell, timer, manual
dmsIllumNumBrightLevels	NTCIP 1203 Clause 2.8.1.1.1.4	At least 16

A.5.12. Auxiliary I/O

A.5.13. Scheduling

As defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 10: Modified Object Ranges for the Scheduling Conformance Group

Object	Reference	Project Requirement
NumActionTableEntries	NTCIP 1203 Clause 2.9.1.1.1.1	At least 21

A.5.14. Sign Status

As defined in NTCIP 1203

A.5.15. Status Error

As defined in NTCIP 1203

A.5.16. Pixel Error Status

As defined in NTCIP 1203

A.5.17. Fan Error Status

As defined in NTCIP 1203

A.5.18. Power Status

As defined in NTCIP 1203

A.5.19. Temperature Status

As defined in NTCIP 1203

Install necessary hardware for the support of items q, r, and s above.

Table 11: Some Optional Object Requirements

Object	Reference	Project Requirement
DefaultFlashOn	NTCIP 1203 Clause 2.5.1.1.1.3	The DMS supports the full range of these objects with step sizes no larger than 0.5 seconds
DefaultFlashOff	NTCIP 1203 Clause	The DMS supports the full

	2.5.1.1.1.4	range of these objects with step sizes no larger than 0.5 seconds
DmsMultiOtherErrorDescription	NTCIP 1203 Clause 2.7.1.1.1.20	If the vendor implements any vendor-specific MULTI tags, the DMS shall provide meaningful error messages within this object whenever one of these tags generates an error.

A.6. Documentation

Supply software with full documentation, including a CD-ROM containing ASCII versions of the following MIB files in Abstract Syntax Notation 1 (ASN.1) format:

- The relevant version of each official standard MIB Module referenced by the device functionality.
- If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. Name this file identical to the standard MIB Module, except that it will have the extension ".man".
- A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- A MIB containing any other objects supported by the device.

Allow the use of any and all of this documentation by any party authorized by the Department for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

B. NTCIP Acceptance Testing

Test the NTCIP requirements outlined above by a third party testing firm. Submit to the Engineer for approval a portfolio of the selected firm. Include the name, address, and a history of the selected firm in performing NTCIP testing along with references. Also provide a contact person's name and phone number. Submit detailed NTCIP testing plans and procedures, including a list of hardware and software, to the Engineer for review and approval 10 days in advance of a scheduled testing date. Develop test documents based on the NTCIP requirements of these Project Special Provisions. The acceptance test will use the NTCIP Exerciser, and/or other authorized testing tools and will follow the guidelines established in the ENTERPRISE Test Procedures. Conduct the test in North Carolina on the installed system in the presence of the Engineer. Document and certify the results of the test by the firm conducting the test and submit the Engineer for review and approval. In case of failures, remedy the problem and have the firm retest in North Carolina. Continue process until all failures are resolved. The Department reserves the right to enhance these tests as deemed appropriate to ensure device compliance.

32.2. MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment for this work will be covered in the applicable sections of these Project Special Provisions at the contract unit price for the DMS and will be full compensation for all work listed above.

33. DMS TESTING REQUIREMENTS

33.1. GENERAL TEST PROCEDURE

Test the DMS system in a series of design approval and functional tests. The results of each test must meet the specified requirements. These tests should not damage the equipment. The Engineer will reject equipment that fails to fulfill the requirements of any test. Resubmit rejected equipment after correcting non conformities and re-testing; completely document all diagnoses and corrective actions. Modify all equipment furnished under this contract, without additional cost to the North Carolina Department of Transportation, to incorporate all design changes necessary to pass the required tests.

Provide 4 copies of all test procedures and requirements to the Engineer for review and approval at least 30 days prior to the testing start date.

Only use approved procedures for the tests. Include the following in the test procedures:

- A step by step outline of the test sequence, showing a test of every function of the equipment or system tested
- A description of the expected nominal operation, output, and test results, and the pass / fail criteria
- An estimate of the test duration and a proposed test schedule
- A data form to record all data and quantitative results obtained during the test
- A description of any special equipment, setup, manpower, or conditions required by the test

Provide all necessary test equipment and technical support. Use test equipment calibrated to National Institute of Standards and Technology (NIST) standards. Provide calibration documentation upon request. Conform to these testing requirements and the requirements of these specifications. The Engineer will reject all equipment not tested according to these requirements. It is the Contractor's responsibility to ensure the DMS system functions properly even after the Engineer accepts the DMS test results.

Provide 4 copies of the quantitative test results and data forms containing all data taken, highlighting any non conforming results and remedies taken, to the Engineer for approval. An authorized representative of the manufacturer must sign the test results and data forms.

33.2. DESIGN APPROVAL TESTS

Design Approval Tests are applicable to DMS systems not currently on the QPL.

The Design Approval Tests consists of all tests described in Section 2.2 "DMS Equipment Tests" of NEMA TS 4-2005 (Hardware Standards for Dynamic Message Signs with NTCIP Requirements). Perform all tests and submit certified results for review and approval.

A. Prototype

Manufacture a prototype DMS and controller of the type and size described in the Project Special Provisions. In the presence of the Engineer, test the prototype according to the Design Approval and Operational Tests. When all corrections and changes (if any) have been made, the Department may accept the prototype DMS and controller as the physical and functional standard for the system furnished under this contract. You may use the prototype units on this project if, after inspection and rework (if necessary), they meet all physical and functional specifications. In the case of standard product line equipment, if the Contractor can provide test results certified by an independent testing facility as evidence of prior completion of successful design approval tests, then the Engineer may choose to waive these tests.

In each Design Approval Test, successfully perform the Functional Tests described below. Apply the extreme conditions to all associated equipment unless stated otherwise in these Project Special Provisions.

33.3. OPERATIONAL FIELD TEST (ON-SITE COMMISSIONING)

Conduct an Operational Field Test of the DMS system installed on the project in the presence of the Engineer to exercise the normal operational functions of the equipment. The Operational Field Test will consist of the following tests as a minimum:

A. Physical Examination

Examine each piece of equipment to verify that the materials, design, construction, markings, and workmanship comply with the mechanical, dimensional, and assemblies requirements of these Project Special Provisions.

Perform the following tests as a minimum:

- Verify that all surfaces are free of dents, scratches, weld burns, or abrasions. Round sharp edges and corners.
- Verify bend radius of cables is not excessive or could potentially cause damage.
- Verify all modules, lamps, and components are properly secured.

- Verify that there are no exposed live terminals.

B. Continuity Tests

Check the wiring to assure it conforms to the requirements of these Project Special Provisions.

C. Functional Tests

Perform the following functional tests:

- Start-up and operate the DMS locally using a laptop computer.
- Use automatic (photo-electric sensor controlled) DMS Control Software to switch between "dim", "normal", and "bright" light levels.
- Operate the DMS with all display elements flashing continuously for 10 minutes at the maximum flash rate.
- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences.
- Automatic poll the DMS by the Control Software at various intervals and verify the data received by Control Software from DMS.
- Download and edit messages using Control Software.
- Execute status request on the DMS controller.
- Observe normal operations during uploading and downloading messages.
- Input and select messages from the sign controller's local user interface.
- Test sequence activation at chosen intervals.
- Display and verify all stored messages.
- Verify resumption of standard operation upon interruption of electrical power.
- Demonstrate detected failures and response functions.
- Demonstrate proper operation of the Failure Log.
- Set controller clock using the Control Software.
- Execute system shutdown using the Control Software and local user interface.
- Verify detection of a power failure in the DMS enclosure and the report feature of the failure to the Control Software.

Approval of Operational Field Test results does not relieve the Contractor to conform to the requirements in these Project Special Provisions. If the DMS system does not pass these tests, document a correction or substitute a new unit as approved by the Engineer. Re-test the system until it passes all requirements.

33.4. MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered in this section.

Payment for this work will be covered in the applicable sections of these Project Special Provisions at the contract unit price for the DMS and will be full compensation for all work covered in this section.

34. DMS ASSEMBLIES

34.1. DESCRIPTION

This section includes all design, fabrication, furnishing, and erection of the DMS assembly; platform and ladder for access to the DMS inspection door and attachment of the DMS enclosure to the structure in accordance with the requirements of these Project Special Provisions and the Plans. Fabricate the supporting DMS assembly from tubular steel. Furnish a pedestal type DMS assembly as shown in the Plans. Cantilevered and Monotube (horizontal truss) DMS structures will not be allowed.

Provide pedestal structures with a minimum clearance from the high point of the road to the bottom of the DMS enclosure as shown in the Plans. The DMS assemblies must allow for field adjustment using shims (horizontal & vertical tilting of +/- 3 degrees) of the DMS enclosure to ensure optimum legibility from all travel lanes.

Design the new Front-Access DMS assembly and footings and submit shop drawings for approval. Design the new Walk-In DMS assembly (with access platform and access ladder) and footings and submit shop drawings for approval. A Professional Engineer that is registered in the state of North Carolina will prepare such computations and drawings. These must bear his signature, seal, and date of acceptance.

The provisions of Section 900 of the Standard Specifications apply to all work covered by this section.

34.2. MATERIAL

Use materials that meet the following requirements of the Standard Specifications:

• Structural Steel	Section 1072
• Overhead Sign Structures	Section 1096
• Signing Materials	Section 1092
• Organic-Zinc Repair Paint	Article 1080-9
• Reinforcing Steel	Sub-article 1070
• Direct Tension Indicators	Sections 440 and 1072

34.3. CONSTRUCTION METHODS

A. General

Fabricate the new Front-Access DMS assemblies in accordance with the details shown in the approved shop drawings and the requirements of these Project Special Provisions.

Fabricate the new Walk-In DMS assemblies, access platforms and ladders in accordance with the details shown in the approved shop drawings and the requirements of these Project Special Provisions.

No welding, cutting, or drilling in any manner will be permitted in the field, unless approved by the Engineer.

Drill bolt holes and slots to finished size. Holes may also be punched to finished size, provided the diameter of the punched holes are at least twice the thickness of the metal being punched. Flame cutting of bolt holes and slots is not permitted.

Erect DMS in accordance with the requirements indicated on the Plans and in these Project Special Provisions. Field drill two holes per connection in the Z bars for attaching the DMS to the structure. Use two bolts at each connection. Provide two (2) U-bolts at each U-bolt connection such as 1) each truss chord to sign hanger, or 2) each truss chord to platform support. Provide two (2) U-bolts at each U-bolts connection where ends of truss chords are supported. Minimum diameter of all U-bolts is to be ½ inch.

Use two coats of a zinc-rich paint to touch up minor scars on all galvanized materials. See Standard Specifications for Roads and Structures Section 1076-6.

For high strength bolted connections, provide direct tension indicator washer.

B. Shop Drawing

Submit to the Engineer for approval a complete design for the DMS assemblies, including footings, DMS assembly hardware, brackets for supporting the DMS and the access platform. Base the design on the line drawings and correct wind speed in accordance with the latest edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals."

The manufacturer of the DMS assemblies must ensure that design of the assemblies are compatible with the DMSs for mounting and attachment.

Submit six copies of complete detailed shop drawings and one copy of the design computations for the DMS assemblies to the Engineer for approval prior to fabrication. Show in the shop drawings complete design and fabrication details including foundations, provisions for attaching the DMS and maintenance platform to supporting structures, applicable material specifications, and any other information necessary for procuring and replacing any part of the complete DMS assemblies.

Allow a minimum of 40 working days for shop drawing approval after the Engineer receives them. If revised drawings are necessary, allow appropriate additional time for review and approval of final shop drawings.

Approval of shop drawings by the Engineer will not relieve the Contractor of his responsibility for the correctness of drawings, or for the fit of all shop and field connections and anchors, including but not limited to the installation of new access platforms and ladders.

C. Design and Fabrication

C.1. Dynamic Message Sign Assembly

Design must be in accordance with the Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4th Edition, 2001, and the latest Interim Specifications.

The wind pressure map that is developed from the 3-second gust speeds, as provided in Article 3.8, shall be used.

The natural wind gust speed in North Carolina shall be assumed to be 5 meters per second or 11.6 mph for inland areas, and 7 meters per second or 15.7 mph for coastal areas. The coastal area shall be defined as any area within 2 miles from the waterfront facing the ocean or sound and all area where the design basic wind speed is above 120 mph, as shown in Figure 3-2.

The fatigue importance category used in the design, for each type of structure, as provided for in Article 11.6, Fatigue Importance Factors, shall be Category II unless otherwise shown on the contract plans.

Wind drag coefficient for Dynamic Message Sign enclosures shall be 1.7.

The following Specification interpretations or criteria shall be used in the design of overhead sign assemblies:

- For design of supporting upright posts or columns, the effective length factor for columns "K", as provided for in Appendix B, Section B.5, shall be taken as the following, unless otherwise approved by the Engineer:
    - Case 1 For a single upright post of span type overhead sign structure, the effective column length factor, "K", shall be taken as 2.0.

- Case 2 For twin post truss-type upright post with the post connected to one chord of a horizontal truss, the effective column length factor for that column shall be taken as 2.0.
- Case 3 For twin post truss-type upright post with the post connected to two truss chords of a horizontal tri-chord or box truss, the effective column length factor for that column shall be taken as 1.65.

- For twin post truss-type upright post, the unbraced length shall be from the chord to post connection to the top of base plate.
- For twin post truss-type upright post that is subject to axial compression, bending moment, shear, and torsion the post shall satisfy Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals Equations 5-17, 5-18 and 5-19. To reduce the effects of secondary bending, in lieu of Equation 5-18, the following equation may be used:

$$\frac{f_a}{F_a} + \frac{f_b}{\left(1 - \frac{0.6 f_a}{F_é}\right) F_b} + \left(\frac{f_v}{F_v}\right)^2 \leq 1.0$$

Where
fa = Computed axial compression stress at base of post

- The base plate thickness for all uprights and poles shall be a minimum of 2" but not less than that determined by the following criteria and design.
  - Case 1 Circular or rectangular solid base plates with the upright pole welded to the top surface of base plate with full penetration butt weld, and where no stiffeners are provided. A base plate with a small center hole, which is less than 1/5 of the upright diameter, and located concentrically with the upright pole, may be considered as a solid base plate.
  The magnitude of bending moment in the base plate, induced by the anchoring force of each anchor bolt shall be calculated using equation M = (P x D1) / 2.
- Case 2 Circular or rectangular base plate with the upright pole socketed into and attached to the base plate with two lines of fillet weld, and where no stiffeners are provided, or any base plate with a center hole that is larger in diameter than 1/5 of the upright diameter.

The magnitude of bending moment induced by the anchoring force of each anchor bolt shall be calculated using equation M = P x D2.

- M, bending moment at the critical section of the base plate induced by one anchor bolt
- P, anchoring force of each anchor bolt
- D1,horizontal distance between the center of the anchor bolt and the outer face of the upright, or the difference between the radius of the bolt circle and the outside radius of the upright
- D2,horizontal distance between the face of the upright and the face of the anchor bolt nut

- The critical section shall be located at the face of the anchor bolt and perpendicular to the radius of the bolt circle. The overlapped part of two adjacent critical sections shall be considered ineffective.
- The thickness of base plate of Case 1 shall not be less than that calculated based on formula for Case 2.
- Uprights, foundations, and trusses shall be designed in accordance with the DMS Foundation Special Provision for the effects of torsion. Torsion shall be considered from dead load eccentricity of these attachments, as well as for attachments such as access platforms, supporting brackets, etc., that add to the torsion in the assembly. Truss vertical and horizontal truss diagonals in particular and any other assembly members shall be appropriately sized for these loads.
- Uprights, foundations, and trusses shall be designed for the proposed sign wind area and future wind areas. The design shall consider the effect of torsion induced by the eccentric force location of the center of wind force above (or below) the center of the supporting truss. Truss vertical and horizontal truss diagonals in particular and any other assembly members shall be appropriately sized for these loads.

Fabricate the supporting structures using tubular members of either aluminum or steel, using only one type of material throughout the project.

Horizontal components of the supporting structures for overhead DMS must be of a truss design to support the DMS. Truss centerline must coincide with centerline of the DMS design area shown on the structure line drawing. Provide permanent camber in addition to dead load camber in accordance with the "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals." Indicate on the shop drawings the amount of camber provided and the method employed in the fabrication of the support to obtain the camber.

For all U-bolt connections of hanger beams to overhead assembly truss chords, provide all U-bolts with a flat washer, a lock washer and double nuts at each end of the U-bolts. All double nuts that are on any U-bolt shall be the same thickness and weight. When assembled, the double nuts shall be brought tight against each other by the use of two wrenches.

Fabricate attachment assemblies for the mounting DMS in a manner that allows easy removal of the sign.

C.2. DMS Access Platform for Pedestal Structure

For walk-in enclosures, provide an access platform a minimum of three feet wide with open skid resistant surface and safety railings on the DMS assemblies for access to the DMS inspection door. Provide platforms with fixed safety railings along both sides from the beginning of the platform to the inspection door.

