Project Special Provisions

U-4704
Chapel Hill-Carrboro Signal System Design

Final

December 30, 2008

Prepared for:
North Carolina Department of Transportation

Kimley-Horn
and Associates, Inc.

PROJECT SPECIAL PROVISIONS

FINAL

TIP U-4704

PREPARED BY:

KIMLEY-HORN AND ASSOCIATES, INC.

POST OFFICE BOX 33068

RALEIGH, NORTH CAROLINA, 27636-3068

PREPARED FOR:

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

INTELLIGENT TRANSPORTATION SYSTEMS SECTION

Signature

12/29/08
Date:

Prepared by: KWS

Project Special Provisions

Intelligent Transportation Systems Section

Prepared By: KWS

30-Dec-08

Contents

1. GENERAL REQUIREMENTS

1.1. DESCRIPTION

A. General

Furnish, install, and fully integrate new fiber optic communications cable, existing fiber optic communications cable, cellular communications links, new traffic signal controllers and cabinets, new closed-circuit television camera 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 Towns of Chapel Hill and Carrboro in North Carolina.

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

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 and existing conduit systems.

Furnish and install new fiber optic communications cable to be used by the Town of Chapel Hill IT Department and the Town of Carrboro IT Department. Town IT cables will be installed as shown on the Plans by lashing to existing cables and new messenger cable installed under this project, and utilizing new and existing conduit systems. Town IT cables will be installed concurrently with signal system cables, or on new cable routing, and terminate inside Town facilities as shown on the cable routing plans and building detail drawings. **The installation of Town 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 Town 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 the fiber optic communications network. Allow for the future installation by others of future CCTV camera assemblies as shown in the Plans by splicing dedicated fiber to the TOC.

Complete and fully integrate a new traffic operations center (TOC) to be housed at the Town Operations Center, Building 2, located at 6900 Millhouse Road in Chapel Hill. Terminate all fiber

optic communications cables at the modified TOC as shown in the Plans. Install and fully integrate remote TOC functionality at the Town Emergency Operations Center (EOC) in Fire Station 1 located at 403 Martin Luther King Jr. Boulevard in Chapel Hill.

Complete and fully integrate new network access points for future video operations at the Chapel Hill Police Department building located at 828 Martin Luther King Jr. Boulevard in Chapel Hill and the University of North Carolina Public Safety building located at 285 Manning Drive in Chapel Hill. Install new Ethernet switches and integrate with the fiber optic communications network to establish a connection between the TOC and the police facilities.

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

Complete and fully integrate video sharing functionality between the TOC and the NCDOT Triangle Regional Transportation Management Center (TRTMC) located at 101 Roscoe Trail in Raleigh. Integrate with existing NCDOT fiber optic cable and fully comply with the existing regional video sharing architecture.

Install system detection loops, local detection loops, detector cards, and other traffic signal equipment as noted in the traffic signal plans.

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, transceivers, codecs, and Ethernet switches.

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

Warrant workmanship and Contractor-furnished equipment for a 60-day observation period under the payment and performance bond from date of acceptance.

If workmanship or equipment fails during the 60-day observation period, repair or replace with new equipment and begin a new 60-day observation period.

All project documentation shall be submitted to the Engineer prior to completion of the 60-day observation period.

The observation period for this work will be part of the work to be completed by the project completion date.

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 two years in length from successful completion of the 60-day observation period. 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 successful completion of the 60-day observation period, 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 firmware performance upgrades that occur during the contract period are available to the Department at no additional cost.

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

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. See Section 24 for list of cabinets provided under this project that shall be painted green.

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.

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. Haul and dispose of all waste as required by Section 802 of the Standard Specifications.

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 Town of Chapel Hill and Town of Carrboro 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 THW 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 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.

E. Performance of Warranty Repair and Maintenance

Provide authorization to the Town of Chapel Hill to perform all warranty repairs after project acceptance. The decision to perform warranty work by Town electronics technicians or to have warranty work performed by the vendor shall be at the discretion of the Town. Provide any training required by the manufacturer to authorize the Town to perform warranty work and ensure manufacturer will furnish parts to the Town for all warranty repairs at no cost to the Town. In addition, ensure the manufacturer agrees to provide prompt technical support to the Town electronics technicians for a period of one year after the end of the warranty period (three years total) at no cost to the Town. Defective parts replaced under warranty by the Town will be returned to the vendor at the vendor's request. Provide schematics, part lists, and other documentation to perform bench repair to the Town within two weeks upon request. The Town 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 Town, manufacturer shall perform warranty repairs to equipment which fails during the warranty period at no cost to the Town including freight costs to ship repaired equipment back to the Town. Ensure all equipment is repaired and returned to the Town 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 including GPS units and material between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Division 7 Traffic Services Office, located at 1584 Yanceyville Street in Greensboro, 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 Town of Chapel Hill 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 Town of Chapel Hill Signal Shop, located at 6900 Millhouse Road in Chapel Hill, 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.

Comply with the sequence of construction in the Plans and these Project Special Provisions when removing existing communications cable.

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

H. Railroad Preemption

Where existing railroad preemption is present at signals, re-install preemption equipment in new cabinets. Ensure preemption functions properly after construction at the signal.

I. Emergency Vehicle Preemption Systems

Where required, implement and install 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.

J. Timing of Signals

Implement timing values for signal controllers. Extract all parameters necessary to implement coordinated signal operations from the existing controllers. Where applicable, request coordinated timing parameters from the Engineer. 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. Grounding

Provide a grounding system at all new and revised electrical service points unless otherwise specified.

In addition to NEC requirements, test grounding electrode resistance at connection point to electrical service ground bus for a maximum of 20 ohms. Furnish and install additional ground rods to grounding electrode system as necessary to meet test requirements. Submit a completed Inductive Detection Loop & Grounding Test Results form. The form is located on the Department's website at:

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

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

M. Contractor's Office

Throughout the project until final acceptance, the Contractor shall maintain full-time staffed office with storage and testing facilities within the Chapel Hill or Carrboro Town Limits.

N. Related Projects

The Town 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.

O. Sequence of Construction

At the direction of the Engineer, install new messenger cable at the beginning of construction to reserve spot on existing utility poles for fiber optic cable to be install under this project. 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 and as shown in the Plans. 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 common controller clock time. Insure clock time is in synch with clock time of existing central software until it is removed. 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 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.

As shown on the Sequence of Construction Detail in the Plans, each traffic signal location has been defined a Zone. Zone A includes traffic signals that are in an existing closed loop system. Zone B includes traffic signals that are not in an existing closed loop system. Zone C includes traffic signals that are in an existing closed loop system on a SuperStreet.