Ensure the design, fabrication and installation of the access platforms complies with the following:

1. The top of the walkway grading surface is vertically aligned with the bottom of the DMS door.
2. The DMS door will open 90-degrees from its closed position without any obstruction from the platform or safety handrails.
3. The platform is rigidly and directly connected to the platform brackets and there is no uneven surface between sections.
4. Install a 4" x 4" safety angle parallel to and along both sides of the platform and extend it the entire length of the platform. Design the safety angle to withstand loading equivalent to the platform.
5. Ensure the platform design allows full access to the DMS enclosure inspection door with no interference or obstructions.

C.3. DMS Access Ladder

Provide a fixed ladder, of the same material as the pedestal structure, leading to the access platform. Equip the ladder with a security cover (ladder guard) and Corbin #2 lock to prohibit access by unauthorized persons. Start the first ladder rung no more than 18 inches above finished ground and end it at the access platform. Design the rungs on 12-inch center to center typical spacing. Attach the security cover approximately 6 feet above the finished ground. Design the ladder and security cover as a permanent part of the DMS assembly and include complete design details in the DMS assembly shop drawings. Fabricate the ladder and cover to meet all OSHA requirements and applicable state and local codes, including but not limited to providing a ladder cage. Attached the bottom of the ladder to a concrete pad a minimum of 4 inches deep, 24 inches wide, and 36 inches long.

C.4. Anchor Rod Assembly

Attach the DMS structure to concrete foundations by the use of straight galvanized anchor rods with galvanized heavy hex nuts and flat washers. The rods, nuts and flat washers shall be galvanized in accordance with AASHTO M232. Provide anchor rods that have an anchor plate or flat washers with nut at the end to be embedded in concrete. Use a minimum of eight anchor rods.

Ensure material used in steel anchor rods conforms to AASHTO M 314 or ASTM F1554, and the specified yield strength does not exceed 55,000 psi. Compute the required projection of the anchor rod above the foundation top. Compute the total projection based on the following:

- Provide between 3 and 5 threads of anchor rod projection above the top nut after tightening is complete. Avoid any additional projection, or a normal depth socket torque wrench shall not be used on top nuts.
- Include the sum of the thickness of top nut, top nut flat washer or top nut beveled washers, base plate, leveling nut flat washer or leveling nut beveled washers, leveling nut.
- Set the maximum distance between the bottom of the leveling nut and the foundation top to one nut height to avoid excessive bending stresses in the anchor rod under service conditions.
- Do not use lock washers.

C.5. Anchor Rod Nut Tightening Requirements for Metal Poles

C.5.1. Prior to installation

Protect the anchor rod threads from damage prior to installation and during installation.

Prior to installation of the rods in the foundation, turn nuts onto and off the rods, well past the elevation of the bottom of the leveling nuts. Turn by the effort of one worker using an ordinary wrench without a cheater bar. Report any thread damage to the Engineer.

C.5.2. <u>During installation</u>

1. Place leveling nuts (bottom nuts) on the anchor rods.

2. Place leveling nut washers on top of the anchor rod leveling nuts.

3. Place a rigid template on top of the leveling nuts to check the level of the nuts. Use beveled washers if the anchor nut and washer cannot be brought into firm contact with the template.

4. Verify that the distance between the bottom of the leveling nut and the top of the concrete foundation is no more than one anchor rod diameter. If an upright is required to be back-raked, then the distance between the bottom of the leveling nut and the top of the concrete foundation should be no more than one anchor rod diameter, averaged over the anchor rod group.

5. Place the base plate and structural element to which it is attached. However, do not attach to the upright element, during tightening of the anchor nuts, cantilever beams or arms with span in excess of 10 feet.

6. Place top nut washers.

7. Do not use lock washers.

8. Lubricate threads and bearing surfaces of top nuts with beeswax, stick paraffin, or other approved lubricant.

9. Place top nuts. Use beveled washers if the anchor nut and washer cannot be brought into firm contact with the base plate.

10. Tighten top nuts to snug tight. A snug-tight condition is defined as the washer and nut being in full contact with the base plate, and the application of the full effort of a workman on a 12-in wrench. Turn top nuts in increments following a star pattern (using at least two full tightening cycles).

11. To ensure proper pre-tensioning, after all top nuts have been brought to snug-tight condition, repeat the procedure on the leveling nuts. Turn leveling nuts in increments following a star pattern (using at least two full tightening cycles).

12. At this point, verify if beveled washers are required. Beveled washers are necessary under the leveling nut or top nut if any face of the base plate has a slope greater than 1:20 and/or any nut can not be brought into firm contact with the base plate.

13. Before further nut turning, make the reference position of the nut in the snug-tight condition with a suitable making (ink or paint that is not water-soluble). Mark on the corner at the intersection

of two flats with a corresponding reference mark on the plate at each nut. After tightening, verify the nut rotation.

14. Achieve pre-tensioning by turn-of-nut method. Turn the top nuts to 1/6 of a turn. Do so in a star pattern using at least two full-tightening cycles.

15. After installation, ensure that firm contact exists between the anchor rod nuts, washers, and base plate on any anchor rod installed.

16. For overhead DMS assemblies: The span type truss or the cantilever truss may be placed on the uprights or attached to the upright at this time.

17. After a period of no less than 4 days, and no more than 2 weeks, and in the presence of the Engineer, use a torque wrench to verify that a torque at least equal to 600 foot-pounds is provided on each top nut. For DMS cantilever or pedestal structures, verify the torque after erection of the remainder of the structure and attaching the DMS to the structure.

18. If any top nut torque reveals less than 600 foot-pounds of effort is required to move the nut, then tighten the nut to no less than 600 foot-pounds.

19. Calibrate the torque indicator on the wrench used for tightening the nuts annually if the project construction extends over a 12 month period. Provide the Engineer with certification of the calibration.

20. Do not place grout under the base plate.

34.4. MEASUREMENT AND PAYMENT

Pedestal structure for (___) DMS will be measured and paid as the actual number of dynamic message sign assemblies furnished, installed, and accepted. Payment includes all design, fabrication, construction, transportation, and attachment of the complete dynamic message sign assemblies, supporting structure, hardware, access platform, direct tension indicators, preparing and furnishing shop drawings, additional documentation, incidentals, and all other equipment and features necessary to furnish the system described above.

DMS Access Ladder will be measured and paid as the actual number of DMS access ladders and cover guards furnished, installed and accepted. Payment includes design, fabrication, transportation, and attachment to the DMS assemblies as described above.

Payment will be made under:

Pedestal Structure for Walk-In DMS .... Each

Pedestal Structure for Front Access DMS ....Each

DMS Access Ladder ....Each

35. DMS FOUNDATION

35.1. DESCRIPTION

This section consists of the design and construction of DMS foundations in accordance with the submitted, approved plans and the requirements of these Project Special Provisions. Design and construct either spread footing type foundations and/or drilled pier type foundations for each DMS unless otherwise directed by the Engineer.

35.2. MATERIAL

Portland Cement Concrete Production and Delivery	Section 1000
Reinforcing Steel	Section 1070
Anchor Bolts	Article 1072-6
Structural Steel and Overhead Sign Structures	Section 1072 and 1096

35.3. CONSTRUCTION METHODS

A. General

A North Carolina Licensed Professional Engineer must seal all design calculations, drawings and recommendations. Design foundations for the effects of dead, wind and ice loads in accordance with the wind zone load shown in the Plans and Section 3 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (including interims). Use either spread footing or drilled pier foundations. In some instances, conflicts with drainage structures may dictate a certain type of foundation. Spread footings or dual drilled pier foundations are required for full span overhead signs (no single drilled pier foundations). When designing dual drilled pier foundations, a rectangular grade beam with a moment of inertia approximately equal to either of the drilled piers is required to connect the pier tops.

Provide reinforced concrete design in accordance with either Section 13.7.2 or 13.6.2 (whichever is applicable), allowable stress design method, of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (including interims).

Consider sloping ground in the design, if applicable. Do not exceed an allowable bearing pressure of 3 ksf for spread footings. For drilled pier foundations, do not exceed an allowable lateral soil pressure of 4 ksf for AASHTO Group II Loading. Use the following default soil parameters and groundwater elevation for foundation design in the absence of a site-specific subsurface investigation in accordance with this provision.

- Total Unit Weight = 120 pcf
- Friction Angle = 30 degrees
- Cohesion = 0 psf

Assume the groundwater elevation is at a depth of 7 feet below the ground surface. If the groundwater is encountered at a depth shallower than 7 feet, the overhead sign foundation must be redesigned based upon the actual field conditions. The default soil parameters and allowable pressures do not apply to very soft or loose soil, muck (generally, SPT blow counts per foot less than 4), weathered rock or hard rock (generally, SPT refusal). If soft or loose soil, muck, weathered rock or hard rock conditions are present, a site-specific subsurface investigation and foundation design is required in accordance with this provision.

Design spread footings in accordance with Sections 4.4.1 through 4.4.10, allowable stress design method, of the AASHTO Standard Specifications for Highway Bridges (including interims). Restrict uplift due to the eccentricity of the loading to one corner of the footing and the tension area may not exceed 25% of the total bearing area of the spread footing.

Design drilled piers in accordance with Sections 4.6.1 through 4.6.5, allowable stress design method, of the AASHTO Standard Specifications for Highway Bridges (including interims). If drilled piers are designed for skin friction only, increase the required length of each drilled pier a minimum of 6 inches to allow for sediment. If drilled piers are designed for end bearing, no additional length is required; however, the drilled piers will be subject to the cleanliness requirements in Section B under "Drilled Pier Construction:" below. Clearly state in the Plans whether end bearing was accounted for in the foundation design.

Calculate expected vertical, lateral and torsional movements for single drilled pier foundations. Provide drilled pier foundations that result in a horizontal lateral movement of less than 1 inch at the top of the pier and a horizontal rotational movement of less than 1 inch at the edge of the pier. Also, use a factor of safety of 2.0 for lateral and torsion failure. Preliminary design methods described in Section 13.6.1.1 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (including interims) may be used to incorporate a factor of safety in foundation design for lateral failure. Wings are required to increase torsion resistance for cantilever signs supported by a single drilled pier.

If a site-specific subsurface investigation is performed, use only a NCDOT Pre-Qualified Geotechnical Engineering Firm to provide a site specific foundation design.

B. Subsurface Investigation

If the default soil parameters or allowable pressures referenced above are not applicable for a given overhead sign foundation site, the Engineer may require a site-specific subsurface investigation. If the Engineer requires a site-specific subsurface investigation, the Department will perform the borings and provide the data to the Contractor. The subsurface investigation will be provided within two weeks of being notified by the Contractor that the site is at rough grade and accessible to a drill rig.

The Contractor may elect to conduct a site specific subsurface investigation at each proposed overhead sign foundation location in accordance with the requirements listed below, in lieu of using the default soil parameters and allowable pressures referenced above. If the Contractor elects to conduct a site-specific subsurface investigation, the costs of the investigation will be considered incidental to the "Footings for DMS Structure" pay item.

Perform a boring at each overhead sign foundation location and provide boring data on an NCDOT Standard Boring Log form. Download this form from the NCDOT site at http://www.ncdot.org/doh/preconstruct/highway/geotech/contractserv/investigation/Documents/BoringLogs.zip. A licensed geologist or a professional engineer registered in the State of North Carolina and employed by an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm must seal each boring log. Use only an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm to conduct the subsurface investigation. Perform the investigation only after rough grade (within 3 feet of final grade) is achieved. Locate each boring within 3 feet of the center of the overhead sign foundation. Drill the boring to a minimum depth of 10 feet below the required spread footing bearing or drilled pier tip elevation, whichever is deeper. Conduct Standard Penetrating Tests at 1 ft, 2.5 ft, 5 ft, 7.5 ft, 10 ft, and every 5-ft after 10 ft below the rough grade in accordance with ASTM D-1586. A boring may be terminated above the minimum depth required (10 ft below the foundation elevation) if one of the following conditions occur: (a) a total of 100 blows have been applied in any 2 consecutive 6-in.intervals; (b) a total of 50 blows have been applied with less than 3" penetration.

C. Foundation Construction

Excavate footings for overhead sign structures in accordance with the applicable provisions of Section 410 of the Standard Specifications. Construct footings for overhead sign structures in accordance with Section 825 of the Standard Specifications. Construct all footings with Class A concrete. Where rectangular forms are used, use forms that have a chamfer strip at all corners for at least that distance protruding above finished ground. Use chamfers, which measure 1 inch along the diagonal face.

Securely brace anchor bolts positioned in the form and hold in proper position and alignment. Provide a rubbed finish on concrete surfaces to be exposed above finished ground in accordance with Section 825-6 (D) of the 2006 Standard Specifications. Do not erect overhead sign structures on foundations until the concrete has reached a minimum compressive strength of 3000 psi. Determine concrete compressive strength by nondestructive test methods or compressive strength tests made in accordance with AASHTO T22 and T23. Furnish equipment used for nondestructive tests and obtain Engineer's approval before performing the tests.

D. Drilled Pier Construction

D.1. Excavation

Perform excavations for drilled piers to the required dimensions and lengths including all miscellaneous grading and excavation necessary to install the drilled pier. Depending on the subsurface conditions encountered excavation in hard rock, weathered rock or removal of boulders and debris may be required.

Dispose of drilling spoils as directed by the Engineer and in accordance with Section 802 of the 2006 Standard Specifications. Drilling spoils consist of all material excavated including water or slurry removed from the excavation either by pumping or with augers.

Construct drilled piers within the tolerances specified herein. If tolerances are exceeded, provide additional construction as approved by the Engineer to bring the piers within the tolerances specified. Construct drilled piers such that the axis at the top of the piers is no more than 3 inches in any direction from the specified position. Build drilled piers within 1% of the plumb deviation for the total length of the piers. When a grade beam is not required at the top of a pier, locate the top of pier elevation between 18 inches above and 6 inches above the finished grade elevation. Form the top of the pier such that the concrete is smooth and level.

If unstable, caving or sloughing soils are anticipated or encountered, stabilize drilled pier excavations with steel casing and/or polymer slurry. Steel casing may be either the sectional type or one continuous corrugated or non-corrugated piece. All steel casings should consist of clean watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill. Use steel casings with an outside diameter equal to the specified pier size and a minimum wall thickness of 1/4 inch. Extract all temporary casings during concrete placement in accordance with this provision unless the Contractor chooses to leave the casing in place in accordance with the requirements below.

Any steel casing left in place will be considered permanent casing. When installing permanent casing do not drill or excavate below the tip of the permanent casing at any time such that the permanent casing is against undisturbed soil. The Contractor may excavate a hole with a minimum diameter of 12 inches smaller than the specified size of the pier in order to facilitate permanent casing installation provided the sides of the excavation do not slough during drilling such that the hole diameter becomes larger than the inside diameter of the casing. Permanent steel casings are only allowed for full span overhead signs as approved by the Engineer and prohibited for cantilever overhead signs. No additional compensation will be paid for permanent casing. If the Contractor chooses to use permanent steel casing, include all casing costs in the "Footings for DMS Structure" pay item.

If the Contractor elects to use polymer slurry to stabilize the excavation, use one of the polymers listed in the table below:

PRODUCT	MANUFACTURER
SlurryPro EXL	KB Technologies Ltd 3648 FM 1960 West Suite 107 Houston, TX 77068 (800) 525-5237
Super Mud	PDS Company 105 West Sharp Street El Dorado, AR 71730 (800) 243-7455
Shore Pac GCV	CETCO Drilling Products Group 1500 West Shure Drive Arlington Heights, IL 60004 (800) 527-9948

Use slurry in accordance with the manufacturer's guidelines and recommendations unless approved otherwise by the Engineer. The Contractor should be aware that polymer slurry might not be appropriate for a given site. Polymer slurry should not be used for excavations in very soft or loose soils. If the excavation can not be stabilized with polymer slurry, the Engineer may require a site-specific subsurface investigation (if not done during design) and the use of steel casing. No additional time or compensation will be provided if both steel casing and polymer slurry are required to stabilize the excavation.

Construct all drilled piers such that the piers are cast against undisturbed soil. If a larger casing and drilled pier are required as a result of unstable or caving material during drilling, backfill the excavation before removing the casing to be replaced. No additional time or compensation will be provided for substituting a larger diameter drilled pier in order to construct a drilled pier cast against undisturbed soil.

Any temporary steel casing that becomes bound or fouled during pier construction and cannot be practically removed may constitute a defect in the drilled pier. Improve such defective piers to the satisfaction of the Engineer by removing the concrete and enlarging the drilled pier, providing a replacement pier or other approved means. All corrective measures including redesign as a result of defective piers will not be cause for any claims or requests for additional time or compensation.

D.2. Bottom Cleanliness

After a drilled pier excavation is complete and immediately before concrete placement, demonstrate acceptable bottom cleanliness of the drilled pier excavation to the Engineer for approval if the plans indicate end bearing was used in the design. Provide any equipment, personnel and assistance required for the Engineer to inspect the drilled pier excavation. The pier excavation bottom is considered clean if no portion of the bottom area has more than 3 inches of sediment as determined by the Engineer.