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

Construction at Zone A traffic signals must be completed by entire control zone. Contractor must ensure that time-of-day plans are installed and running to ensure coordination while off-line.

Construction at Zone C traffic signals must be completed such that communication and coordination is maintained during construction.

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

P. 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.

Q. Requirements for Cables Crossing Railroads

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

Q.1. Railroad Crossings

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

	Encroachment	Near	Agency	Route
1	Homestead Rd.	Merin Rd.	NSRC	Overhead Crossing
2	Cameron Ave.	Merrit Mill Rd.	NSRC	Underground Crossing
3	E. Main St.	Roberson St.	NSRC	Underground Crossing
4	N. Greensboro St.	Poplar Ave.	NSRC	Underground Crossing

Q.2. Requirements for Insurance

In addition to any other forms of insurance or bonds required under the terms of the contract and specifications, the Prime 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 Railroad right(s) of way by carrying insurance of the following kinds and amounts:

Q.2.1. Contractor's Commercial General Liability Insurance

The Contractor shall furnish an original and one copy of the certificate of insurance and one certified copy of the policy to the Department as evidence that, with respect to the operations he performs on railroad right of way, he carries regular Commercial General Liability Insurance having a combined single limit of not less than $2,000,000 per occurrence for all loss, damage, cost and expense, including attorneys' fees, arising out of bodily injury liability and property damage liability during the policy period. Said policy shall include explosion, collapse, and underground hazard (XCU) coverage, shall be endorsed to name Railroad specified below as an additional insured, and shall include a severability of interests provision.

Q.2.2. Railroad Protective Liability Insurance

The Contractor shall furnish to the Department an original and one duplicate of the Railroad Protective Liability Insurance having a combined single limit of not less than $2,000,000 each occurrence and $6,000,000 in the aggregate applying separately to each annual period. If the project involves track over which passenger trains operate, the insurance limits required are not less than a combined single limit of $5,000,000 each occurrence and $10,000,000 in the aggregate applying separately to each annual period. Said policy shall provide coverage for all loss, damage or expense arising from bodily injury and property damage liability, and physical damage to property attributed to acts or omissions at the job site.

The standards for the Railroad Protective Liability Insurance are as follows:

a. The insurer must be rated A- or better by A.M. Best Company, Inc.

b. The policy must be written using one of the following combinations of Insurance Services Office ("ISO") Railroad Protective Liability Insurance Form Numbers:

(1) CG 00 35 01 96 and CG 28 31 10 93; or

(2) CG 00 35 07 98 and CG 28 31 07 98; or

(3) CG 00 35 10 01; or

(4) CG 00 35 12 04.

c. The named insured shall read:

Norfolk Southern Railway Company

Three Commercial Place

Norfolk, Virginia 23510-2191

Attn: Scott Dickerson, Risk Management

d. The description of operations must appear on the Declarations, must match the project description in this agreement, and must include the appropriate Department project and contract identification numbers.

The Description and Designation shall read:

Installation of fiber optic cable over/under tracks in Orange County, North Carolina, U-4704.

e. The job location must appear on the Declarations and must include the city, state, and appropriate highway name/number.

f. The name and address of the prime contractor must appear on the Declarations.

g. The name and address of the Department must be identified on the Declarations as the "Involved Governmental Authority or Other Contracting Party."

h. Other endorsements/forms that will be accepted are:

(1) Broad Form Nuclear Exclusion – Form IL 00 21

(2) 30-day Advance Notice of Non-renewal or cancellation

(3) 60- day written notice be given the Department prior to cancellation or change

(4) Quick Reference or Index Form CL/IL 240

i. Endorsements/forms that are NOT acceptable are:

(1) Any Pollution Exclusion Endorsement except CG 28 31

(2) Any Punitive or Exemplary Damages Exclusion

(3) Known injury or Damage Exclusion form CG 00 59

(4) Any Common Policy Conditions form

(5) Any other endorsement/form not specifically authorized in item no. h above.

If any part of the work is sublet, similar insurance, and evidence thereof as specified above, shall be provided by or on behalf of the subcontractor to cover its operations on Railroad's right of way. As an alternative, the Prime Contractor may provide insurance for the subcontractor by means of separate and individual policies.

Prior to entry on Railroad right-of-way, the original and one duplicate copy of the Railroad Protective Liability Insurance Policy shall be submitted by the Prime Contractor to the Department at the address below for its review and transmittal to the Railroad. In addition, certificates of insurance evidencing the Prime Contractor's and any subcontractors' Commercial General Liability Insurance shall be issued to the Railroad and the Department at the addresses below, and one certified copy of the Prime Contractor and any Subcontractors policy is to be forwarded to the Department for its review and transmittal to the Railroad. All policies and certificates of insurance shall state that the insurance coverage will not be suspended, voided, canceled, or reduced in coverage or limits without (30) days advance written notice to Railroad and the Department. No work will be permitted by Railroad on its right-of-way until it has reviewed and approved the evidence of insurance required herein.

DEPARTMENT:	RAILROAD:
Department of Transportation	Mr. Scott Dickerson
Rail Division	Risk Management
c/o Mr. David Hinnant, State Railroad Agent	Norfolk Southern Railway Company
1556 Mail Service Center	Three Commercial Place
Raleigh, NC 27699-1556	Norfolk, Virginia 23510-2191

The insurance required herein shall not limit the obligations of Department or its Contractors under the terms of this agreement.

All insurance herein before specified shall be carried until the final inspection and acceptance of the project, or that portion of the project within railroad right of way, by the Department 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 that 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, Contractor shall immediately notify the Department of Transportation and shall 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, Contractor shall 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 and the Railroad Company as to form and amount prior to beginning work on railroad right of way.

No separate payment will be made for any extra cost incurred on account of compliance with these special provisions. All such cost shall be included in prices bid for other items of the work as specified in the payment items.

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

Send to Department:
Department of Transportation
Rail Division
c/o Mr. David Hinnant, State Railroad Agent
1556 Mail Service Center
Raleigh, NC 27699-1556

Q.3. Failure to Comply

In the event the Contractor violates or fails to comply with any of the requirements of these Special Provisions:

(1) The Railroad Engineer may require that the Contractor vacate Railroad property.

(2) The Engineer may withhold all monies due the Contractor on monthly statements.

Any such orders shall remain in effect until the Contractor has remedied the situation to the satisfaction of the Railroad Engineer and the Engineer.

Q.4. Delays Caused By Operations of Others

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

Q.5. Cooperation with Others

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

Q.6. Authority of Railroad Engineer

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

Q.7. 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.

Q.8. 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 for damage to such material and equipment from any cause and that the Railroad Engineer may move or require the Contractor to move, at the Contractor's expense, such material and equipment.