D.3. Reinforcing Steel

Completely assemble a cage of reinforcing steel consisting of longitudinal and spiral bars and place cage in the drilled pier excavation as a unit immediately upon completion of drilling unless the excavation is entirely cased. If the drilled pier excavation is entirely cased down to the tip, immediate placement of the reinforcing steel and the concrete is not required.

Lift the cage so racking and cage distortion does not occur. Keep the cage plumb during concrete placement operations and casing extraction. Check the position of the cage before and after placing the concrete.

Securely crosstie the vertical and spiral reinforcement at each intersection with double wire. Support or hold down the cage so that the vertical displacement during concrete placement and casing extraction does not exceed 2 inches.

Do not set the cage on the bottom of the drilled pier excavation. Place plastic bolsters under each vertical reinforcing bar that are tall enough to raise the rebar cage off the bottom of the drilled pier excavation a minimum of 3 inches.

In order to ensure a minimum of 3 inches of concrete cover and achieve concentric spacing of the cage within the pier, tie plastic spacer wheels at five points around the cage perimeter. Use spacer wheels that provide a minimum of 3 inches "blocking" from the outside face of the spiral bars to the outermost surface of the drilled pier. Tie spacer wheels that snap together with wire and allow them to rotate. Use spacer wheels that span at least two adjacent vertical bars. Start placing spacer wheels at the bottom of the cage and continue up along its length at maximum 10-foot intervals. Supply additional peripheral spacer wheels at closer intervals as necessary or as directed by the Engineer.

D.4. Concrete

Begin concrete placement immediately after inserting reinforcing steel into the drilled pier excavation.

D.4.1. <u>Concrete Mix</u>

Provide the mix design for drilled pier concrete for approval and, except as modified herein, meeting the requirements of Section 1000 of the 2006 Standard Specifications.

Designate the concrete as Drilled Pier Concrete with a minimum compressive strength of 4500 psi at 28 days. The Contractor may use a high early strength mix design as approved by the Engineer. Make certain the cementitious material content complies with one of the following options:

- Provide a minimum cement content of 640 lbs/yd3 and maximum cement content of 800 lbs/yd3; however, if the alkali content of the cement exceeds 0.4%, reduce the cement content by 20% and replace it with fly ash at the rate of 1.2 LB of fly ash per LB of cement removed.
- If Type IP blended cement is used, use a minimum of 665 lbs/yd3 Type IP blended cement and a maximum of 833 lbs/yd3 Type IP blended cement in the mix.

Limit the water-cementitious material ratio to a maximum of 0.45. Do not air-entrain drilled pier concrete.

Produce a workable mix so that vibrating or prodding is not required to consolidate the concrete. When placing the concrete, make certain the slump is between 5 and 7 inches for dry placement of concrete or 7 and 9 inches for wet placement of concrete.

Use Type I or Type II cement or Type IP blended cement and either No. 67 or No. 78M coarse aggregate in the mix. Use an approved water-reducer, water-reducing retarder, high-range water-reducer or high-range water-reducing retarder to facilitate placement of the concrete if necessary.

Do not use a stabilizing admixture as a retarder in Drilled Pier Concrete without approval of the Engineer. Use admixtures that satisfy AASHTO M194 and add admixtures at the concrete plant when the mixing water is introduced into the concrete. Redosing of admixtures is not permitted.

Place the concrete within 2 hours after introducing the mixing water. Ensure that the concrete temperature at the time of placement is 90°F or less.

D.4.2. Concrete Placement

Place concrete such that the drilled pier is a monolithic structure. Temporary casing may be completely removed and concrete placement may be temporarily suspended when the concrete level is within 42 to 48 inches of the ground elevation to allow for placement of anchor bolts and construction of grade beam or wings. Do not pause concrete placement if unstable caving soils are present at the ground surface. Remove any water or slurry above the concrete and clean the concrete surface of all scum and sediment to expose clean, uncontaminated concrete before inserting the anchor bolts and conduit. Resume concrete pouring within 2 hours.

Do not dewater any drilled pier excavations unless the Engineer approves the dewatering and the excavation is entirely cased down to tip. Do not begin to remove the temporary casing until the level of concrete within the casing is in excess of 10 feet above the bottom of the casing being removed. Maintain the concrete level at least 10 feet above the bottom of casing throughout the entire casing extraction operation except when concrete is near the top of the drilled pier elevation. Maintain a sufficient head of concrete above the bottom of casing to overcome outside soil and water pressure. As the temporary casing is withdrawn, exercise care in maintaining an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the drilled pier concrete. Exerting downward pressure, hammering or vibrating the temporary casing is permitted to facilitate extraction.

Keep a record of the volume of concrete placed in each drilled pier excavation and make it available to the Engineer.

After all the pumps have been removed from the excavation, the water inflow rate determines the concrete placement procedure. If the inflow rate is less than 6 inches per half-hour, the concrete placement is considered dry. If the water inflow rate is greater than 6 inches per half-hour, the concrete placement is considered wet.

- Dry Placement: Before placing concrete, make certain the drilled pier excavation is dry so the flow of concrete completely around the reinforcing steel can be certified by visual inspection. Place the concrete by free fall with a central drop method where the concrete is chuted directly down the center of the excavation.

- Wet Placement: Maintain a static water or slurry level in the excavation before placing concrete. Place concrete with a tremie or a pump in accordance with the applicable parts of Sections 420-4 and 420-5 of the 2006 Standard Specifications. Use a tremie tube or pump pipe made of steel with watertight joints. Passing concrete through a hopper at the tube end or through side openings as the tremie is retrieved during concrete placement is permitted. Use a discharge control to prevent concrete contamination when the tremie tube or pump pipe is initially placed in the excavation. Extend the tremie tube or pump pipe into the concrete a minimum of 5 feet at all times except when the concrete is initially introduced into the pier excavation. If the tremie tube or pump pipe pulls out of the concrete for any reason after the initial concrete is placed, restart concrete placement with a steel capped tremie tube or pump pipe.

Once the concrete in the excavation reaches the same elevation as the static water level, placing concrete with the dry method is permitted. Before changing to the dry method of concrete placement, remove any water or slurry above the concrete and clean the concrete surface of all scum and sediment to expose clean, uncontaminated concrete.

Vibration is only permitted, if needed, in the top 10 feet of the drilled pier or as approved by the Engineer. Remove any contaminated concrete from the top of the drilled pier and wasted concrete from the area surrounding the drilled pier upon completion.

D.4.3. Concrete Placement Time

Place concrete within the time frames specified in Table 1000-2 of the 2006 Standard Specifications for Class AA concrete except as noted herein. Do not place concrete so fast as to trap air, water, fluids, soil or any other deleterious materials in the vicinity of the reinforcing steel and the annular zone between the rebar cage and the excavation walls. Should a delay occur because of concrete delivery or other factors, reduce the placement rate to maintain some movement of the concrete. No more than 45 minutes is allowed between placements.

E. Scheduling and Restrictions

If caving or sloughing occurs, no additional compensation will be provided for additional concrete to fill the resulting voids.

During the first 16 hours after a drilled pier has achieved its initial concrete set as determined by the Engineer, do not drill adjacent piers, do not install adjacent piles and do not allow any heavy construction equipment loads or "excessive" vibrations to occur at any point within a 20 foot radius of the drilled pier.

In the event that the procedures described herein are performed unsatisfactorily, the Engineer reserves the right to shut down the construction operations or reject the drilled piers. If the integrity of a drilled pier is in question, use core drilling, sonic or other approved methods at no additional cost to the Department and under the direction of the Engineer. Dewater and backfill core drill holes with an approved high strength grout with a minimum compressive strength of 4500 psi. Propose remedial measures for any defective drilled piers and obtain approval of all proposals from the Engineer before implementation. No additional time or compensation will be provided for losses or damage due to remedial work or any investigation of drilled piers found defective or not in accordance with these Project Special Provisions or the Plans.

35.4. MEASUREMENT AND PAYMENT

Footings for DMS structure will be measured and paid as the actual number of cubic yards of concrete that has been incorporated into the completed and accepted footing. Computing the number of cubic yards of concrete will be done from the dimensions shown in the Plans or from revised dimensions authorized by the Engineer, calculated to the nearest 0.01 of a cubic yard.

Payment will be made under:

Footings for DMS Structure.. Cubic Yards

36. SYSTEM SOFTWARE

36.1. 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 (latest IP version of NCDOT's state-licensed OASIS software package). The Engineer will furnish the latest version of the software at the time of burn-in. Request the software from the Engineer a minimum of five business days prior to burn-in.
- DMS Control Software (Version 4 of NCDOT's state-licensed client-server Daktronics Vanguard Professional software). The Engineer will furnish the software at the time of installation. Request the software from the Engineer a minimum of five business days prior to installation.

The Contractor shall be responsible for the development of and integration of all system graphics (and associated system devices) described in the following specifications.

36.2. FUNCTIONAL REQUIREMENTS

A. General

The overall architecture of the system shall be a client server design based on hybrid centralized/distributed intersection control concepts.

Processing shall be distributed and the communications protocol of the state-licensed local controller software shall be used for all intersection controller interfaces. Client workstations shall access networked file servers that perform traffic management, system communications, database management, and system graphics.

The system shall be implemented using standard, commercially available computer hardware required in Section 37 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.

The software shall be portable, as a minimum, across multiple PC hardware platforms and shall be 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, and common office productivity software products.

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 and current day light savings time dates automatically without user intervention or adjustment.

A.1. Local Area Network Requirements

A 10/100/1000 Base-T Ethernet, local area network (LAN) shall support the distributed client/server architecture. The requirements for the LAN are in Section 38 of these Project Special Provisions.

The software shall allow for a minimum of sixteen (16) simultaneous users (including remote users) of the traffic signal system applications software. No degradation in system performance shall occur when sixteen operators use the system simultaneously. Each user, subject to his or her security level, shall have full access for system control, database entry/examination, malfunction diagnosis, system operation evaluation and measures of effectiveness analysis. Access by any particular user to any particular command shall be allowed or disallowed based upon that user's assigned security level.

A.2. Software License

Provide a perpetual, irrevocable software license to the Department and the City of Jacksonville that gives them the right to copy and use the distributed processing software furnished with this project at any facility within the 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 TMC/City Hall building, City of Jacksonville Signal Shop, NCDOT Division 3, 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 of the Jacksonville signal system.

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 copyrighted commercial off-the-shelf (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 Jacksonville 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 the latest revision available as recommended by the supplier of the system software.

The network operating system (NOS) shall 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 and all other software (video, cellular, productivity, LAN, etc.).

B. Distributed Processing Signal System Software

B.1. General

The signal system software shall not be 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 the local intersection 2070 controllers installed under this project. The use of remote communication units (RCUs) is not permitted. The signal system software shall interface with the latest IP version of NCDOT's state-licensed local controller software package. The system shall use a client-server design based on hybrid centralized/distributed intersection control.

The 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 alarms or malfunction indicators, diagnosing component failures, and manually "fine-tuning" new timing plans.

The software shall provide central monitoring of up to 1000 intelligent controllers. The system design shall accommodate future expansion. The addition of new intersections and detectors, in the field, shall not require additional software or central hardware and shall require only modification of the control database. The software design shall facilitate the easy, future incorporation of additional control strategy, software logic, and additional system features.

All changes to the system, including adding new controllers, configuring communications, modifying maps and intersection displays, etc., shall be performed through the system graphical user interface or by updating files in the system software folders. The use of initialization files and external editors shall not be required.

A laptop utility program shall provide on-street accessibility to off-line controllers.

B.2. Start-Up and Shut-Down

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.

The traffic control system shall accommodate a planned shutdown of the monitoring functions of the traffic control software.

B.3. Power Failure

Interface system software with the uninterruptible power supply. Upon detection of a loss of power, the system software shall notify the operator.

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.4. Backup Intersection Operation

The system shall provide for backup intersection 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.

When operating by centrally controlled scheduled events, the local controllers shall automatically implement local TBC, according to the day plan programmed into the controller whenever communication to central is absent.

When operating by centrally controlled manual commands, the local controllers shall continue to run according to those commands regardless of the state of communications.

B.5. Clock Updates

Upon login, each workstation clock shall be automatically updated by the Microsoft Windows operating system to the current time of the distributed system server clock.

B.6. Remote Access

The system shall allow full access to the system for a multiple user by means of Ethernet access through a secured firewall, using means approved by the department. The remote user shall be allowed to perform any functions and available to any other user with the same level of security regardless to where the user is physically located.

B.7. Paging

The system shall be capable of automatically sending alphanumeric messages (SMS – text messaging) to cellular telephones and email addresses upon detecting problems with the system or from any device. Malfunctions notifications shall also appear as a pop-up alarm, or similar notification approved by the department, on each workstation logged into the system. An audible alert shall be associated with a pop-up alarm, and configurable by the user.

The visual pop-ups and audible alerts shall be configurable to stay up for a specified time period or to stay up indefinitely until closed by the user. Malfunction notifications shall consist of at least three (3), user configurable, priority levels, to include low priority, medium priority and high priority alerts. Acknowledgements of incoming malfunction alarms shall be required for all medium and high priority on-screen notifications. Low priority alarm notifications shall not require acknowledgements.

Malfunction alerts shall be sent via text (SMS) or email notifications and shall be configurable by TOD/DOW, allowing recipients to be selected based upon severity or priority of event and to issue text/email messages sent to multiple devices or addresses.

Notifications shall allow a confirmation to assure that the malfunction has been acknowledged. If no acknowledgement is received upon expiration of a user programmable time-out period, subsequent notifications shall be configurable to be sent to alternate devices.

The system shall log all malfunction notifications, retries, and acknowledgements with time and date stamps. The first acknowledgement shall be recorded; all others shall be ignored.

B.8. Field Communications

Within the Jacksonville computerized signal system, traffic signal controllers will be integrated with field Ethernet switches that are arranged in a multi-drop communications channels capable of supporting a minimum twenty (20) traffic signal controllers on a dedicated communications channel. Each controller is connected to the system via a pair of optical fibers and field Ethernet switch. A channel consists of two fibers: one transmitting and the other receiving.

Each channel with its boundaries and the controllers and ITS devices contained within it are depicted on the cable schematic diagram shown in the Plans.

B.9. Database Preparation

Complete all data entry necessary to implement the operation of the system software.

The Engineer will furnish intersection timing information and coordination parameters (cycle, split, offset). Any custom intersection displays will also be provided by the Department or City. Otherwise, default intersection timing data and standard intersection maps will be utilized when configuring intersections onto the system. Program all system detectors shown in the plans. Coordinate with the City to provide setup, naming/labeling, logging and any features required for the operation of all system detectors.

TOW/DOW plans, alarms and other information for the operation of the signal system shall be entered by the contractor.

B.10. System Function Monitoring

Verification of on-street system operation shall be incorporated in the new signal system. Operation of all controller equipment shall be monitored, with current displays and malfunctions reported in near real-time. Continuous, polled communication shall occur from the local controller to the communication server.

B.11. Database Backup and Restoration

The system shall a simple means of copying the database files from the hard disk to a removable storage device. All files required to restore the system to operation without the need to manually re-enter data shall be included on removable storage device.

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 the removable storage device. The system shall enable an operator to copy all selected detector data to the removable storage device.

The software shall provide simple, straightforward means for restoring system operation from the backup database files.

B.12. Graphical User Interface

An object-oriented, graphical user interface (GUI) shall be provided to control and access all systems displays, reports, and dialogue boxes. The GUI shall provide access to all signal system monitoring and control options from a single screen.

Graphical icons shall be used on the displays to represent system devices. The icons shall provide easy access to traffic control data (signal timing, geometric, etc.), real-time data (intersection, link status, etc.), the database, and graphical image files.

The GUI shall include an intersection/link base map with windowed table reports and management input windows. The GUI shall provide interactive mechanisms to assist in creating, editing, and modifying editable dynamic graphic screens that are linked to system dynamic elements. As a result, all operator actions shall be immediately visible as a change in the system graphic.

The workspace session window shall display a toolbar near one of the window borders. The toolbar shall contain buttons and other controls specific for actions relating to a selected window. Actions supported by and pertaining to an active window shall be invoked through the toolbar, action bars, menu selection, popup menu or controls internal to the window itself.

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.

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).

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 graphics objects directly to system database elements without low level code programming, use of initialization files, or program 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 zoomed levels, on the system map.

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 refresh rate of one second.

B.12.1. System Graphics

These dynamic condition maps shall provide a simple mechanism for system navigation, presentation of status, and selections within the user interface.

Backgrounds for the system-wide graphic shall be capable of containing commercial vector images of geographically accurate maps or scanned images. These images shall be compatible with common GIS software packages. These images shall be used as the display layers of real-time graphics displays.

Backgrounds for the control section and intersection displays shall be .bmp or .jpg formats. Resolution or file size shall not be limited.

Zooming, scrolling and automatic control layers of graphic presentations shall be included with the system.