Q.9. Flagging Protection or Watchman Service

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

Q.10. 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.

R. Requirements for Historic Areas

As shown in the Plans, some work will be conducted within areas determined to contain properties with documented historic significance. If it is necessary to deviate from the Plans in these areas, alert the Engineer to contact Project Development And Environmental Analysis Branch-Historic Architecture Group of the North Carolina Department of Transportation for an effects determination before proceeding.

1.4. 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. SIGNAL HEADS

3.1. 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.

3.2. 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.

D. Pedestrian Push-Buttons

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.

Where required, provide post mounting for push-buttons. Use 2" maximum metallic conduit for

push-button post with minimum height of 5' above ground level. Use class B or better concrete for post foundation with minimum dimensions of 12" x 12" x 18" (L x W x D). Use 2" metallic conduit elbow in concrete foundation to connect post to conduit for lead-in cable.

E. 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.

3.3. 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

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. Pedestrian Push-Buttons

Comply with Standard Drawings 1705.02 for mounting push-buttons and signs. Mount push-buttons on existing supports or new posts as shown in the Plans. Ensure push-buttons are mounted 3' 6" above ground level, and are accessible from an adjacent paved surface. Install signs with mounting hardware immediately above pedestrian push-buttons.

Connect new push-buttons to the cabinets as shown in the Plans and using lead-in cable as specified in Section 15 of these Project Special Provisions. Ensure each push-button is wired independently.

Connect existing push-buttons to the controller cabinets as shown in the Plans, either by using the existing cable or by installing new lead-in cable as specified in Section 15 of these Project Special Provisions. Ensure each push-button is wired independently. Connect the push-buttons as shown on the electrical detail to the correct DC isolator(s) furnished as part of the cabinet specified in Section 24 of these Project Special Provisions.

3.4. 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.

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.

Pedestrian push-button, when installed and to be integrated with existing pedestrian signal heads, will be measured and paid for as the actual number furnished, installed, and accepted.

Pedestrian push-button, when existing and to be integrated with the cabinet that require new lead-in cable, risers, trenching, or other work, will be measured and paid for under applicable line items listed in these Project Special Provisions.

No measurement will be made of signs, conduit for mounting posts, conduit connectors, conduit caps, other associated mounting hardware, or bonding and grounding as these will be considered incidental to furnishing and installing pedestrian bush-buttons or updating pedestrian signal heads.

Payment will be made under:

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

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

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

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

Signal Cable ..... Linear Foot

Pedestrian Push-Button ..... Each

4. SIGNAL PEDESTAL

4.1. DESCRIPTION

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

4.2. 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 3 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.

4.3. CONSTRUCTION METHODS

Comply with Standard Drawings 1705.02.

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.

4.4. 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

5. SIGNS INSTALLED FOR SIGNALS

5.1. DESCRIPTION

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

Signs related to bicycle detection will be provided and installed by the Town of Chapel Hill. Coordinate with the Engineer to provide 30-day notice on when the signs will be required to be installed.

5.2. 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.

5.3. 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.

5.4. 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

6. PAVEMENT MARKING SYMBOLS

6.1. DESCRIPTION

Furnish and install pavement markings in accordance with the plans.

6.2. MATERIALS

A. General

Refer to and fully comply with section 1087 of the standard specifications.

B. Material Qualification

Use pavement markings which are on the Department's Approved Products List or are traffic qualified by the Traffic Control Unit.

C. Historical Performance

Historical performance of the pavement marking material will be used in determining future use of the material by the Department, even if material has been traffic qualified. Poor past or poor current performance of pavement marking material at any site, whether or not related to a specific contract may be grounds for non-acceptance of a product on any project under contract.

6.3. CONSTRUCTION METHODS

A. General

Refer to and fully comply with section 1205 of the standard specifications.

B. Application Equipment

Use pavement marking application equipment such that all parts that come in contact with pavement marking material are constructed for easy accessibility during cleaning and maintenance.

Keep the marking guns of the application device in full view of the operators at all times. Use applicators that are mobile and maneuverable to the extent that straight lines can be followed and all standard curves can be made in true arcs.

C. Surface Preparation and Curing Compound Removal

Prepare the pavement to accept pavement markings to insure maximum possible adhesion. Clean, seal and remove curing compound as necessary to insure that the markings adhere to the pavement. Obtain approval for all surface preparation methods prior to implementing.

Pavements shall be free of grease, oil, mud, dust, dirt, grass, loose gravel and other deleterious material, prior to applying pavement markings.

Prepare the pavement surface, including removal of curing compound, a minimum of 2" wider than the pavement markings to be placed, such that, an additional 1" of prepared area is on all sides of the pavement markings after they are applied.

Remove all curing compound and surface laitance on Portland cement concrete pavements where long-life pavement markings will be placed. Perform curing compound removal by high-pressure water or shot blasting methods. Ensure that the surface is free of all residue, laitance and debris prior to applying the pavement marking.

When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air to remove residue or debris.

Curing compound removal will be paid for at the applicable contract unit price. All other surface preparation will be considered incidental to the work covered by this specification.

If required, apply a primer sealer to pavement surfaces before applying pavement marking material as recommended by the manufacturer. Apply primer sealer in a continuous film in such a way as to not cause any noticeable change in the appearance of the pavement markings. Submit a sample of the primer sealer to the Engineer, prior to application.

Conduct all pavement surface preparation including curing compound removal in such a manner that the pavement or joint material is not damaged or left in a condition that will mislead or misdirect the motorist. Repair any damage caused to the pavement, or joint materials caused by surface preparation or the removal of curing compound by acceptable methods and at no additional cost to the Department.

Where pavement surface preparation results in obscuring existing pavement markings of a lane occupied by traffic, immediately remove the residue, including dust, by approved methods.

D. Application of Pavement Markings

Install pavement marking material that has a uniform thickness, a smooth surfaced cross section throughout its entire length, width and length not less than the dimensions specified in the plans and that does not exceed the dimension by more than 1/2".

Do not apply pavement marking materials over a longitudinal joint. See Standard Drawing No. 1205.01 sheet 2 of 2 for details.

Install pavement marking lines that are straight or have uniform curvature and conform with the tangents, curves, and transitions as specified in the plans.

Produce finished lines that have well defined edges and are free of horizontal fluctuations. Do

not exceed 1/2" in lateral deviation from the proposed location alignment at any point. Any greater deviations may be cause for requiring the material to be removed and replaced at no additional cost.