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.12.2. System Map

The GIS-based system-wide map or approved equivalent shall provide a dynamic display of the entire surveillance area and any layers the agency requires, including but not limited to interstate highways, major arterial roads, railroads, jurisdiction boundaries, and bodies of water. It shall be possible to "zoom in" and "drill down" 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.

It shall be possible to display intersection icons in different formats, using the menu bar. The system map shall provide a dynamic display of the signal system signalized intersections in the following two modes:

- Intersection phasing
- Intersection plan

The graphic shall also dynamically display the status of the controllers (e.g., coordination, emergency vehicle preemption, railroad preemption, transition, free operation, flashing, failure, intersection phase status). Intersection status and roadway links shall change color dynamically based on user definable color selection.

Intersection phase status (green, yellow and red) shall be displayed in real-time on the intersection phasing icon. The intersection control status shall be displayed as the background color on the intersection plan icon. Intersection plan information shall be displayed as a number on the intersection plan icon.

Link status shall be shown as different (user defined) colors for differing traffic flow conditions.

The system 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.

B.12.3. Control Section Map

Create default subsection maps/zones or areas to provide a display. The default displays will be called Control section maps, and shall provide a more detailed display of selected zones or areas of the system. A Control section shall be able to be called from the system map display via a double mouse click or from a drop down menu. 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 levels 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 City 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. Submit a sample of a Control Section display or map for review by the Engineer.

B.12.4. Intersection Display

The Contractor shall be responsible for the development of and integration of all system graphics (and associated system devices) described in the following specifications.

The intersection graphic shall display both static and dynamic information. The static information shall include the intersection name, geometrics of the intersection (including a graphic display of the number of lanes and their associated use), adjacent land use, the location of the controller, and a layout of the intersection with the intersections signal locations and number of heads. The dynamic information to be displayed shall include:

- All vehicle signal indications for each active phase, and up to sixteen (16) overlaps with red, yellow, and green indicators
- All pedestrian signal indications, for up to sixteen (16) active phases. WALK, flashing DONT WALK, and steady DONT WALK shall be shown
- Vehicle and pedestrian detector actuations for each active phase
- Cycle timer (central and local clocks)
- Timing plan in effect (with cycle length and offset)

Operational status of the intersection shall include the following, but not be limited to:

- Timing in effect (in coordination, TOD, TR, etc.)
- Status mode (transition, free operation, flash, pre-emption (railroad or emergency vehicle)
- Control mode (manual control, local control, failed, etc.)

The intersection display shall accommodate all phasing of the state-licensed local controller software.

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.

B.13. 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.

The software shall monitor for the following conditions:

B.13.1. 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.13.2. Communication Error

If communication between the communications server and local intersection is lost for a number of consecutive seconds, a failure shall be identified and an error message shall be logged and the intersection shall be dropped from system monitoring. Upon identification of a communications error, the software shall continuously attempt to re-establish communications to the intersection and regain monitoring of the intersection.

B.13.3. Flash Conditions

The system shall have the following flash mode capabilities:

- **Central Flash**: Individual intersections and control 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 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.

B.13.4. Local Preemption

The system shall monitor and recognize the occurrence of preemption at each local intersection. Accordingly, a preempted intersection shall not be erroneously diagnosed as having experienced a coordination failure. 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.).

B.13.5. Implemented Local Manual Control

Local manual control shall be initiated and controlled by hardware at the intersection. The software shall identity any intersection that is in local manual control by means of a status message. 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 normal operation and the system log messages shall be recorded at the start and end of local manual control condition.

B.13.6. Local and System Detectors

The system shall allow users to set up and gather detector data from local and system detectors for Traffic Responsive Operation or other analytical purposes.

The software shall be able to recognize and report failed detectors (e.g. constant call, no calls, etc.). A detector shall be automatically suspended from use if it is failed. Parameters for determining under counting, over counting, maximum presence shall be adjustable by the user. Detectors classified as marginal shall remain in use, but shall be identified. A change in classification to either failed or marginal 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. System detector activity reported from any local controller type shall be monitor for under counting, over counting, and maximum presence.

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 either acceptable or marginal, or until the operator enters a command that releases it from suspension.

Detector data smoothing shall be provided to prevent short-term fluctuations from incorrectly influencing traffic-responsive control algorithms. The system software shall automatically use historical data for the traffic-responsive control algorithms when detectors have been classified as failed.

B.13.7. Timing Plans

An intersection timing plan shall be defined as a unique combination of cycle length, split and offset at an intersection. The software shall monitor a minimum of sixty-four (64) timing plans for controllers. In addition, the software shall enable selection of both flashing and free operation of any intersection.

Cycle lengths, offsets, and splits shall be reported in one-second increments, or as a percentage of the cycle length if selected by the user.

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 reference. For each intersection on the system, the software shall recognize and display a message that local transition is in effect.

B.13.8. Phase Movements

The system shall monitor each independent movement of up to sixteen (16) phases, for the quad-ring controller. This monitoring shall include force off points, and permissive periods for each phase.

B.13.9. Clock Updates

Following each update of the clock on the communications server, the system shall update the clocks in each local controller and the distributed system server.

The system shall be able to receive clock updates from an external time synchronization source. Clock updates shall be demonstrated and approved by the Engineer. The system shall broadcast, unicast, or use a combination of both to send time updates to controllers on a user-configurable schedule. The user shall be able to configure how often the broadcast is performed, the hour at which the broadcast begins, the number of times the broadcast is repeated, and the time period between repeated broadcasts.

The system shall provide a means of monitoring the time drift of clocks on controllers, provided the controller supports this functionality.

For each controller that supports this functionality, the system shall allow checking controller clock times on a user-specified interval.

The system shall display the time the controller's clock was last checked and the difference between that controller clock and the system time reference.

The system shall also provide the ability to automatically synchronize a controller's clock if the time drift exceeds a user-specified threshold.

The system shall provide a means to synchronize controller clocks with the system time reference upon user command.

This functionality shall be provided in addition to the scheduled time broadcasts previously specified.

B.14. Intersection Control

The software shall allow any user to control and implement changes to any intersection controller via the GUI, either through scheduled events, manually controlled events, or time-of-day plans programmed in the local controller. All parameters and events that can be programmed from the controller front panel shall be available at central for remote implementation. Any aspect of the controller timing shall be assessable from central, and shall allow editing of all timings. Full upload and download of timings to controllers shall also be allowed.

B.14.1. Central Scheduler

It shall not be necessary to use a special function to implement any of the local controller's basic functions. These functions shall be inherited from the timing plans associated with each type of controller.

The system shall include a centrally based event scheduler that issues scheduled commands to controllers. The set of schedulable events shall include:

- Coordination Plans
- Software Flash
- Free Operation
- Local TOD
- Traffic Responsive Operation
- Special Functions (supported by local controller type)

The event scheduler shall support the following features:

- **Day Plans**: The scheduler shall support scheduling of up to 100 unique day plans. Each day plan shall support up to 100 individually schedulable events. The individual events shall be implemented for a specific controller or a control section. The time resolution of each event shall be one minute.
- **Week Plans**: The scheduler shall support up to 52 week plans. Each week plan shall

support individual day plan selection for each day of the week.

- **Annual Calendar**: An annual calendar shall support both week plan and individual day plan selection. The calendar shall automatically roll permanently scheduled events from one year to the next.
- **Individual Event Scheduler**: The scheduler shall support up to 500 Individual events to be scheduled at a higher priority than the Calendar events.
- **Manual Command/Temporary Event Scheduler**: The scheduler shall support implementation of temporary events. These events shall be programmed to begin immediately or within a scheduled timeframe. These events shall be automatically deleted from the system upon completion.

B.14.2. 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.

B.14.3. Coordination Plan and Scheduler Resolution

Events in the scheduler (both turn-on and turn-off) shall be adjustable in minimum increments of one minute.

B.14.4. Section (Zone) Control

The software shall achieve coordinated operation across the boundaries of all control sections 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.

Timing plan selection shall not be limited to entire sections. Timing plans, at the discretion of the system operator, shall be implemented for a single intersection, section of intersections, or system-wide. The timing plan shall be selectable by the operator (Manual mode), by a time clock scheduler (Time-of-Day/Day-of-Week mode), or by the local controller itself.

B.14.5. Traffic-Responsive Operation

In traffic-responsive operation (TRO), the system software implement a V+kO, threshold matching algorithm, and shall select the timing plan based upon system detector information and coordination threshold parameters that have been defined by the user.

The system database shall identify the system detectors that are assigned to each control section for traffic-responsive operation. System detectors may be assigned to more than one control section.

In traffic-responsive operation, the software shall use weighted volume and occupancy from the active system detectors. When the system is running TRO, it shall monitor the control section for failed detectors. Upon detection of failed detectors, TRO will continue to function until the percentage of failed detectors exceeds an operator-specified threshold. 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 is below a different operator specified threshold. At this time traffic-responsive operation shall automatically resume.

Minimum plan execution time and threshold hysteresis shall be established by the operator 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 user shall have the ability to run Traffic Responsive as a background process wherein a Traffic Responsive plan is selected, but not implemented. This shall allow the user to verify Traffic Responsive operation in an off-line mode.

B.15. Database Management

The system shall be built around a multi-user commercial off-the-shelf (COTS) database software product. The database shall be used to store, retrieve, and maintain system data and parameter files and shall be available for common computer hardware platforms.

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.

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 programming entries shall primarily consist of numerical values, "Yes" or "No" entries, and bit data. During configuration data entry, the new data shall overwrite the old data. If the data is in error, changes shall not be permitted and the user shall be alerted by either an error message on the display or a warning tone.

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 any case, the system shall allow the operator to re-enter the item. Prior to or simultaneously with reentry, the diagnostic message, if any, shall be erased.

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 record. 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. 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.

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.15.1. Copy Facility

It shall be possible to copy an entire controller database (except for intersection name and identification number) from one controller database to another controller database.

It shall be possible to copy from within the database software all logical segments of the controller database to other like segments of the same controller database using menu commands (IE Timing Table page 1 → Timing Table page 2).

It shall be possible to copy from within the database software all logical segments of the controller database to other like segments of another controller database using menu commands (IE Timing Table page 1 [intersection 100] → Timing Table page 2 [intersection 101]).

It shall be possible to copy from one cell within a database table to another like cell in the same table (IE min green phase 1 to min green phase 2).

B.15.2. Upload/Download of Database

Any workstation shall provide for uploading (copying) the database, and logical segments thereof, from any local controller. The software shall similarly provide for downloading (copying) the database, and logical segments thereof, to a 2070 controller from any workstation.

Uploading a controller database from the field to central (or downloading from central to the field) from one type of controller to another type shall not be permitted.

The upload/download feature shall use block transfer techniques with a cyclic redundancy check (CRC) to ensure data integrity. Non-verified data shall cause termination of the upload or download operation, with no transfer of the corrupted block occurring. A status message shall be displayed when improper termination of the upload or download operation occurs.

B.15.3. Database Comparison

Following an upload, the system shall allow the operator to 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.16. Reports

The system shall generate a number of pre-configured reports. The database software shall permit the operator to retrieve data and produce pre-configured reports. System report information shall be able to be exported to a XML file with report data, CSV (comma delimited), PDF file, TIFF file or a DOC file. All reports should show asset ID number, Main Street, Cross Street, asset type and prevalent information to the asset.

The formats of all reports shall be submitted to the Engineer for approval.

The list of pre-configured reports shall include, but not be limited to, the following:

- System Errors/Alerts
- Communications Status Online/Offline
- System and Local Detector VOS Data
- Device Communications Configuration
- Device Configuration
- Events Log
- Control Section/Links Data
- Scheduler
- Signal Changes
- Signal Detector Events

- Split Monitor
- System Activity
- System Events
- Time Drift
- Upload and Compare
- User Login
- Detector VOS
- Daily
- Hourly
- Multi-date / Hourly
- Multi-date / Daily

Use of 3rd party software for the development of custom reports shall be provided by the contractor. The software shall interface with the signal system software and its data base to allow the user to create custom reports. The user shall be able to define the format of those reports. The system shall also provide a means by which user-specific reports can be created and added to the Reports menu item without the requirement of additional software or custom development work by the software provider.

Training shall be provided on the editing, creation, exporting and general use of pre-configured and custom reports.

B.17. Security

In addition to the network security features provided by the Operating System, the software shall provide customizable levels of access security. Each user must enter a login name a password before gaining access to the software.

The system shall accept any number of users to be configured onto the database. The system shall have 3 default levels of security, as follows:

- Admin User
- Read Write
- Read Only

The top level (Admin User) 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, add new users and delete existing users.

A bottom level (Read Only) shall permit viewing of all information (except access security codes) yet not permit the operator to make any changes to the database.

The system shall also provide the ability to customize each user's privileges with respect to system functionality. Specific privileges shall be configurable for each user, with respect to each of the following System Permissions:

- User Setup (Admin User Only)
- Asset Group
- Location
- System Preferences
- Archive Logs
- Export Logs
- Restore Logs
- Purge Logs

Specific privileges shall be configurable for each user, with respect to each of the following Traffic Permissions:

- Communications Server Setup
- Detectors
- Sections
- ICM Port Configuration
- Scheduler
- Traffic Responsive
- Time Space Diagram
- AEM
- W4 Special Functions
- Traffic Preferences

Specific privileges shall be configurable for each user, with respect to each of the following Alarm Assignments:

- Central Communications Failure
- Field Communications Failure
- Technician Flash
- Monitor / Conflict Flash
- Controller Error
- Stop Time
- Detector Failure
- Police Switch
- Door Open
- Local Clock Failure
- Special Function 1
- Special Function 2
- Special Function 3
- Special Function 4

Each user shall have separate privileges to each asset group (a group of intersections defined within the system, which may cross jurisdictional boundaries, allowing multiple agencies to use a single system). Specific privileges shall be configurable for each user, with respect to each of the following Asset Group functions:

- Properties
- Delete
- Graphics Editor
- Timing Tables
- Upload
- Download
- Manual Commands

- Real Time Clock

B.18. Help

The signal system software shall have comprehensive, online help screens. The help screens shall be context sensitive, providing information specific to the highlighted fields or windows displayed.

C. CCTV System Software

The Contractor shall load CCTV system software on the digital video server for a user to distribute video streams among different monitor outputs and control the PTZ operations of the CCTV cameras in the field. The system software shall provide for the management of IP based video networks and be fully compatible with the digital video system provided under this project. The system software shall support TCP/IP and SNMP. The system software will have the capability to access and control (pan/tilt/zoom) the video images. The system software will have access to the video network and have the ability to select CCTV images to be brought to any operator workstation running the CCTV software client as well as be directed to the display wall monitor or overhead projector. The system software will have full control over the selection of video inputs and outputs through the use of a single Graphical User Interface (GUI). Table-based and map-based video selection shall be provided by the GUI.

This CCTV system software will have the following basic functions:

- Provide standard windows based user interfaces and will run on the servers and workstations being provided under this project.
- The software will operate in Client/Server architecture and communicate with the video management server via IP.
- Utilize GUI for the purpose of directing CCTV and/or RGBHV images to display wall monitors seamlessly via a simple mouse click.
- Utilize GUI for Pan/Tilt/Zoom (PTZ) of video system CCTV cameras.
- Provide menu tree structure for selection of devices and provide simple-to-use Telnet hook commands for incorporation into map based GUI.
- Provide the capability to receive, view, and distribute analog NTSC video, standard formatted digital video (MPEG- 4) or digital RGBHV video images simultaneously in one application utilizing the same GUI window.
- Allow the user to select any video signal and view it on any computer desktop with the

software client and tied to the LAN with a connection containing a suitable bandwidth.

- The software shall allow the computer Operator to view the selected video image in a separate window on the computer desktop.
- The software shall launch a window for the viewing of video images on the computer desktop.
- Images selected will automatically switch views within the viewing window once a connection to the video source has been made.
- The software shall support the creation of CCTV tours. A minimum of 25 tours shall be supported with each tour consisting of a minimum of 20 individual steps and/or commands. These shall include individual CCTV assignment of specific devices, movement to preset position and zooming of individual CCTV to preset position.

The client software interface will allow the Operator to execute the following commands:

- Select CCTV cameras from the video network to be displayed on the Operator's computer desktop.
- Command and control of CCTV cameras such as pan, tilt and zoom (PTZ), iris controls and presets where available.
- Store and recall CCTV camera presets, where available.
- Select video images (either VGA, RGBHV or NTSC) brought to the Operator's computer to be redirected for display on the LCD monitor or video projector.
- Setup Quad displays for viewing of four (4) individual video signals to be displayed in one full screen view.
- Allow the selection of video feeds for viewing through the use of a programmable menu tree structure.
- Contain a map based GUI for the selection of video signals. The 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.
- The software shall allow each client interface with the ability to simultaneously connect

to and control up to four (4) separate video sessions in one Client GUI.

The client and server software, as an integrated system, shall have the intelligence necessary to handle the contention mentioned above and it shall have a facility for the display of which video streams are linked to which network devices. This may be a tabular text or graphic representation and will also be a function of the administrative software.

- The system will direct selected video images to appear in a window, one image at a time, on the Operator's computer desktop and will allow the Operator to redirect the images to selectable endpoints such as the monitors or projector.
- Through the use of the client software, the Operator will have the ability to view live, streaming MPEG-4 video on the Operator's workstation and shall have the capability to distribute selected video streams to the dedicated video processor units for viewing on the monitors or projector.
- The network server and administration software must have the capability to fully manage and distribute the MPEG-4 multicast streams within the video network.
- The video control software must allow for grouping of video network resources to specific video network users or devices.
- The video control software shall have an unlimited amount of user priority levels available, enabling the allocation of specific video resources to be available to specific users.
    - The priority level scheme shall allow for a user with a higher priority level to automatically take control of video resources when logging into the video control software.
    - The priority level scheme shall allow for the provisioning of a single user login with unlimited access to all video resources.
    - Priority level settings will be assigned to each user of the video control software.
    - Upon login to the video network via username and password, the system will automatically recognize the user and allocate the available video resources allowed of that user's priority level setting.
- The video management server shall have a command pathway to the CCTV cameras and shall have serial (RS-232/422/485) connectivity to the CCTV camera through the data channel provided in the encoders.

- The video management server shall use a Lightweight Directory Access Protocol (LDAP) database for storage of all system devices and users.
- The video management server shall communicate with the Operator's workstation and the dedicated video processor units via Internet Protocol (IP).
- The video management server shall be fully manageable remotely via IP using the administrative software. The administrative software shall allow the Operator to have the capability to execute the following commands both locally and remotely:
    - Connect and disconnect calls between devices
    - Configure user profiles
    - Configuration of the video network and video network devices
    - Manage system security

The furnished software shall be capable of managing a minimum of 50 unique digital video input streams, and 50 output devices, and 5 controller access points.

D. System Support Software

D.1. Signal Timing Software

Furnish traffic signal timing optimization and simulation software of the latest version that is compatible with the computer operating system provided on the computer workstations furnished under this project.

Furnish time-space diagram generation software of the latest version that is compatible with the computer operating system provided on the computer workstations furnished under this project.

Furnish two (2) handheld GPS Receivers with Cigarette Lighter Adapters for each receiver. The GPS receivers shall be fully compatible with the signal timing software provided and shall be considered necessary accessories and incidental to furnishing the time-space diagram generation software.

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.

D.2. Productivity Software

Furnish a network version of the latest release of office productivity suite, including software packages for spreadsheets, databases, documents, and presentations. A license shall be provided for each workstation and notebook furnished with the project. Furnish and install a copy of the latest release of the productivity software on each workstation and notebook computer furnished.

D.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.

36.3. INSTALLATION AND INTEGRATION

A. General

Install and fully integrate distributed processing signal system software on Distributed Processing Signal System server called for in Section 37 of these Project Special Provisions. Install and fully integrate distributed processing signal system software on each workstation and notebook computer in the Jacksonville signal system.

Install and fully integrate distributed processing signal system software on Distributed Processing Signal System Communications server called for in Section 37 of these Project Special Provisions as required.

Install and fully integrate CCTV central software on CCTV server called for in Section 37 of these Project Special Provisions as required.

Install and fully integrate DMS control software on DMS server called for in Section 37 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 remote operations on the notebook computers.

Register all software products furnished with this project with the software supplier. The City of Jacksonville 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 server based installation program shall be provided for installing the software on the file server. Provide a separate 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 60-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. Contractor shall install all displays and fully integrate with system software. <u>Submit all graphics to the Engineer for approval prior to the System Operational Test and prior to integration in the software.</u>

Program all new system detectors installed under this project, and <u>all</u> existing system detectors being reused, in the signal system software. Install all associated graphics related to system detectors. Integrate system detector locations (based on the actual installation in the field) on all associated system graphics.

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. Local Controller Software

Install NCDOT-furnished local controller software on all new controllers. Use the latest version available at the time of installation as directed by the Engineer. Request local controller software from Engineer a minimum of one (1) week prior to use of software during burn-in period.

At locations where 2070L 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 Signal System shall have identical local software.

D. CCTV System Software

Install and integrate the CCTV system software with the field hardware. Install server version of the CCTV system software onto CCTV server. Install CCTV client software onto workstations and notebook computers at the TOC and Signal Shop. Install CCTV client software onto all video monitor processor units provided under this project. Fully integrate all new and existing CCTV cameras that are shown in the Summary of Work in the Plans.

E. DMS Control Software

Install and integrate the DMS control software with the field hardware. Install server version of the DMS control software onto DMS server. Install DMS control client software onto workstations and notebook computers at the TOC and Signal Shop. Fully integrate all new and existing DMS that are shown in the Summary of Work in the Plans.

F. System Support Software

Install the signal timing software, productivity software, and utility software on all workstations and notebook computers provided with the project.

36.4. TESTING

A. General

Provide the following tests and demonstration of the system software:

- System Demonstration Test, if required (see below)
- System Operational Test (as called for in Section 43)
- 60-Day Observation Period (as called for in Section 1 and Section 43

B. System Demonstration

If the signal system software package proposed for this project has not been deployed for a state or municipal system in North Carolina, a system demonstration is required. Otherwise, the system demonstration requirements are considered to have been fulfilled under previous projects.

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 Jacksonville 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.

36.5. MEASUREMENT AND PAYMENT

Signal system software shall be measured and paid as a lump sum. This shall include the furnishing, installation, testing, and all materials, 3rd party software for reporting, 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.

CCTV system software shall be measured and paid as a lump sum. This shall include the furnishing, installation, testing, and all materials, 3rd party software for reporting, 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.

System support software and devices shall be measured and paid as a lump sum. 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 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.

No measurement will be made for the installation of the NCDOT-provided local controller software on existing signals that will not be replaced under this project, as this will be considered incidental to the Signal System Software and required to have a fully functioning system.

Testing will not be paid for separately but will be considered incidental to equipment installation.

Payment will be made under:

Signal System Software .... Lump Sum

CCTV System Software .... Lump Sum

System Support Software .... Lump Sum

37. COMPUTER HARDWARE AND PERIPHERALS

37.1. DESCRIPTION

Furnish and install server computers, workstation computers, and laptop computers at the TOC 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 39 of these Project Special Provisions.

Install all computer hardware as shown in the Block Diagram contained in the Plans.

All servers and other associated components will be installed in existing rack cabinets installed and maintained by the City of Jacksonville. Existing rack cabinets are integrated with building UPS facilities.

37.2. 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

All computer hardware and peripherals not connected to an Uninterruptible Power Supply (UPS) shall be connected to a surge suppression power strip. Provide surge suppression power strips equipped with an on-off switch, an indicator lamp, isolating filter banks, and a minimum of six (6) 120 VAC, 60 Hz outlets. At a minimum, the filter banks shall attenuate high frequency noise

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

Jacksonville Signal System LAN.

C.2.1. Features

The Signal System Server shall feature a modular, upgradeable architecture with Intel Xeon Quad Core or greater processors. Furnish server with a minimum of two processors. The server shall have the following minimum features:

- A minimum clock running speed of 2.33 GHz (both processors)
- 400 MHz front end bus.
- 512KB of integrated L2 ECC cache.
- 4 Gig of error checking and correcting (ECC) RAM.
- 4 PCI expansion slots.
- 24X speed CD ROM drive.
- Hard disk drive storage capacity to accommodate all LAN software, office productivity software, Distributed System software and databases, ten days of traffic monitoring data at the ultimate Distributed System size of 512 intersections and 50[illegible] system detectors, and 36GB of unused capacity (minimum of three 300GB drives).
- A redundant array of inexpensive disks (RAID) with the chassis, hardware, and interfaces necessary to implement Level 5 RAID storage over three disks.
- The ability to "hot-swap" any single hard disk drive unit without interruption of the server or the LAN.
- RAID storage capacity expandable to 2 TB.
- Ultra-wide SCSI controllers, with a minimum of 160 Mb/s per channel of data through put as needed to accommodate the RAID disk drive units.
- Ultra-narrow SCSI controllers as needed to accommodate SCSI peripheral devices.
- Two (2) 1000 Base-T network interface cards
- A minimum of two (2) Universal Serial Bus (USB) ports (2.0).
- A minimum of one (1) RS-232 serial port, or provided adaptor that replicates an RS-232 serial connection using one of the other data ports.
- Rack mountable in standard EIA 19" equipment rack

Modems (and software) capable of operating at line bit per second (bps) transfer rates ranging from 1,200 to 56,000. The modem shall be capable of automatically adjusting to the maximum bit transfer rate of the device it is dialing to or has been dialed from. The modem shall have standard features such as auto-answer, auto-dial, and phone number storage.

C.2.2. Operating System

The operating system for the Signal System Server shall be Microsoft Windows Server 2008. The release used shall be the latest revision available as recommended by the supplier of the system software.

C.2.3. Additional Software

The Signal System Server shall be furnished with all necessary software required to operate the signal system properly, which includes Microsoft® SQL Server 2008 or other version compatible with the signal system software and approved by the Engineer, and all applicable licenses.

C.2.4. Modems

The modem shall meet the following ITU-T standards:

- **Data Compatibility**: V.34, V.FC, V.32, V.32bis. V.22. V.22bis. V.90.
- **Fax compatibility**: V.17, V.29, V.27ter.
- **Error Control and Data Compression**: V.42/MNP 24 error control (hardware based), V.42bisiMNP 5 data compression (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 36 of these Project Special Provisions, including once-per-second polling of all traffic signal controllers.

C.4. CCTV Video Server

Furnish a Video Server to process video from and control CCTV cameras in the field.

C.4.1. Features

Furnish video server that has the same features as the Signal System Server.

C.5. DMS Server

Furnish a DMS Server to control the posting of messages to DMS units in the field.

C.5.1. Features

Furnish DMS server that has the same features as the Signal System Server.

C.6. 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.6.1. Features

Furnish Remote Access Server with same features as the Signal System Server.

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 (version Windows XP and later)
- 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 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 Remote Desktop functionality or approved equal.

Furnish server with all required operating system and third party support software to fully operate remote access server.

C.7. Backup Storage Server

Furnish Backup Storage server to provide backup and restore functionality of the hard-drive(s) in the Signal System Server.

C.7.1. Features

Furnish Backup Storage Server that has the same features as the Signal System Server as well as those that follow:

- RAID 5 hard drive configuration
- All drives are hot-swappable

D. Computer Workstations

Each microcomputer workstation shall be upgradeable and shall meet the following minimum requirements:

- Dual (2) flat screen monitors and required video cables. Minimum monitor size shall be 20" , 18.5" viewable with a 1,600 × 1,200 resolution
- Dual processors with minimum clock running speed of 3.4 GHz for primary processor, minimum clock running speed of 2 GHz for secondary processor
- A minimum of 4GB of RAM shall be provided, expandable to 8GB of RAM
- A minimum dual SVGA video card with advanced graphics processor (AGP) and 3-D graphics with at least 768MB of video memory, a 64-bit graphics chip, upgradeable to 1.5 GB of video memory, with display resolutions up to 1920 × 1200, support for up to 16.7 million colors, and support for dual monitors
- A 100/1000 Base-T network interface card (NIC)
- 300-watt power supply
- Mini-Tower chassis
- Dual, Quad Core Intel Xeon processor, or approved equivalent
- 250 GB hard drive
- 48X/32X speed CD-RW/DVD drive
- Microsoft 2-button/scroll mouse

- Full function, 104 keyboard with separate numeric and cursor control keys
- Speakers
- A minimum of four (4) universal serial bus (USB) ports
- Six (6) expansion slots, with a minimum of:
  - One (1) AGP slot
  - Five (5) PCI slots
- Stand-alone UPS unit, with a minimum
  - Surge protection and filtering
  - Battery capable of providing 6 minutes of backup time at full load
  - Three (3) NEMA 5-15R output connections (with battery backup)
  - Three (3) NEMA 5-15R output connections (with surge protection)

The operating system for the signal system workstation(s) shall be Microsoft Windows 7. The release used shall be the latest revision available as recommended by the supplier of the system software.

The operating system shall provide for true multi-tasking and graphical user interface. It shall be possible for workstation users to run Windows-based programs in one or more windows while the traffic signal system applications software continues in full operation.

E. Notebook Computers

Provide notebook computers with Windows 7 operating system with the following minimum features:

- Processor clock speed 2.8 GHz,
- 4 GB of RAM expandable to 8 GB of RAM,
- 15 inch TFT display,
- 250 GB hard disk,
- one internal 24X CD-RW/DVD-ROM drive,
- one parallel port,
- one RS-232 serial port, or provided adaptor that replicates an RS-232 serial connection using one of the other data ports

- two USB ports
- 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,
- 100/1000 Base TX (100 Mbps/1 Gbps Ethernet) with RJ-45 connector on board,
- IEEE 802.11g wireless network adapter card
- USB to Serial cable adapter
- Compatible docking station
- cushioned, soft-side carrying case.

37.3. CONSTRUCTION METHODS

A. General

Furnish and install the central hardware required to support the software functions called for in Section 36 of these Project Special Provisions.

Furnish and install the hardware in the Server Room and TOC at the Public Safety Complex as shown in the block diagram in the Plans.

All computer hardware called for in this section shall be installed within sixty (60) days of date of purchase. Provide receipt with purchase date to Engineer during hardware installation. Any hardware older than sixty (60) days may be installed at the sole discretion of the Engineer.

All cables for each piece of hardware installed shall be clearly labeled, using a label convention approved by the Engineer. All cabling shall be manufacturer assembled and without any adapters, unless otherwise approved by the Engineer.

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 existing equipment rack cabinet at Server Room as shown in the Plans. Integrate with LAN switch, and existing rack cabinet power source. Integrate with signal system communications server using direct serial, parallel, USB, or network connection. Fully configure server to operate distributed system processing software. Integrate with backup storage server to support scheduled and on-demand backup of data.

C.2. Signal System Communications Server

Install signal system communications server into existing equipment rack at Server Room as shown in the Plans. Integrate with LAN switch, and existing rack cabinet power source. Integrate with fiber optic communications system using core ethernet switch. Fully configure server and ports to facilitate signal system communications.

C.3. CCTV Video Server

Install video server into existing equipment rack at Server Room as shown in the Plans. Integrate with LAN switch, and existing rack cabinet power source.

C.4. DMS Server

Install DMS server into existing equipment rack at Server Room as shown in the Plans. Integrate with LAN switch, and existing rack cabinet power source.

C.5. Remote Access Server

Install remote access server into existing equipment rack cabinet at the Server Room. Integrate with LAN switch, and existing rack cabinet power source.

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 for remote access. Install all third party software and drivers required to create fully functional remote access server. Install all client software on new notebook computers required for operation of all software services available on the LAN.

C.6. Backup Storage Server

Install remote access server into existing equipment rack cabinet at the Server Room. Integrate with LAN switch, and existing rack cabinet power source.

Integrate with distributed processing signal server to support scheduled and on-demand backup of data.

D. Computer Workstations

Install two (2) computer workstations in operator work center at the TOC as shown in the Plans. Integrate with LAN switch. Fully configure microcomputer workstation with all client software to operate all signal system subsystems including distributed processing signal system, CCTV, and DMS subsystems.

Install one (1) computer workstation at the Signal Shop as shown in the Plans. Integrate with LAN switch. Fully configure microcomputer workstation with all client software to operate all signal system subsystems including distributed processing signal system, CCTV, and DMS subsystems.

E. Notebook Computers

Furnish three (3) notebook microcomputers. Deliver notebooks to the TOC or Signal Shop 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, CCTV, and DMS subsystems. 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 Jacksonville 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.

F. Printers

The City will provide all printers being installed under this project.

Install and integrate one (1) printer in the TOC and one (1) printer in the Signal Shop. Integrate printers with Ethernet switch and enable printing functions on all workstations and notebook computers.

G. 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 Public Safety Complex 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.

37.4. MEASUREMENT AND PAYMENT

(____) server will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Computer workstation will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Notebook computer will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Computer hardware integration will be measured and paid as a lump sum price. This item 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 Public Safety Complex.

All cabling, labeling, sockets, 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.

Payment will be made under:

Signal System Processing Server.....Each

Signal System Communications Server.....Each

CCTV Video Server.....Each

DMS Server ....Each

Remote Access Server ....Each

Backup Storage Server..Each

Computer Workstation...Each

Notebook Computer...Each

Computer Hardware Integration ....Lump Sum

38. LOCAL AREA NETWORK

38.1. DESCRIPTION

A. General

Furnish, install, configure, and test a 10/100/1000 Fast Ethernet local area network (LAN). Furnish LAN than interconnects central hardware including computer workstations, server computers, and CCTV and DMS central equipment. Furnish LAN connections as shown on the block diagram. LAN connections within facilities shall be made with Category 6 wiring.