Apply all longitudinal pavement marking lines 8" or less in width with one pass of the pavement marking equipment. Pavement marking lines greater than 8" in width and pavement marking symbols may be applied with multiple passes of the pavement marking equipment

The stem portion of straight arrows shall be applied in a single pass and the stem portion of turn arrows is to be applied in a maximum of 2 passes of the application equipment. Arrowheads may be applied by multiple passes of the application equipment, not to exceed three passes.

Install all pavement marking lines, characters, and symbols that require multiple passes of the application equipment such that there are no gaps separating the application passes.

Install characters and symbols so that they conform to the sizes and shapes shown in the plans.

Use pavement marking material that is capable of accepting an overlay of compatible material.

Protect the pavement markings until they are track free. Remove any markings tracked by a vehicle by acceptable methods and at no additional expense to the Department.

Reapply any molten pavement marking that is crossed by a vehicle. Payment will only be made for 1 application of molten pavement marking.

Remove all pavement marking materials spilled on the road surface by acceptable methods at no additional expense to the Department.

Use yellow, white, and black pavement markings, without drop-on glass beads, that visually match the color chips that correspond to the Federal Test Standard Number 595a for the following colors. Use markings that when subjected to accelerated weathering as described in U.S. Federal Specification No. (TT-P-115F) are within the tolerance limits of the color chips listed below:

- WHITE: Color 17886
- YELLOW: Color 13538
- BLACK: Color 37038

E. Pavement Markings Observation Period

This pavement markings observation period shall be a separate entity than the system observation period defined in these Project Special Provisions.

Maintain responsibility for the pavement markings for a 180 day observation period beginning upon the satisfactory completion of all work required in the plans. Guarantee the markings under the

payment and performance bond in accordance with Article 105-17.

Have traffic operating on the facility during the entire 180 day observation period unless otherwise directed.

During the 180 day observation period provide pavement marking material that shows no signs of failure due to blistering, excessive cracking, chipping, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, gasoline drippings, spilling, poor adhesion to the pavement materials, loss of reflectivity, vehicular damage, or normal wear.

Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation.

F. Pavement Marking Installer Qualifications

Have at least one member of every pavement marking crew certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. The certified crewmember is not required to be the same person throughout the life of the contract.

6.4. THERMOPLASTIC (ALKYD/MALEIC)

A. Application Equipment

Use equipment to install hot thermoplastic pavement marking material that includes the following features:

Premelting Kettle: oil-jacketed or air-jacketed utilized for uniform heating and melting of the thermoplastic material. Use a kettle that is equipped with an automatic thermostat control device to provide positive temperature control and continuous mixing and agitation of the thermoplastic material. Do not premelt thermoplastic material in handliner type equipment.

Applicator Storage Kettle: Equip long line pavement marking vehicles with an automatic thermostat control device to maintain the thermoplastic material at the application temperature and provide continuous mixing and agitation of the thermoplastic material during installation. Construct the equipment so that all mixing and conveying parts, up to and including the application apparatus, maintains the thermoplastic pavement marking material at the specified installation temperature and which has a capacity of a minimum of 1500 lbs. of molten thermoplastic pavement marking material. Hand transfer is not allowed.

Hand Liner type application vehicles may contain the premelting and applicator storage

functions in the same kettle. Agitation and mixing can be done manually. Drag box type and bucket type application is not allowed.

Use premelting and applicator storage kettles that meet the requirements of the National Board of Fire Underwriters, the National Fire Protection Association, and State and local authorities.

Use application equipment that is constructed to assure continuous uniformity in the thickness and width of the thermoplastic pavement marking.

Use application equipment that provides multiple width settings ranging from 4" to 12" and multiple thickness settings to achieve the pavement marking thickness ranging from 0.090" to 0.120". Special thickness equipment may be required for in lane or shoulder transverse rumble strip pavement markings.

Do not use spray thermoplastic unless approved by the Work Zone Traffic Control Unit.

B. Weather Limitations and Seasonal Limitations

Do not apply thermoplastic pavement markings on existing or new pavements unless the ambient air temperature and the temperature of the pavement is 50°F or higher.

Do not apply thermoplastic pavement markings between November 30 and the following April 1.

Exception to the above: When traffic is maintained on a portion of roadway and thermoplastic pavement marking will not be placed within 30 calendar days due to seasonal limitations, place pavement marking paint and beads in accordance with Subarticle 1205-8(C).

C. Application

Use only thermoplastic markings that are of the hot, machine applied type. Apply Alkyd/Maleic thermoplastic pavement markings by extrusion methods only. Extrusion may be accomplished using either conventional extrusion equipment or ribbon gun extrusion devices.

Apply Drop-on Beads uniformly to the surface of the molten thermoplastic material so that the beads are partially embedded and at a rate to immediately obtain the minimum reflectance values. At the time of installation, produce in place markings with the minimum retroreflective values shown below, as obtained with a LTL 2000 Retroreflectometer or Department approved mobile retroreflectometer. Maintain the retroreflective values shown below for a minimum of 30 days from the time of placement of the marking material.

- White: 375 mcd/lux/m2
- Yellow: 250 mcd/lux/m2

Ensure that the marking is uniformly retroreflective upon cooling and has the ability to resist deformation caused by traffic throughout its entire length.

A thin layer of pavement marking paint at the proper width may be placed prior to applying the thermoplastic markings. If this option is chosen, when not specified in the plans or by the Engineer, direct payment for the paint will not be made. Cover any such thin layer of pavement marking paint with thermoplastic pavement marking within 30 calendar days of placement. Apply the thin layer of pavement marking paint and beads at the rate necessary to produce a dry film thickness of 5 - 8 mils. Apply drop-on glass beads at a rate of 1-3 pounds per gallon of paint.

Provide drainage openings at intervals of 250 feet in edge lines placed on the inside of curves and in edge lines on the low side of tangents. Provide openings that are a maximum of 12" and a minimum of 6" in length.

Produce a cross sectional thickness of the thermoplastic markings above the surface of the pavement as follows:

- 240 mils: In-lane and shoulder-transverse pavement markings (rumble strips) may be placed in 2 passes.
- 120 mils: Center lines, skip lines, transverse bands, mini-skip lines, characters, and crosswalk lines.
- 90 mils Edge lines, gore lines, diagonals, and arrow symbols.

D. Testing

Retroreflective measurements will be taken within 30 days prior to the end of the 180 day pavement markings observation period. Maintain minimum retroreflective values as shown below throughout the 180 day pavement markings observation period.

- White: 325 mcd/lux/m2
- Yellow: 200 mcd/lux/m2

At the end of the Pavement Markings Observation Period, the thermoplastic pavement marking material shall be within 10 mils of the initial pavement marking thickness as required in the plan. Take the thickness measurements as specified by Materials and Tests Unit Procedure PM-1.0. See the Construction Manual for details.

6.5. MEASUREMENT AND PAYMENT

Pavement Marking Symbols will be measured and paid for as the actual number of pavement

marking symbols that have been satisfactorily placed and accepted by the Engineer.

Payment at the contract unit price for the item above will be full compensation for the item. No direct payment will be paid for work involved in applying the symbols, reapplication of molten pavement marking crossed by a vehicle, removal of all pavement marking materials spilled on the roadway surface.

Payment will be made under:

Thermoplastic Pavement Marking Symbol (Bicycle Loop) .....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.

Use 3/8-inch messenger cable for spans supporting signal heads.

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

For permanent installation, install messenger cable in continuous lengths with no splices except where an insulator is required. 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 signal heads or loop lead-in cable attached to joint use poles, install a new grounding system that complies with Article 1720-3 for bonding messenger cable. If a pole ground exists on the joint use pole, bond new pole grounding system to existing pole ground using number 6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or Burndy clamps (UCG25RS) at each end.

For messenger cable for communications cable attached to joint use poles, bond messenger cable to existing pole ground using Burndy clamps (UCG25RS) 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 number 6 AWG minimum solid bare copper wire and bond with split bolt connectors or Burndy clamps (UCG25RS) or equivalent and terminate to pole ground.

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

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

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

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 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 smooth outer wall and 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.

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

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

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

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

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

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

Comply with Subarticle 1400-2(H) Duct and Conduit Sealer.

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

8.3. CONSTRUCTION METHODS

A. General

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. Seal conduits containing signal cable and loop lead-in wire with moldable duct seal.

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 PVC, 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.

E. Bore and Jack

For bore and jack areas, comply with Subarticles 1540-3 A & B except as follows:

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

Comply with the *NCDOT Policies and Procedures for Accommodating Utilities on Highway Rights-of-Way* in effect on the date of advertisement.

F. Multi-Duct Installation in Outer-Duct

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

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

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

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

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

G. Reuse of Existing Conduit

At certain locations, the Plans call for the use of existing communications ducts made available by the Town of Chapel Hill, NCDOT, or others.

Prior to use of existing conduit, the Contractor shall be responsible for verifying the usability of the conduit for the size cable(s) called for in the Plans. For any locations where new conductors are to be installed where existing cable is present, the Contractor shall not damage nor affect the

usability of performance of the existing cable.

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.

Bore and jack (qty, size) will be measured in horizontal linear feet of bore and jack for underground conduit installation furnished, installed, and accepted. Measurement will be along the approximate centerline of the bore from junction box to junction box. Payment will be in linear feet.

Multi-duct (qty, size) in outer-duct (qty, size) will be measured in horizontal linear feet of multi-duct conduit 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, 2") ..... Linear Foot

Unpaved Trenching (2, 2") ..... Linear Foot

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

Bore and Jack (1, 5") ..... Linear Foot

Multi-Duct (2, 2") in Outer-Duct (1, 5") ..... 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.

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.

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 Town, 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.

Payment will be made under:

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

Junction Box (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 a minimum of 40 feet above ground level.

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 number 4 or 6 AWG solid bare copper wire that is exothermically welded to a ground rod. 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. Install ground rod at base of pole.

10.4. MEASUREMENT AND PAYMENT

Wood pole will be measured and paid as the actual number of wood poles for either communications cable or 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.

Payment will be made under:

Wood Pole.....Each

11. CCTV METAL POLES AND FOUNDATIONS

11.1. DESCRIPTION

Furnish and install metal poles, grounding systems, and all necessary hardware. The work covered by this special provision includes requirements for the design, fabrication, and installation of both standard and custom/site specifically designed metal traffic signal supports and associated foundations.

Provide metal poles that contain no guy assemblies, struts, or stay braces. Provide designs of completed assemblies with hardware that equals or exceeds AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals 4th Edition, 2001 (hereafter called 4th Edition AASHTO), including the latest interim specifications. Provide assemblies with a round or near-round cross-sectional design consisting of no less than six sides. The sides may be straight, convex, or concave.

Standard Drawings for Metal Poles are available that supplement these project special provisions. These drawings are located on the Department's website:

http://www.ncdot.org/doh/preconstruct/traffic/ITSS/ws/mpoles/poles.html

The required drawings are M 1, M 2, M 3, M 6, and M 7.

Comply with Subarticle 1098-1B "General Requirements" of the Standard Specifications for submittal requirements. Furnish shop drawings for approval. Provide triplicate copies of detailed shop drawings for each type of structure. Ensure that shop drawings show materials specifications for each component and identifies welds by type and size. Do not release structures for fabrication until structural drawings have been approved. Provide an itemized bill of materials for all structural components and associated connecting hardware on the drawings.

Provide a sealed copy of the pre-approved shop drawings that includes a project number or work order number on the drawings. Provide design calculations with these submittals.

Summary of information needed for metal pole review submittals:

- Shop drawings & supporting calculations
- Foundation design
- Soil boring logs
- Soil boring location map or other means to correlate borings and the corresponding poles

- Geotechnical report

11.2. MATERIALS

A. Metal Poles

Fabricate monotube shafts with a uniform linear taper of 0.14 in/ft with steel that conforms to ASTM A-595 minimum Grade A or an approved equivalent. Galvanize in accordance with AASHTO M111.

Use the submerged arc process to continuously weld shafts for the entire length. Ground or roll smooth exposed welds until flush with the base metal. Ensure shafts have no circumferential welds except at the lower end joining the shaft to the base. Provide welding that conforms to Article 1072-20 of the Standard Specifications, except that no field welding on any part of the pole will be permitted.

Refer to Standard Drawings for Metal Poles M2 for fabrication details. Fabricate anchor bases from plate steel meeting the requirements of ASTM A 36M or cast steel meeting the requirements of ASTM A 27M Grade 485-250, AASHTO M270 grade 36 or an approved equivalent. Conform to the applicable bolt pattern and orientation specified by the design as shown on drawing M2.

Ensure hardware is galvanized steel or stainless steel.

Ensure material used in steel anchor bolts conforms to AASHTO M 314, and yield strength does not exceed 55,000 psi. Unless otherwise required by the design, ensure each anchor bolt is 2" in diameter and 60" in length. Provide 10" minimum thread projection at the top of the bolt, and 8" minimum at the bottom of the bolt. Galvanize each anchor bolt in accordance with AASHTO M232 or M298 from the top of the bolt to a minimum of 2" below the threads.

Provide a circular anchor bolt lock plate that will be secured to the anchor bolts at the embedded end with 2 washers and nuts. Provide a base plate template that matches the bolt circle diameter of the anchor bolt lock plate. Construct plates and templates from ¼" minimum thick steel with a minimum width of 4". Galvanizing is not required.