Furnish, install, and integrate a virtual private network (VPN) firewall at the TOC to control remote access to the signal system and to configure the Internet connection. Integrate the City of Jacksonville provided Internet connection at the Public Safety Complex to serve as the gateway from the Internet for remote users that is physically separate from the gateway to the Internet for the City-maintained wide area network.

All ethernet core switches and other associated components will be installed in existing rack cabinets installed and maintained by the City of Jacksonville. Existing rack cabinets are integrated with building UPS facilities.

B. Requirements Definition Document

Prior to commencing work, the Contractor shall develop a Requirements Definition Document (RDD) that will form the basis for the overall network architecture and design.

- Complete description of the proposed implementation of the access, distribution and core layers for the network as described in the Plans and these Project Special Provisions
- Development of an IP Design Scheme with ranges assigned to each node to be integrated by the Contractor (address ranges, geographic distribution, standards for addresses within each cabinet)
- Proposed IP subnet definition and addressing including any and all masks
- Proposed IP multicast configuration including multicast routing (i.e., PIM sparse or dense) and Rendezvous Point (RP) designation as necessary
- Proposed recommendations for failover and redundancy including network device power, supervisor cards, and network ports
- Proposed configuration and guidelines for L3 routing (OSPF, VRRP, EIGRP, RIP, etc.);

- Proposed configuration and guidelines for Virtual LAN assignments including management VLANs, device VLANs and routing VLANs; and
- Proposed configuration and guidelines for L2 broadcast storm prevention, loop prevention and fault tolerance mechanisms. (Spanning Tree diagram with designated, blocking and forwarding ports indicated. Root bridge and backup root bridge must also be specified.) Incorporation of Multiple Spanning Tree Protocol.
- Proposed configuration and guidelines to mitigate common security threats such as denial of service, man in the middle, MAC/IP spoofing and brute force dictionary attacks.
- Proposed configuration and guidelines for 802.1p Class of Service (COS) queue assignments
- Proposed configuration and guidelines for specific port assignments on each of the L2 and L3 devices

The RDD shall be prepared and signed by a qualified networking professional (minimum CCNA or a manufacturer-approved equivalent based on the approved hardware vendor) and will be approved by the Engineer. The Qualified network professional will be present during the installation and testing of the local area network as well as during system testing.

38.2. MATERIALS

A. General

Furnish equipment for the LAN that complies with IEEE standard 802. Furnish Ethernet Switches of all types that are fully compatible and interoperable with the network monitoring software and network hardware operating system software.

Furnish Ethernet Switches of all types that comply with the following electrical safety requirements: UL60950 or CSA C22.2 No. 60950 (safety requirements for IT equipment) and FCC Part15 Class A for EMI emissions.

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 workstations (up to 10) designated by the Engineer.

Furnish software capable of monitoring all nodes and utilized ports on the enterprise. Furnish software capable of 50% expansion in the number of nodes and ports managed over the number of nodes and ports present and utilized at the final acceptance of the project as documented in the RDD.

The software shall use a GUI to configure, manage, and monitor the local network. At a minimum, the software shall provide the following functions and features:

- SNMP based
- Full management of network firewall
- Support SSH
- Utilize a GUI Web/browser style interface
- Provide a schematic display of the entire network enterprise that may be drilled down to the port level or panned out to the System level
- Provide Inventory tracking
- Provide bandwidth monitoring
- Provide SMTP support
- Provide auto alerting
- Monitor QOS
- Support management VOIP
- Support NETFLOW
- Support Wireless network management
- Receive SYSlog messages
- Generate usage/error reports
- Be capable of "pushing" upgrades to network gear via TFTP
- Detect switch failures
- Detect router failures
- Detect cable failures
- Provide network performance information
- Support the monitoring of cabinet and equipment temperature alarms via use of SNMP traps.
- Provide switch configuration backup capabilities via TFTP
- Provide configuration change tracking capabilities

C. Field Ethernet Switch

Furnish Field Ethernet switches fabricated for use in field equipment cabinets that are ruggedized to meet or exceed NEMA TS-2 requirements for temperature, shock, humidity, and vibration.

Furnish Field Ethernet Switches that are DIN rail mounted and come equipped with hardware to permit mounting in an EIA 19" equipment rack.

Furnish Field Ethernet Switches that weigh no more than 15 lbs and are no more than 250 cubic inches in volume.

Furnish Field Ethernet Switches with the following minimum characteristics and features:

- Eight (8) 10BASE-T/100BASE-TX ports:
- Minimum of two (2) 1000 BaseX Optical uplink ports that utilize small form-factor pluggable (SFP) connectors.
- Furnish SFP modules rated to service the Field Ethernet to Field Ethernet optical uplinks and Field Ethernet to 10 Gig-E Hub Uplink rated for optical attenuation required to service the link. Use SFP modules that are LX and are matched and compatible with the SFP module it is mated with. Furnish attenuators if required to service link without saturation receiving optics.
- Furnish SFP modules rated for use with the optical cable furnished under this project.
- Furnish SFP modules with SC connector or other connector approved by the Engineer.
- SFP modules shall be considered incidental to the field Ethernet switch.
- Management console port

Furnish Field Ethernet switches with the following features:

- 10/100BaseTX ports:
  - RJ45 connectors
  - Cable type: Category 5, unshielded twisted pair (CAT 5 UTP)
  - Segment Length: 100m
  - Auto-negotiation support (10/100Mbps)
  - Auto MDIX crossover capability
  - Full Duplex operation (IEEE 802.3x)

- TVS (transient voltage suppression) between Line +/-, Line +/ground, and Line - ground to protect the circuitry

Furnish Field Ethernet switches with the following networking requirements:

- The switch shall support automatic address learning of up to 8192 MAC addresses.
- The switch shall support the following advanced layer 2 functions:
  - IEEE 802.1Q VLAN, with support for up to 4096 VLANs
  - IEEE 802.1p priority queuing
  - IEEE 802.1w rapid spanning tree
  - IEEE 802.1s multiple spanning tree
  - IEEE802.1AD link aggregation
  - IEEE 802.3x flow control
  - IGMPv2 with 256 IGMP groups
  - Port Rate Limiting
  - Configuration via test file which can be modified through standard text editor
  - Forwarding/filtering rate shall be 14,880 packets per second (PPS) for 10Mps,148,800 for 100Mps, 1,488,000 for 1000Mps
  - DHCP Option 82

Furnish Field Ethernet switches with the following network management functionality requirements:

- SNMPv2, SNMPv3
- RMON
- GVRP
- Port Mirroring
- 802.1x port security
- Radius Server
- TACACS+ Server
- SSL – Secure Socket Layer

- SSH – Secure Shell
- TFTP,
- Network Time Protocol (NTP),
- Simple Network Time Protocol (SNTP)
- Management via web or Telnet

D. Core Ethernet Switch

A Core Ethernet Switches will be furnished by the City of Jacksonville IT Department for installation and integration by the Contractor, and will meet the following requirements and come equipped with the following components:

- L3 core modular, high-availability, switch equipped with redundant fans, power supplies, and support for redundant supervisor/route processor engines, or approved equivalent functionality.
- A minimum of four (4) slots for switch/routing processor modules, but at least one spare slot shall remain after configuring required ports/interfaces herein.
- Copper Ethernet modules shall support a minimum of 16 ports of 10/100/1000 Base-T.
- SFP fiber modules shall support a minimum of 44 SFP ports.
- The following minimum connectors:
  - A minimum 44 1000BASE-LX SFP-based ports: SC fiber connectors (single-mode) as needed to meet distance requirements at Core Switch and to be compatible with matched Field Switches to support the distances shown in the Plans for switches connected to the Core switches. Attenuators will be furnished if required to service link without saturating receiving optics.
  - Fiber jumper cables with appropriate connectors to connect with switch and adjacent drop cable connectors and/or other switches.
  - Ethernet management port: RJ-45 connectors
  - Management console port: RJ-45-to-DB9 cable for PC connections
  - Minimum of 48 10/100/1000 Base-TX copper RJ-45 connectors
- Dynamic Host Configuration Protocol (DHCP)
- Automatic QoS (AutoQoS)

- Autonegotiation on all ports for auto selection of speed and duplexing modes.
- Link Aggregation Control Protocol (LACP)
- Automatic media-dependent interface crossover (MDIX)
- Switching Capacity per line card 300 Gbps
- 256 MB DRAM or greater
- 128 MB FLASH or greater
- 1000 VLANs
- 4000 VLAN IDs
- 1000 Switched Virtual Interfaces (SVIs)
- 9216 Byte Jumbo Frames or greater
- 100 Mpps Forwarding Rate or greater
- Support 1000 IGMP groups and multicast routes
- Support automatic address learning of up to 12,000 MAC addresses
- Security:
    - DHCP Snooping
    - Dynamic ARP Inspection (DAI)
    - Secure Shell (SSH) Protocol, EAP, and Simple Network Management Protocol Version 3 (SNMPv3), Network Time Protocol Version 3 (NTPv3)
    - Port Mirroring
    - TACACS+ and RADIUS authentication
    - MAC Address Notification
    - Port Security
    - Bridge protocol data unit (BPDU) protection and filtering
    - Root Guard
    - IGMP snooping
    - Dynamic VLAN assignment

- Standards: Supply a L3 Ethernet switch that meets or exceeds the following standards:
  - IEEE 802.1s Multiple Spanning Tree Protocol (64 regions)
  - IEEE 802.1w Rapid Reconfiguration Spanning Tree Protocol
  - IEEE 802.1x
  - IEEE 802.3ad
  - IEEE 802.3af
  - IEEE 802.3x full duplex on 10BASE-T, 100BASE-TX, and 1000BASE-T ports
  - IEEE 802.1D Spanning Tree Protocol
  - IEEE 802.1p CoS Prioritization
  - IEEE 802.1Q VLAN
  - IEEE 802.3 10BASE-T specification
  - IEEE 802.3u 100BASE-TX specification
  - IEEE 802.3ab 1000BASE-T specification
  - IEEE 802.3z 1000BASE-X specification
  - An IP gateway redundancy protocol such as virtual router redundancy protocol (VRRP – RFC 2338), hot-standby router protocol (HSRP - proprietary) or gateway load balancing protocol (GLBP - proprietary), or an approved equal will be used to provide a redundant IP gateway in the event of a primary gateway failure.
  - OSPFv2 and v3: RFC 2328 for IPv4 and RFC 5340 for IPv6
- The following Indications:
  - Per-port status LEDs: link integrity, disabled, activity, speed, and full-duplex indications
  - System-status LEDs: system, power supplies, fans, and bandwidth utilization indications
- Environmental Requirements:
  - Operating temperature: 0°C to 40°C minimum range
  - Relative humidity operating: 5 to 90% (non-condensing)

- Mean Time Between Failures of greater than 80,000 hours
- Power Supply
  - Rated to handle input power of 115 VAC/60Hz (± 10%), unless otherwise approved by the Engineer
  - Hot-swappable redundant modules
- Physical Requirements
  - EIA standard rack mounting in an IT equipment cabinet
  - No larger than 10 RU
- Safety Requirements
  - FCC Part 15 Class A for EMI emissions

E. VPN Firewall

Furnish network firewall and virtual private network (VPN) server integrated in a single unit. Unit shall be in a rack mountable chassis with a maximum height of 1 RU. Furnish unit with the following minimum features:

- Integrated bandwidth management functionality
- Integrated intrusion detection functionality
- Four (4) Fast Ethernet (10/100 Mbps) ports
- One (1) serial com port
- 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
- Diagnostic LEDs on front of unit showing states for power, status, and LAN at a minimum

Provide user license to allow at least 12 concurrent remote users to access the signal system LAN.

F. Cable and Wall Information Outlets

Furnish coaxial, Category 6 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.

38.3. CONSTRUCTION METHODS

A. LAN Integration

Fully integrate field and core switches to form a complete local area network for communications between the TOC and each field device.

Fully integrate switches and firewall with computer and central system hardware to form a complete local area network that allows users from the TOC as shown on the block diagram in the Plans to access applications on application servers. Fully integrate network to allow the notebook computer users to be able to connect to the network via the LAN port on the notebook computer using a network cable.

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.

All cables for each piece of hardware installed shall be clearly labeled, using a label convention approved by the Engineer. All cabling shall be manufacturer assembled and without any adapters, unless otherwise approved by the Engineer.

B. Field Ethernet Switches

Install and integrate all Ethernet switches at field locations as depicted in the diagrams and tables and called for in these Project Special Provisions. Integrate with computer hardware, and field devices as called for.

Provide inline surge protection for all Ethernet connections in field cabinets.

Install two (2) field ethernet switches at the Signal Shop. One switch shall be integrated with the test cabinet and controller. One switch shall be integrated with the Ethernet Core Switch at the TOC to provide remote operations of the system.

C. Ethernet Core Switch

Fully integrate with application servers. Fully configure switch with performance monitoring software and operating system software/firmware.

Configure and test all Ethernet equipment prior to installation.

D. VPN Firewall

Install one (1) VPN firewall switch in the Server Room. Integrate with the core switch 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.

E. Cable and Wall Information Outlets

Route Category 6 network cabling in raised floors, drop ceilings, existing cable raceways, and locations approved by the Engineer in the Public Safety Complex, to interconnect networked devices.

38.4. MEASUREMENT AND PAYMENT

(____) ethernet switch will be measured and paid as the actual number furnished, installed, integrated, and accepted. All SFP modules, optics, cabling, attenuators, configuration, and testing or other labor or materials required to install and integrate the field Ethernet Switch will be considered incidental and not be paid for separately.

VPN firewall will be measured and paid as the actual number furnished, installed, integrated, and accepted.

LAN integration will be measured and paid as a lump sum. LAN integration includes configuration and integration of all LAN hardware, firmware, software, and VPN firewall to complete the LAN architecture, and submittal of the RDD. All cabling, hardware, patch panels, accessories, labor, and materials required to make the unit function as part of this project shall be considered incidental and not paid for separately. Furnishing, installing, and configuring the LAN Network Performance Management and Remote Monitoring Software shall be included as part of the LAN integration and not paid for separately. Partial payments for this item will be made on the following schedule: 20% upon completion and acceptance of the RDD; 20% upon installation, integration and acceptance of LAN equipment, 20% upon installation, integration and acceptance of LAN equipment at Routing Switch locations, 20% upon deployment and acceptance of the Network Performance Management and Monitoring Software, and 20% upon installation, integration and acceptance of the entire project furnishing of and acceptance of network as-built documentation.

Payment for all cabling, sockets, and other hardware shall be considered incidental and no separate payment will be made.

Payment will be made under:

Field Ethernet Switch..Each

VPN Firewall ....Each

LAN Integration...Lump Sum

39. CENTRAL VIDEO SYSTEM

39.1. 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) video monitors, camera control panels, and video monitor processors.

Provide remote monitoring of Jacksonville CCTV cameras over a standard internet connection for remote users of the system.

39.2. 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.

B. CCTV Control Panel

Control consoles, with an integrated joystick device, shall be furnished and installed in the TOC and Signal Shop. 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.

Furnish desktop camera control panels at each workstation in the TOC and Signal Shop 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.

C. Video Monitor Processor Unit

Furnish video monitor processor units that shall be servers capable of software decoding MPEG 4 digital video to a single video output for display on the LCD monitors and the video projection unit. Furnish server with the following minimum specifications:

- Intel Quad Core (or greater) processor with a minimum speed of 3.0 GHz
- 1 GB of RAM, expandable to 32 GB
- DirectX 9 video card with display resolutions up to 1600 x 1200, compatible with the LCD monitors and video project unit furnished under this project
- Capable of software decoding up to sixteen (16) MPEG 4 digital video input streams at 25 frames per second, D1 resolution
- Minimum hard drive storage of 72 GB
- Operating system of Microsoft Windows Server 2008, and compatible with operating system of the video server installed under this project
- 10/100/1000 MB network interface card
- Minimum 2 PCI expansion slots
- Minimum 2 Universal Serial Bus ports
- Minimum 1 EIA 232/EIA 422 serial port
- Minimum 1 video output
- Rack mountable with a maximum height of 2 RU

D. Network Video Recorder (NVR)

Furnish network video recorder and all necessary software and hardware to store CCTV video streams for a user-defined length of time. The CCTV cameras to be stored shall be user selectable.

The network video recorder shall support a minimum of two cameras at 30 frames per second, 4 common intermediate format (CIF) resolutions, and it shall supply a minimum of 4 simultaneous playback streams. The network video recorder shall be capable of continuous and scheduled recording and shall be fully programmable on a per-channel basis.

The network video recorder shall have expandable storage capacity and it shall maximize storage efficiency that identifies data to be removed when storage time expires.

The network video recorder shall offer plug-and-play configuration and data authentication facilities. The network video recorder shall have outputs viewable on a minimum of 4 individual workstations simultaneously, shall record video and data streams for every channel, and shall have storage locking. The network video recorder shall have full over-the-network remote control and administration, and it shall have system diagnostics and error logging.