Provide 4 heavy hex nuts and 4 flat washers for each anchor bolt. For nuts, use AASHTO M291 grade 2H, DH, or DH3 or equivalent material. For flat washers, use AASHTO M293 or equivalent material.

Ensure end caps for poles are constructed of cast aluminum conforming to Aluminum Association Alloy 356.0F.

Provide ground lug at 0° on the pole's radial index for grounding spanwire. Ensure #4 or #6

AWG wire will pass through opening.

B. Foundation

Perform a soil test at each proposed metal pole location. Furnish and install foundations for NCDOT metal poles with all necessary hardware in accordance with the plans and specifications.

Design the foundation to conform to the applicable provisions in the NCDOT Metal Pole Standards and Non-Standard Foundation Design Section below. If non-standard site specific foundations are designed for standard QPL approved strain poles, the foundation designer must use the design moment specified by load case on drawing M8 of the Standard Drawings for Metal Poles. Failure to conform to this requirement will be grounds for rejection of the design.

C. Soil Test and Foundation Determination

C.1. General

Drilled piers are reinforced concrete sections, cast in place against in situ, undisturbed material. Drilled piers are of straight shaft type and vertical.

For non-standard site-specific poles, the contractor-selected pole fabricator will determine if the addition of wing walls is necessary for the supporting foundations.

C.2. Soil Test

Perform a soil test at each signal location. Complete all required fill placement and excavation at each signal pole location to finished grade before drilling each boring. Drill one boring to a depth of 26 feet.

Perform standard penetration tests (SPT) in accordance with ASTM D 1586 at depths of 1, 2.5, 5, 7.5, 10, 15, 20 and 26 feet. Discontinue the boring if one of the following occurs:

- A total of 100 blows have been applied in any 2 consecutive 6-in. intervals.
- A total of 50 blows have been applied with < 3-in. penetration.

Describe each intersection as the "Intersection of *(Route or SR #)*, *(Street Name)* and *(Route or SR #)*, *(Street Name)*, Orange County, CCTV No. _____". Label borings with "B- N, S, E, W, NE, NW, SE or SW" corresponding to the quadrant location within the intersection. Pole numbers should be made available to the drill contractor. Include pole numbers in the boring label if they are available. If they are not available, ensure the boring labels can be cross-referenced to corresponding pole numbers. For each boring, submit a legible (hand written or typed) boring log signed and sealed by a licensed geologist or professional engineer registered in North Carolina. Include on each boring the SPT blow counts and N-values at each depth, depth of the boring, and a general description of

the soil types encountered.

C.3. Non-Standard Foundation Design

Design non-standard foundations based upon site-specific soil test information collected in accordance with Soil Test above. Provide a drilled pier foundation for each pole with a length and diameter that results 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. Contact the Engineer for pole loading diagrams for standard poles to be used for non-standard foundation designs. Submit any non-standard foundation designs including plans, calculations, and soil boring logs to the Engineer for review and approval before construction. A professional engineer registered in the state of North Carolina must seal all plans and calculations.

11.3. CONSTRUCTION METHODS

A. Metal Poles

Erect metal poles only after concrete has attained a minimum allowable compressive strength of 3000 psi. Follow anchor nut-tightening procedures below to complete the installation of the upright.

Connect poles to grounding electrodes and the intersection grounding systems.

For holes in the poles used to accommodate cables, install grommets before wiring pole or arm. Do not cut or split grommets.

Attach the terminal compartment cover to the pole by a sturdy chain or cable. Ensure the chain or cable is long enough to permit the cover to hang clear of the compartment opening when the cover is removed, and is strong enough to prevent vandals from being able to disconnect the cover from the pole. Ensure the chain or cable will not interfere with service to the cables in the pole base.

Attach cap to pole with a sturdy chain or cable. Ensure the chain or cable is long enough to permit the cap to hang clear of the opening when the cap is removed.

Perform repair of damaged galvanizing that complies with the Standard Specifications, Article 1076-6 "Repair of Galvanizing."

Install metal poles, hardware, and fittings as shown on the manufacturer's installation drawings. Install metal poles so that when the pole is fully loaded it is within 2 degrees of vertical. Install poles with the manufacturer's recommended "rake." Use threaded leveling nuts to establish rake.

Maximum deflection at top of pole shall not exceed 1-inch in 30 mph non-gusting wind.

A.1. Anchor Nut Tightening Procedure

Compute the required projection of the anchor bolt above the foundation top. Compute the total projection based on the following:

- Provide between 3 and 5 threads of anchor bolt projection above the top nut after tightening is complete. Avoid any additional projection, or a normal depth socket torque wrench cannot be used on top nuts.
- Include the sum of the thickness of top nut, top nut flat washer or top nut beveled washer, base plate, leveling nut flat washer or leveling nut beveled washer, and 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 bolt under service conditions.
- Do not use lock washers.

Installation Procedure:

1. Place a leveling nut and washer on each anchor bolt and install a template on top of the leveling nuts to verify that the nuts are level and uniformly contact the template. Use beveled washers if the leveling nuts cannot be brought into firm contact with the template. Verify that the distance between the bottom of the leveling nuts and the top of the concrete is no more than one nut height. Consider how attachments and applied loads may affect the vertical nature of the metal pole after erected and fully loaded. If necessary, induce a rake to the upright in the opposite direction of the anticipated loads during the initial erection by adjusting the leveling nuts accordingly. Failure to consider this could result in the upright being out of the allowable vertical tolerance as specified in the Construction Methods of this special provision.
2. Install the vertical upright on the anchor bolts, and tighten nuts in compliance with steps 3, 4, and 5 below. Do not attach cantilever arms or messenger cable to the vertical post until all of the top nuts and leveling nuts have been properly tightened on the anchor bolts.
3. Install top nuts and washers. Install flat washers under the top and leveling nuts. Use beveled washers if the nuts cannot be brought into firm contact with the base plate. Lubricate threads of the anchor bolts, nuts, and bearing surface of the nuts and tighten to a snug-tight condition with a spud wrench following a star pattern (using at least two increments). Snug-tight condition is defined as 20% to 30% of the verification torque

(600 ft-lbs.). Ensure lubricant is beeswax, stick paraffin, or other approved lubricant.