The network video recorder shall meet or exceed the following functional specifications while supporting the storage and playback requirements noted in this chapter or as otherwise approved by the Engineer:

- System Storage: two days of full-stream video
- Video Standard: NTSC
- Video Compression: MPEG-4
- Video Resolution: 4CIF: 704 x 480, 2CIF: 704 x 240, CIF: 352 x 240, QCIF: 176 x 120
- Network Interface: Ethernet RJ-45 port (100BaseT)
- Auxiliary Interface: Two high-speed USB 2.0 ports
- Dimensions: 3 RU per unit

Provide system software to interface with the network video recorder. The software shall have a graphical user interface with drag-and-drop operations and shortcut menus. The software shall allow users to view live video, record video; and search, playback, and export recorded video. Recorded video shall be searchable by device, time, and date. The software shall provide an administrative interface to configure the network video recorder, set up users with rights and permissions, and creating recording schedules. The software shall have the following minimum characteristics:

- Runs on workstations with Windows 7 operating system
- Synchronized playback of 2 camera video streams
- Digital zoom in live or playback video
- Export video and still images in MPEG-4 and JPG formats

Provide four (4) seat licenses for the network video recorder system software.

E. LCD Video Monitors

Furnish new minimum 40" LCD video monitors. The video monitors will be used in a 24/7/365 environment at the TOC and remote video operation facilities.

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 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 or video wall units as directed by the engineer.

Furnish wall-mounting brackets (and all applicable hardware) for each LCD monitor that allow for the unit to be tilted. Ensure the wall-mounting bracket complies with the recommendations of the monitor's manufacturer and can be attached to the TOC wall as shown in the Plans.

F. Video Projection Unit

Furnish Video Projection Unit (VPU) for CCTV video and computer graphics. The projected display measuring a minimum of 80 inches diagonally and shall be clearly readable in a fully-lighted room from any viewing angle within 30 degrees of an axis perpendicular to the screen. Furnish projector with minimum image resolution of 1280 X 1024 pixels minimum. Furnish unit capable projecting the following input formats and resolutions: NTSC; PAL; SECAM; VGA; S-VGA; XGA; S-XGA; U-XGA

The VPU shall be contained within a compact, chassis-style/high resolution LCD projector. Furnish VPU projector that meets or exceeds the following specifications:

- Variable focus lens with throw distance between 1.5 and 3 times screen width
- 1,500-Hour Lamp (User Replaceable)
- 2200 ANSI Lumens Brightness
- Input video resolutions up to 2000x1280
- One (1) Ethernet Port with 10/100 Network interface card
- RS232 Serial Port for PC/Serial Device Control

- (2) Computer RGB Inputs; (1) NTSC Video Inputs
- On-Screen Menus/Bar Graph Displays
- Built-In Test Pattern Generator (Color Bars, Checkerboard, etc.)
- Digital Image Size, Freeze, and Enlarge Features
- Ten Programmable and Selectable Source Settings
- Hinged Panel For Quick Lamp Replacement
- Custom Color Temperature Adjustment
- ISO 9001 Certification
- FCC Part 15 Class B Compliance For EMI

Furnish VPU unit with wireless remote control with lens and unit control capabilities. Wireless remote shall be able to control the unit from a minimum distance of 25 feet, and shall be able to control the unit from an operator workstation when in its ceiling mounted position.

Furnish unit that has Ethernet LAN connectivity, is IP addressable, and has software that permits unit control by users on the LAN. This may be achieved through use of a terminal server.

Furnish unit that is ceiling mountable and contains all hardware and accessories required for ceiling mounting. Ceiling mounting shall be capable of sustaining a minimum dead load of 1.5 times the unit's weigh and shall permit the user access to the units control panels, communications ports, input ports, and output ports. Unit shall be able to be removed from and replaced to the ceiling mounting bracket by the user without use of tools.

- Operating temperature Range: 32 Degrees F to 95 Degrees F
- Humidity: 0%-95%, non-condensing
- Voltage: 120 VAC, 60Hz

Furnish all hardware, software, and cabling to form a complete system including RS-232 cabling, Ethernet cabling and software.

Furnish an 80" diagonal projection screen that can be permanently mounted (i.e. not a manual or motorized pull-down configuration) on a wall. The projection screen shall have a 16:9 ratio viewing area with a black border aluminum frame on all sides to maintain screen tension. The projection screen shall be fabricated with a matte white vinyl surface.

39.3. CONSTRUCTION METHODS

A. General

Install and test all central video equipment in accordance with the manufacturer's recommendations. Furnish and integrate any manufacturer software not explicitly stated in these Project Special Provisions, but required for any central video equipment to provide full the stated functionality. Provide a copy of any installed manufacturer software to the Department.

Route all cabling in ceiling, floor, conduit, or cable raceways unless otherwise approved by the Engineer.

All cables for each piece of hardware installed shall be clearly labeled, using a label convention approved by the Engineer. All cabling shall be manufacturer assembled and without any adapters, unless otherwise approved by the Engineer.

B. Video Display

As shown in the Plans, mount each LCD monitor and projection screen on the TOC wall. Mount the monitor and screen according to manufacture recommendations and as approved by the Engineer. Mount monitors in a manner that permits full access to all knobs, buttons, and dials on front and sides of monitor units. Allow a minimum of 36" between the bottom of the large screen and the floor and a minimum of 12" between the top of the large screen and the ceiling. Furnish cable raceways or wire molds of the same color as the wall for the discrete placement of cabling.

Prior to installation of the video displays, develop shop drawings and submit to Engineer for approval prior to commencement of installation of the units.

C. CCTV Control Panel

Furnish, install, and fully integrate CCTV control panels at each workstation provided under this project. Furnish any additional hardware (serial boards, cables, etc.) necessary to connect the control panel to the workstation.

D. Video Monitor Processor Unit

Install five (5) video monitor processor units at the TOC. Fully integrate with LAN switch and video monitor.

Install one (1) video monitor processor unit at the Signal Shop. Fully integrate with LAN switch and video monitor.

E. Network Video Recorder (NVR)

Install network video recorder in the Computer Room and integrate with the Core Ethernet

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 NVR with the LAN. Furnish software to control NVR and view video over the LAN on all workstations and notebook computers provided under this project.

Do not setup and configure the NVR for continuous recording as it will be used only for training purposes in the future.

F. LCD Video Monitor

Install four (4) LCD video monitors 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 each monitor with a video monitor processor unit. This includes installation of cabling and connection of monitors to power source.

Install one (1) LCD video monitor on the wall in the Signal Shop 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 the monitor with the video monitor processor unit. This includes installation of cabling and connection of monitors to power source.

G. Video Projection Unit

Install Video Projection unit on ceiling of TOC. Position to allow for clear resolution, 80" diagonal image on the video wall. Connect, configure, and fully integrate projection unit with a video monitor processor unit. This includes installation of cabling and connection of projection unit to power source. Connect projection unit with LAN switch using Cat-6 Ethernet cable for user control. Connect projection unit with TOC workstation using RGB cable. Route cabling in cable raceways or wire molds as approved by the Engineer.

39.4. MEASUREMENT AND PAYMENT

CCTV control panel will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Video monitor processor unit will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Network video recorder will be measured and paid as the actual number furnished, installed, integrated, and accepted.

LCD video monitor will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Video projection unit will be measured and paid as the actual number furnished, installed, integrated, and accepted. No measurement will be made for the projection screen, as that is considered incidental to the video projection unit.

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.

Payment will be made under:

CCTV Control Panel....................Each

Video Monitor Processor Unit....................Each

Network Video Recorder....................Each

LCD Video Monitor....................Each

Video Projection Unit....................Each

40. SUBMITTAL DATA

40.1. 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.

40.2. 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
- Subsystem Testing
- System Operational Testing
- Training

- 60-Day Observation Period
- Final Acceptance

Demonstrate compliance with the sequence of construction detailed in Section 1 of these Project Special Provisions and in the Plans.

C. Certification

Provide written certification to the Department that all Contractor-furnished material is in accordance with the contract. When requested by the Department, provide additional certifications from independent testing laboratories and sufficient data to verify item meets applicable Specifications. Ensure additional certification states the testing laboratory is independent of the material manufacturer and neither the laboratory nor the manufacturer has a vested interest in the other.

D. Submittal Data

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

For Contractor-furnished material listed on the QPL, furnish submittals in the format defined by the QPL.

For Contractor-furnished material not on the QPL, furnish three copies of the equipment list including three (3) copies of catalog cuts. Identify proposed material on catalog cuts by a reproducible means (highlighter pen does not transfer to copies). Ensure material lists contain material description, brand name, manufacturer's address and telephone number, stock number, size, identifying trademark or symbol, and other appropriate ratings. Submit for review by the Engineer 40 days prior to installation. Do not fabricate or order material until receipt of the Engineer's approval.

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 – Signal Equipment
- Group B – Central System and Local Controller Software
- Group C – Cabinet and Controller Equipment
- Group D – Fiber Optic Network Cable and Splicing Equipment, Cellular Modems, Wireless Radio Transceivers
- Group E –LAN Equipment
- Group F – Computer Hardware and Peripherals
- Group G –CCTV Camera Assemblies
- Group H – DMS Enclosures and Structural Assemblies
- Group I – Central Video System (hardware and software)
- Group J – System Support Equipment and Test Equipment

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 all groups shall list the Project Special Provision section and sub-section requirements for each hardware item being considered for use on this project. It shall also show the corresponding data from the hardware item being submitted and how the submittal meets or exceeds the requirements. Attach appropriate documents or statements indicating how the submittal will fulfill the Project Special Provisions. This shall be all-inclusive for each pay item. Hardware submittals that do not address all the requirements in the Project Special Provisions will be rejected for insufficient information.

Cabinet prototypes shall be considered submittals.

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 line or pay 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.

40.3. MEASUREMENT AND PAYMENT

Submittals shall be incidental to the contract price for each item requiring submittal data.

No separate payment shall be made for submittals.

41. DOCUMENTATION

41.1. DESCRIPTION

This section specifies the documentation to be provided by the Contractor.

41.2. DOCUMENTATION

A. General

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.

B. Plan of Record Documentation

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 in reproducible format. These as-built drawings of construction changes shall be submitted as soon as that change is complete. Each change shall be noted and dated. Failure to revise as-built documentation to reflect current work may result withholding of payments until the as-built documentation is brought current. The submitted as-built may be field-checked by the Engineer at his discretion. If the as-built documentation is found to have an unacceptable number of inaccuracies, the Engineer may withhold payment until the as-built plans are corrected. The Plans shall include all field installations including the SMFO cable network 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 in use by the Department) format on CD. Submit hard copy as-builts on 22x34 inch 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) on compact disc (CD).

C. Equipment Locations

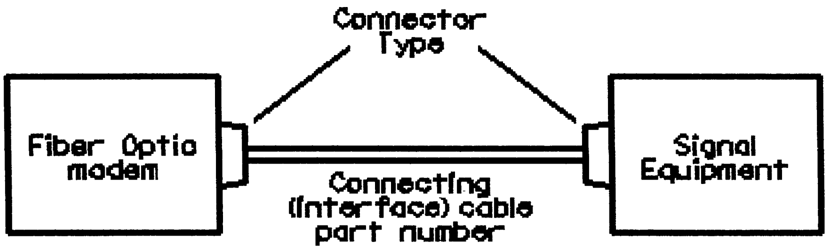
Provide real world coordinates for all ITS devices, junction boxes, and signal controller and equipment cabinets installed or utilized under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet in the horizontal plane and 3.3 feet in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer.

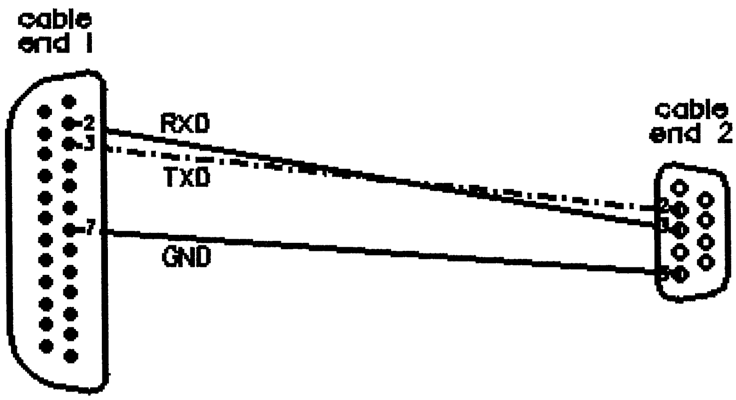
Provide both a digital copy and hard copy of all information regarding the location (including to but not limited to manufacturer, model number, and NCDOT inventory number) in the spreadsheet provided by the Department, shown by example below.

NCDOT Inv #	Name	Location	Latitude	Longitude	Manufacturer	Model #
05-0134	Equipment Cabinet	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5500	35.6873	McCain	Type-332
05-0134	Junction Box # 1 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5516	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 2 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5506	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
5-0134	Junction Box # 3 (Near Cabinet)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5501	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 4 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5486	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 5 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5493	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 6 (Phase 4 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5503	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)

D. 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 two copies of system connection diagrams showing system interconnection cables and associated terminations. Use naming convention approved by the Engineer and conforming to Belcore standards.





connector 1 pin number		connector 2 pin number
2	RXD	3
3	TXD	2
7	GND	5

Provide one electronic copy of the wiring diagrams in MicroStation and AutoCAD formats.

E. 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 formats on a CD and in hard copy format.

F. Manuals and Equipment Documentation

F.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. Twenty five (25) sets of such manuals and instructions and one (1) set of electronic PDF files on CD shall be provided to the City.
- 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 These shall include final as built field hook-ups, system and local detectors, fiber optic communications interface connections, preemption wiring, surge protection, and all auxiliary relays. These final diagrams shall reflect any changes made to the original diagrams. Hand marked changes shall be allowed. 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 60-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.

F.2. 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

F.3. Central Video Software

Furnish two (2) copies of manuals for Central Video software installed under this system detailing the configuration, the operation, maintenance, and troubleshooting procedures for controlling the new and existing CCTV cameras that are part of the system.

F.4. DMS Control Software

Furnish two (2) copies of manuals for DMS control software installed under this system detailing the configuration, the operation, maintenance, and troubleshooting procedures for controlling the DMS units that are part of the system.

F.5. 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 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.

F.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.

41.3. MEASUREMENT AND PAYMENT

All documentation shall be considered incidental to the construction of the system and shall be completed before acceptance of the Project.

Preparation of as-built drawings shall be considered incidental to the bid items and no separate payment shall be made.

42. SYSTEM SUPPORT AND TEST EQUIPMENT

42.1. DESCRIPTION

A. General

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.

B. Signal System Support Equipment

Furnish new, unused signal system support equipment to the Engineer in the quantities shown below:

- Three (3) 2070L signal controllers as installed and accepted under this project
- One (1) pole-mounted 336 cabinets as installed and accepted under this project
- Two (2) base-mounted 332 cabinets as installed and accepted under this project
- Three (3) DC isolators as installed and accepted under this project
- Three (3) AC isolators as installed and accepted under this project
- Six (6) detector cards as installed and accepted under this project
- Three (3) conflict monitors as installed and accepted under this project
- One (1) optical preemption detector as installed and accepted under this project.
- One (1) optical preemption phase selector as installed and accepted under this project.
- One (1) controller tester as specified below
- One (1) signal monitor tester as specified below
- Three (3) model 200 load switches as installed and accepted under this project
- Ten percent (10%) of surge protectors of each type as installed and accepted under this project
- Two (2) flasher modules as installed and accepted under this project
- Four (4) flash transfer relays as installed and accepted under this project
- One (1) test cabinet and controller as specified below

C. Communication System Support Equipment

Furnish new, unused communication system support equipment to the Engineer in the quantities shown below:

- Three percent (3%) of each fiber count of fiber optic cable installed and accepted under this project
- Five (5) fiber optic interconnect centers as installed and accepted under this project
- Two (2) splice enclosures as installed and accepted under this project
- Eight (8) mechanical ST-type splice connectors as installed and accepted under this project
- Eight (8) mechanical SC-type splice connectors as installed and accepted under this project
- Eight (8) factory connectorized (ST-type) jumpers of three foot length as installed and accepted under this project
- Eight (8) factory connectorized (SC-type) jumpers of three foot length as installed and accepted under this project
- Eight (8) factory connectorized (SC-type to ST-type) jumpers of three foot length as installed and accepted under this project
- Eight (8) factory connectorized (ST-type) pigtails of ten foot length as installed and accepted under this project
- Eight (8) factory connectorized (SC-type) pigtails of ten foot length as installed and accepted under this project
- Eight (8) fiber optic field ethernet switches as installed and accepted under this project
- Two (2) wireless radio transceivers as installed and accepted under this project
- One (1) fiber optic restoration kit as specified below
- One (1) fiber optic power meters as specified below
- One (1) optical light generators as specified below
- Five (5) units of heat shrink tubing for risers as installed and accepted under this project
- Five (5) heat shrink tubing retrofit kits as installed and accepted under this project

D. CCTV System Support Equipment

Furnish new, unused CCTV system support equipment to the Engineer in the quantities shown below.

- Two (2) CCTV assembly as installed and accepted under this project
- Two (2) video CODEC units as installed and accepted under this project
- One (1) CCTV Test Monitor as specified below
- One (1) CCTV test cabinet as specified below

E. DMS System Support Equipment

Furnish new, unused DMS system support equipment to the Engineer in the quantities shown below.

- Two (2) DMS controllers as installed and accepted under this project

42.2. 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

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 the local controller software being provided by NCDOT.

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 the local controller software being provided by NCDOT (found in the chart below). No other vendor specific functionality shall be present on the display panel:

C1 Connector	Controller Function
35	2PY
36	6PY
37	4PY

C1 Connector	Controller Function
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 local controller software being provided by NCDOT. 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 defaults for inputs are listed in the chart located on the following page.

C1 Connector	Controller Function
56	Det. 1 / Ø1
39	Det. 2 / Ø2
58	Det. 3 / Ø3
41	Det. 4 / Ø4
55	Det. 5 / Ø5
40	Det. 6 / Ø6
57	Det. 7 / Ø7

C1 Connector	Controller Function
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

C1 Connector	Controller Function
70	8 Ped
51	Preempt 1
54	-
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 of equal requirements to other notebook computers furnished under this project 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 Signal Shop. The test cabinet shall include a 2070L controller in a Type 336 cabinet. The test cabinet shall include a full complement of detector amplifiers, switch packs, a signal monitor, and one fiber optic field Ethernet switch. The test cabinet shall also contain two (2) AC Isolators and two (2) DC Isolators. 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 336 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 cabinet/controller 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 ethernet switch to the communication system.

C. Communication System Support Equipment

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

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.

D.2. CCTV Test Cabinet

Furnish and install a CCTV test cabinet at the Signal Shop. The test cabinet shall be identical to those provided in the field at CCTV locations under this project. The test cabinet and panel shall be fully labeled.

D.2.1. Construction

The CCTV test cabinet shall have a heavy-duty aluminum dolly base with heavy duty casters. The base shall accommodate a fully equipped base-mounted 336 cabinet.

D.2.2. Connection to System

The CCTV test cabinet will be connected to the field ethernet switch in the signal test cabinet, in a configuration similar to that being installed in the field under this project. Furnish and install a jumper cable sixteen (16) feet (minimum).

42.3. MEASUREMENT AND PAYMENT

Furnish 2070L Controller will be measured and paid as the actual number furnished and accepted.

Furnish 336 Cabinet will be measured and paid as the actual number furnished and accepted.

Furnish 332 Cabinet will be measured and paid as the actual number furnished and accepted.

Furnish DC Isolator Card will be measured and paid as the actual number furnished and accepted.

Furnish AC Isolator Card will be measured and paid as the actual number furnished and accepted.

Furnish Detector Card will be measured and paid as the actual number furnished and accepted.

Furnish Conflict Monitor will be measured and paid as the actual number furnished and accepted.

Furnish Optical Preemption Detector will be measured and paid as the actual number furnished and accepted.

Furnish Optical Preemption Phase Selector will be measured and paid as the actual number furnished and accepted.

Furnish Controller Tester will be measured and paid as the actual number furnished and accepted.

Furnish Signal Monitor Tester will be measured and paid as the actual number furnished and accepted. Notebook computer shall be considered incidental to the signal monitor tester and will not be paid for separately.

Furnish Load Switch will be measured and paid as the actual number furnished and accepted.

Furnish Surge Protector will be measured and paid as the actual number furnished and accepted.

Furnish Flasher Module will be measured and paid as the actual number furnished and accepted.

Furnish Flash Transfer Relay will be measured and paid as the actual number furnished and accepted.

Furnish Test Cabinet/Controller will be measured and paid as the actual number furnished and accepted.

Furnish Drop Cable (___-Fiber) will be measured and paid as linear feet furnished and accepted.

Furnish Communications Cable (___-Fiber) will be measured and paid as linear feet furnished and accepted.

Furnish Fiber Optic Interconnect Center will be measured and paid as the actual number furnished and accepted.

Furnish Splice Enclosure will be measured and paid as the actual number furnished and accepted.

Furnish ST Splice Connector will be measured and paid as the actual number furnished and accepted.

Furnish SC Splice Connector will be measured and paid as the actual number furnished and accepted.

Furnish ST Jumpers will be measured and paid as the actual number furnished and accepted.

Furnish SC Jumpers will be measured and paid as the actual number furnished and accepted.

Furnish SC-ST Jumpers will be measured and paid as the actual number furnished and accepted.

Furnish ST Pigtails will be measured and paid as the actual number furnished and accepted.

Furnish SC Pigtails will be measured and paid as the actual number furnished and accepted.

Furnish Field Ethernet Switch will be measured and paid as the actual number furnished and accepted.

Furnish Wireless Radio Transceiver will be measured and paid as the actual number furnished and accepted.

Furnish Fiber Optic Restoration Kit will be measured and paid as the actual number furnished and accepted.

Furnish Fiber Optic Power Meter will be measured and paid as the actual number furnished and accepted.

Furnish Optical Light Generator will be measured and paid as the actual number furnished and accepted.

Furnish Heat Shrink Tubing will be measured and paid as the actual number furnished and accepted.

Furnish Heat Shrink Tubing Retrofit Kit will be measured and paid as the actual number furnished and accepted.

Furnish CCTV Assembly will be measured and paid as the actual number furnished and accepted.

Furnish Video CODEC Unit will be measured and paid as the actual number furnish and accepted.

Furnish CCTV Test Monitor will be measured and paid as the actual number furnished and accepted.

Furnish CCTV Test Cabinet will be measured and paid as the actual number furnished and accepted.

Furnish DMS Controller will be measured and paid as the actual number furnished and accepted.

Payment will be made under:

Furnish 2070L Controller	Each
Furnish 336 Cabinet	Each
Furnish 332 Cabinet	Each
Furnish DC Isolator Card	Each
Furnish AC Isolator Card	Each
Furnish Detector Card	Each
Furnish Conflict Monitor	Each
Furnish Optical Preemption Detector	Each
Furnish Optical Preemption Phase Selector	Each
Furnish Controller Tester	Each
Furnish Signal Monitor Tester	Each
Furnish Load Switch	Each
Furnish Surge Protector	Each
Furnish Flasher Module	Each
Furnish Flash Transfer Relay	Each
Furnish Test Cabinet/Controller	Each
Furnish Drop Cable (6 Fiber)	Linear Foot
Furnish Communications Cable (12 Fiber)	Linear Foot
Furnish Communications Cable (24 Fiber)	Linear Foot
Furnish Communications Cable (48 Fiber)	Linear Foot
Furnish Communications Cable (72 Fiber)	Linear Foot
Furnish Fiber Optic Interconnect Center	Each
Furnish Splice Enclosure	Each

Furnish ST Splice Connector....................Each

Furnish SC Splice Connector....................Each

Furnish ST Jumpers....................Each

Furnish SC Jumpers....................Each

Furnish SC-ST Jumpers....................Each

Furnish ST Pigtails....................Each

Furnish SC Pigtails....................Each

Furnish Field Ethernet Switch....................Each

Furnish Wireless Radio Transceiver....................Each

Furnish Fiber Optic Restoration Kit....................Each

Furnish Fiber Optic Power Meter....................Each

Furnish Optical Light Generator....................Each

Furnish Heat Shrink Tubing....................Each

Furnish Heat Shrink Tubing Retrofit Kit....................Each

Furnish CCTV Assembly....................Each

Furnish Video CODEC Unit....................Each

Furnish CCTV Test Monitor....................Each

Furnish CCTV Test Cabinet....................Each

Furnish DMS Controller....................Each

43. TESTING & ACCEPTANCE

43.1. 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 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.

43.2. EQUIPMENT TESTS

A. Manufacturer Certification

Upon request by the Engineer, provide manufacturer's certification that all field equipment furnished under this project complies with the environmental and electrical requirements of the Project Special Provisions.

Field units are defined as follows:

- CCTV Camera Assembly

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 Jacksonville. 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, set up the designated cabinet/controller for each intersection at your facility in Jacksonville. 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 conflict monitor programming cards are properly programmed before installation at intersections. Demonstrate that simultaneous inputs to conflicting phases will cause the conflict monitor 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.

43.3. CABLE TESTS

Provide cable manufacturer's attenuation and Optical Time Domain Reflectometer (OTDR) testing data for each reel of cable prior to installation, in a format approved and accepted by the Engineer.

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.

Test results may be provided in hardcopy or electronic format. If provided in electronic format, include all necessary software required to view and print the results at no cost to the Department.

43.4. 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 field Ethernet switch.

43.5. 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, remote video operation facilities, 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 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. 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
- Remote access to the signal system software and CCTV software from the notebook computers and remote video operation facilities

- Local Area Network operations
- Demonstrate that all features of the CCTV central software operates as called for with all field equipment

43.6. OBSERVATION PERIOD

A 60-day observation period shall begin upon the successful completion of the tests described in this Section of the Project Special Provisions as well as the correction of all known deficiencies, including minor construction items and punch-list items developed by the Engineer. During the observation period, the Department shall observe equipment and software operations to determine that all components of the signal system operate properly and function according to the requirements of the Plans and these Project Special Provisions over an extended length of time.

During the observation period, respond to failures of the Contractor's equipment within two (2) hours and make repairs within eight (8) hours. For items that pose a traffic safety hazard (such as a controller failure), make repairs within four (4) hours. If any failures affect major system components (as defined below) for more than forty-eight (48) hours, the Department shall suspend the observation period beginning when the failure occurred. Resume the observation period after successful repair or replacement of equipment or software. Failures that necessitate a redesign of any component or failures in any of the major system components exceeding a total of three (3) instances of like nature in any thirty (30) day period shall terminate the observation period. Once the redesigned component has been installed and/or the failures corrected, the observation period shall be restarted from zero with the approval of the Engineer.

The major system components are:

- Local controllers and cabinets
- Fiber Optic Communication Network, including field Ethernet switches
- System hardware and software
- CCTV System
- DMS field controller, display module, and workstation software
- Local Area Network

A successful 60-day observation period shall consist of continuous operation with no more than a total of five (5) calendar days on non-operation due to mechanical, electrical, or other malfunctions.

The observation period shall be completed by the project completion date and prior to final acceptance of the project. The observation period shall not begin until all testing has been successfully completed and shall not begin without the approval of the Engineer.

43.7. FINAL ACCEPTANCE

Final system acceptance is defined as the time when all work and materials described in the Plans and these Project Special Provisions have been furnished and completely installed by the Contractor; all parts of the work have been approved and accepted by the Engineer; and successful completion of the 60-day observation period.

The project will be ready for final acceptance upon the satisfactory completion of all tests detailed in this Section of the Project Special provisions; the rectification of all punch-list discrepancies; the submittal of all project documentation; and the completion of all required training.

43.8. MEASUREMENT AND 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.

44. TRAINING

44.1. DESCRIPTION

Provide training for the installation, operation and maintenance of the computerized traffic system.

44.2. MATERIALS

A. General

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.

A.1 Submittal Requirements

Prior to commencement of the training course, submit the following to the Engineer for review and approval:

- Detailed course curricula
- Draft training manuals, and course handouts
- Resumes of all instructors

The Engineer may request modification to the submitted material

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 all 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

Jacksonville 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.

B. 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
Traffic Control Center Computer Hardware – Session 1	1 Day
Traffic Control Center Computer Hardware – 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
Signal Controller and Cabinet Assemblies (for Signal Timing Personnel and Maintenance Personnel)	3 Occurrences at 5 Days Each
Fiber Optic Communications System	2 Occurrences at 3 Days Each
Communications Hardware – Session 1	1 Day
Communications Hardware – Session 2	1 Day
Central Communications and LAN Equipment	3 Days
CCTV Central and Field Equipment – Session 1	2 Days
CCTV Central and Field Equipment – Session 2	1 Day
DMS Central and Field Equipment – Session 1	2 Days
DMS Central and Field Equipment – Session 2	1 Day

C. Required Content and Format

C.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.

C.2. Traffic Control Center Computer Hardware

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 backup system (including maintenance, proper replacement, etc.)
- Traffic Control Center and Signal Shop workstation and printer operation, maintenance, proper 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).

C.3. Traffic Control Applications Software

These 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:

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.

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.

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.

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.

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.

C.4. Signal Controller and Cabinet Assemblies

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.**

Training for controllers and cabinets shall be integrated into a single session with training exercises for cabinets and training exercises for controllers running concurrently. Instructors from the controller vendor and instructors from the cabinet vendor shall be in attendance during all days of the session.

Controller-specific instruction during the 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. Cabinet-specific instruction during the session shall be taught by a field service specialist(s) employed by the manufacturer.

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.

The signal controller and cabinet assemblies session shall include, but not be limited to, the following.

- Formal classroom presentation of the functional operation of the signal cabinet, including a discussion on each individual component of the cabinet that details it function, installation techniques, and normal operation
- Formal classroom presentation of the functional operation of the 2070L controller.
- Formal classroom presentation of proper cabinet wiring procedures
- Hands-on workshop on installation of electrical components and surge protection for cabinets.

- Formal classroom presentation and hands-on workshop on operation of signal monitor tester
- Hands-on workshop on timing data entry for 2070L controller.
    - All local intersection timing parameters
    - All coordination timing parameters
    - All parameters and threshold levels associated with traffic responsive operation
- Formal classroom presentation and hands-on workshop on operation of local controller utility software
- Formal classroom presentation and hands-on workshop on operation of controller tester
- Hands-on workshop of proper installation, programming, and troubleshooting of conflict monitors
- Hands-on workshop of proper installation, programming, and troubleshooting of detector cards and lead-in cable
- Hands-on workshop wherein maintenance personnel will troubleshoot simulated controller and cabinet assembly faults to the component level

The signal controller and cabinet assemblies session shall have the following daily agenda topics:

- Day 1 – Signal cabinets
- Day 2 – Signal cabinets (continued)
- Day 3 – Signal controller software and hardware
- Day 4 – Signal controller software and hardware (continued)
- Day 5 Morning – Signal controller software and hardware (continued)
- Day 5 Afternoon – Conflict monitors

C.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 following procedures:

- Cable terminations
- 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
- 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.

C.6. Communications Hardware

The training session shall consist of classroom training and workshops regarding the operation of each of the communications system hardware elements and the technician interface. Conduct training by experienced vendor personnel.

The first session shall involve the operation and maintenance procedures for the fiber optic Ethernet switches (field and central models). At a minimum, cover the following subjects in this segment of the training session:

- Overview of equipment functions and interactions.
- Initialization startup and restarting of hardware.
- Functional operation of the fiber optic Ethernet switches (including maintenance, proper replacement, etc.)
- Troubleshooting and problem identification of equipment.

The second session shall involve the operation and maintenance procedures for the cellular modems and wireless radio systems. At a minimum, the second session shall consist of the following:

- Overview of equipment functions and interactions.
- Overview of setup and operation of any associated software.
- Initialization startup and restarting of hardware.
- Functional operation of the cellular modems (including maintenance, proper replacement, integration with telephone demarcation in field, integration with servers at TOC, etc.)

- Functional operation of the wireless radio systems (including maintenance of fiber optic Ethernet switches and antennas, integration with signal controller and cabinet, etc.)
- Troubleshooting and problem identification of cellular and wireless radio equipment.

Each of these two training sessions shall have a minimum duration of one (1) day (lectures and/or workshops).

C.7. Central Communications and LAN Equipment

Provide a training session, conducted by experienced vendor personnel and consisting of both operation and maintenance training of the Central Communication and LAN Equipment for the signal system. As a minimum, this session shall include the following subjects:

- Present system topology
- Operational theory of IP/Ethernet communications
- Operational procedures for network monitoring software
- Operational procedures for Ethernet switches
- Operational procedures for remote user operation
- Procedures for adding future devices to the network
- Troubleshooting procedures

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.

C.8. 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 including CCTV camera, equipment cabinet, controller, and video CODEC units. The training shall address the preventative maintenance and troubleshooting procedures for all the field and central equipment.

This session shall consist of a mixture of lecture and hands-on workshops and shall have a minimum duration of two (2) days.

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
- LCD monitors and video projector (including video monitor processor units)

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.

C.9. DMS Central and Field Equipment

Provide two sessions for the DMS central and field equipment training.

The first session shall address the maintenance of the DMS equipment including DMS display, equipment cabinet, controller, and cellular modems. The training shall address the preventative maintenance and troubleshooting procedures for all the field and central equipment.

This session shall consist of a mixture of lecture and hands-on workshops and shall have a minimum duration of two (2) days.

The second session shall address the operational theory and procedures of the DMS 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:

- DMS Server
- Camera control software

Include "hands-on" training workshop with a minimum duration of one (1) day as part of this session. The DMS training sessions shall be presented by field service specialist(s) employed by the suppliers of the DMS system components.

44.3. MEASUREMENT AND PAYMENT

Training will be paid for as contract lump sum price.

Payment will be made under:

Training..Lump Sum