4. After the top nuts have been snug tightened, snug tighten the bottom nuts up to the base plate using the same procedure as described above. The base-plate must be in firm contact with both the top and bottom nuts to achieve the proper pretension in the anchor bolts.
5. Before further turning of the nuts, mark the reference position of the top nut in the snug-tight condition by match marking each nut, bolt shank, and base plate. Use ink or paint that is not water-soluble.
6. Turn the top nuts in increments using the star pattern (using at least two full tightening cycles) to 1/6 of a turn. Use a torque wrench to verify that at least 600 ft-lbs. is required to further tighten the top nuts. At least 48 hours after the entire structure and any attachments are erected, use a torque wrench again to verify that at least 600 ft-lbs. is still required to tighten the top nuts. Verify that the leveling nuts remain in firm contact with the base plate.
7. Do not place non-shrink grout between the base plate and foundation. This will allow for future inspection of leveling nuts and for adequate drainage of moisture.

B. Drilled Pier Foundation

B.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 weathered rock or removal of boulders may be required.

Dispose of drilling spoils as directed and in accordance with Section 802 of the Standard Specifications. Drilling spoils consist of all material excavated including water or slurry removed from the excavation either by pumping or with augers.

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 payment will be made for substituting a larger diameter drilled pier in order to construct a drilled pier cast against undisturbed soil.

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. Construct the finished top of pier elevation between 5 inches above and 2 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 either steel casing or polymer slurry. Steel casing may be either the sectional type or one continuous corrugated or non-corrugated piece. Ensure all steel casings 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 inches. Extract all temporary casings during concrete placement in accordance with this special provision unless the Contractor chooses to leave the casing in place in accordance with the requirements below.

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 compensation.

Any steel casing left in place will be considered permanent casing. Permanent steel casings are only allowed for strain poles. 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 smaller than the specified pier size to facilitate permanent casing installation. Ensure the sides of the excavation do not slough during drilling. Ensure the hole diameter does not become larger than the inside diameter of the casing. No additional compensation will be paid for permanent casing.

If polymer slurry is chosen to stabilize the excavation, use one of the following polymers listed in the table below:

PRODUCT	**MANUFACTURER**
SlurryPro CDP	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
Novagel Polymer	Geo-Tech Drilling Fluids 220 North Zapata Hwy, Suite 11A Laredo, TX 78043 (210) 587-4758

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 may not be appropriate for a given site. Polymer slurry should not be used for excavations in soft or loose soils as determined by the Engineer.

In wet pour conditions, advise and gain approval from the Engineer as to the planned construction method intended for the complete installation of the drilled pier before excavating.

B.2. 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 is not required.

Lift the cage so racking and cage distortion does not occur. Keep the cage plumb during concrete operations and casing extraction. Check the position of the cage before and after placing the concrete.

Securely cross-tie 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.

B.3. Concrete

Begin concrete placement immediately after inserting reinforcing steel into the drilled pier excavation. If the drilled pier excavation is entirely cased down to the tip, immediately placement of the concrete is not required.

B.3.1. Concrete Mix

Provide the mix design for drilled pier concrete for approval and, except as modified herein, meeting the requirements of Section 1000 of the 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. Make certain the cementitious material content complies with one of the following options:

- Provide a minimum cement content of 640 lbs/yd3 and a 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 degreed F or less.

B.3.2. 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 stopped when the concrete level is within 42 to 48 inches of the ground elevation to allow for placement of anchor bolts and conduit. 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 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 420-6 and 420-8 of the 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.

Permanently mark the top of each foundation with a stamp or embedded plate to identify the depth of the foundation.

B.4. Concrete Placement Time

Place concrete within the time frames specified in Table 1000-2 of the 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.

B.5. Scheduling and Restrictions

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, install adjacent piles, or allow any heavy construction equipment loads or "excessive" vibrations to occur at any point within a 20 foot radius of the drilled pier.

The foundation will be considered acceptable for loading when the concrete reaches a minimum compressive strength of 3000 psi. This provision is intended to allow the structure to be installed on the foundation in a shorter time frame, and does not constitute full acceptance of the drilled pier. Full acceptance will be determined when the concrete meets its full strength at 28 days.

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 compensation will be paid for losses or damage due to remedial work or any investigation of drilled piers found defective or not in accordance with these special provision or the plans.

11.4. CUSTOM DESIGN OF CCTV CAMERA METAL POLES

A. General

Design CCTV camera metal poles with foundations.

CCTV camera heights above the roadway are detailed in Section 27 of these project special provisions. Determine the actual length of each pole to achieve mounting height above roadway from field measurements and adjusted cross-sections. Furnish the revised pole heights to the Engineer. Use all other dimensional requirements shown on the plans.

Design all traffic signal support structures using the following 4th Edition AASHTO specifications:

- Design for a 50 year service life as recommended by Table 3-3 (Recommended Minimum Design Life) in the 2003 Interim to the 4th Edition AASHTO.
- Use the wind pressure map developed from 3-second gust speeds, as provided in Article 3.8.

- Ensure metal poles include natural wind gust loading and truck-induced gust loading in the fatigue design, as provided for in Articles 11.7.3 and 11.7.4, respectively. Designs need not consider periodic galloping forces.
- Assume the natural wind gust speed in North Carolina is 11.2 mph.
- Design for Category II fatigue, as provided for in Article 11.6, unless otherwise specified.
- Calculate all stresses using applicable equations from Section 5. Maximum allowable stress ratios for all signal support designs is 0.9.
- Conform to article 10.4.2 and 11.8 for all deflection requirements.

Ensure that the design permits cables to be installed inside poles as shown in the details of the Plans.

B. Metal Poles

Submit design drawings for approval including pre-approved QPL poles. Show all the necessary details and calculations for the metal poles including the foundation and connections. Include project number on design drawings. Include as part of the design calculations the ASTM specification numbers for the materials to be used. Provide the types and sizes of welds on the design drawings. Include a Bill of Materials on design drawings. Ensure design drawings and calculations are signed, dated, and sealed by the responsible Professional Engineer licensed in the State of North Carolina. Immediately bring to the attention of the Engineer any structural deficiency that becomes apparent in any assembly or member of any assembly as a result of the design requirements imposed by these Specifications, the plans, or the typical drawings. Said Professional Engineer is wholly responsible for the design of all poles and arms and review and acceptance of these designs by the Department does not relieve said Professional Engineer of this responsibility. Do not fabricate the assemblies until receipt of the Department's approval of the design drawings.

For metal poles, where ice is present, assume wind loads as shown in Figure 3-5 of the 4th Edition AASHTO Specification for Group III loading.

Design tapers for all pole shafts that begin at the base with diameters that decrease uniformly at the rate of 0.14 inch per foot of length.

Design a base plate on each pole. The minimum base plate thickness for all poles is determined by the following criteria:

Case 1 Circular or rectangular solid base plate 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 1/3 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 is $M = (P \times D_1) / 2$, where

M = bending moment at the critical section of the base plate induced by one anchor bolt

P = anchoring force of each anchor bolt

D_1 = horizontal distance between the anchor bolt center and the outer face of the upright, or the difference between the bolt circle radius and the outside radius of the upright

Locate the critical section at the face of the anchor bolt and perpendicular to the bolt circle radius. The overlapped part of two adjacent critical sections is considered ineffective.

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 1/3 of the upright diameter.

The magnitude of bending moment induced by the anchoring force of each anchor bolt is $M = P \times D_2$, where

P = anchoring force of each anchor bolt

D_2 = horizontal distance between the face of the upright and the face of the anchor bolt nut

Locate the critical section at the face of the anchor bolt top nut and perpendicular to the radius of the bolt circle. The overlapped part of two adjacent critical sections is considered ineffective.

If the base plate thickness calculated for Case 2 is less than Case 1, use the thickness calculated for Case 1.

The following additional owner requirements apply concerning pole base plates.

- Ensure that whichever case governs as defined above, the anchor bolt diameter is set to match the base plate thickness. If the minimum diameter required for the anchor bolt exceeds the thickness required for the base plate, set the base plate thickness equal to the required bolt diameter.

Ensure that designs have anchor bolt holes with a diameter 1/4 inch larger than the anchor bolt diameters in the base plate.

Ensure that the anchor bolts have the required diameters, lengths, and positions, and will develop strengths comparable to their respective poles.

Provide designs with a 6 x 12-inch hand hole with a reinforcing frame for each pole.

Provide designs with a terminal compartment with cover and screws in each pole that encompasses the hand hole and contains provisions for a 12-terminal barrier type terminal block.

For each pole, provide designs with provisions for a 1/2 inch minimum thread diameter, coarse thread stud and nut for grounding which will accommodate a Number 6 AWG ground wire. Ensure the lug is electrically bonded to the pole and is conveniently located inside the pole at the hand hole.

Where required, design couplings on the pole for mounting pedestrian pushbuttons at a height of 42 inches above the bottom of the base. Provide mounting points consisting of 1-1/2 inch internally threaded half-couplings that comply with the NEC that are mounted within the poles. Ensure the couplings are essentially flush with the outside surfaces of the poles and are installed before any required galvanizing. Provide a threaded plug for each half coupling. Ensure that the surface of the plug is essentially flush with the outer end of the mounting point when installed and has a recessed hole to accommodate a standard wrench.

11.5. MEASUREMENT AND PAYMENT

CCTV camera metal pole and foundation will be measured and paid as the actual number of poles and foundations without regard to height or load capacity furnished, installed and accepted. No measurement or payment will be made for soil samples, metal pole design, or foundation design.

Payment will be made under:

CCTV Camera Metal Pole and Foundation ..... Each

12. GUY ASSEMBLIES

12.1. DESCRIPTION

Furnish and install guy assemblies with all necessary hardware.

12.2. 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.

12.3. 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.

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 Burndy Clamp (UCG25RS) or equivalent. 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.

12.4. 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, or fittings as this will be considered incidental to furnishing and installing guy assemblies.

Payment will be made under:

Guy Assembly.....Each

13. RISER ASSEMBLIES

13.1. DESCRIPTION

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

13.2. 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.

Provide Tyco™ (Raychem™) part number 066193-000 or equivalent heat shrink tubing for the installation of fiber-optic or coaxial cable in new risers.

Provide Tyco™ (Raychem™) part number FOSC-ACC-CABLE-SEAL-2-NW or equivalent heat shrink tubing retrofit kits for the installation of new fiber-optic or coaxial cable in existing riser with existing fiber-optic or coaxial cables.

13.3. CONSTRUCTION METHODS

A. New Installations

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

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

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

Use separate 1-inch riser with weatherhead for electrical service.

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

Use separate 2-inch 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 inches in length with a minimum of 2.5 inches extended over cables and 2.5 inches 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 in lieu 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.

Transition from the 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.

13.4. 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 for removing and replacing heat shrink tubing to install new fiber optic cable into an existing riser with heat shrink tubing.

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 weatherhead connections or communications cable.

Payment will be made under:

1" Riser with Weatherhead ..... Each

2" Riser with Weatherhead ..... Each

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

Heat Shrink Tubing Retrofit Kit ..... Each

14. INDUCTIVE DETECTION LOOPS

14.1. DESCRIPTION

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

14.2. 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.

14.3. 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 is located on the Department's website and shown here.

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)

SIDE STREET

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.

14.4. 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

15. LOOP LEAD-IN CABLE

15.1. DESCRIPTION

Furnish and install loop lead-in cable with all necessary hardware.

15.2. 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.

15.3. 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 14 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.

15.4. 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

16. FIBER OPTIC CABLE

16.1. DESCRIPTION

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

All fiber optic cables (including plenum rated and drop cables) furnished under this project shall be from the same manufacturer.

16.2. MATERIALS

A. SMFO Communications Cable

Furnish loose tube fiber-optic cable with required fiber count that complies with RUS CFR 1755.900, single mode with a dielectric central member. Use single mode fiber in 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. Plenum Rated SMFO Cable

Where called for on the Plans, the SMFO cable shall be an indoor/outdoor Plenum/OFNR-rated cable.

The Plenum/OFNR cable shall comply with Bellcore GR-409-Core, *Generic Requirements for Premises Fiber Optic Cable* and with Bellcore GR-20-Core, *Generic Requirements for Optical Fiber and Fiber Optic Cable*. The Plenum rated cable shall meet all other operating characteristics of the SMFO communications cable called for in these Project Special Provisions, with the exception of the requirement for a maximum 0.35 dB/km loss at 1310 nm. Plenum rated cables shall have a maximum 0.65 dB/km loss at 1310 nm.

C. 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.

D. 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.

For all signal system fiber optic cables furnish cable wraps containing the following text in black:

WARNING
TOWN OF CHAPEL HILL FIBER OPTIC CABLE
CONTACT TELEPHONE NUMBER: 919-968-2833
WARNING
TOWN OF CHAPEL HILL FIBER OPTIC CABLE

Overall Marker Dimensions: 7"(l) x 4"(w)
Lettering Height: 3/8 inch for *WARNING*, ¼" for all other lettering

For all Chapel Hill IT fiber optic cables furnish cable wraps containing the following text in black:

WARNING
TOWN OF CHAPEL HILL FIBER OPTIC CABLE
CONTACT TELEPHONE NUMBER: 919-968-2712
WARNING
TOWN OF CHAPEL HILL FIBER OPTIC CABLE

Overall Marker Dimensions: 7"(l) x 4"(w)
Lettering Height: 3/8 inch for *WARNING*, ¼" for all other lettering

For all Carrboro IT fiber optic cables furnish cable wraps containing the following text in black:

WARNING
TOWN OF CARRBORO FIBER OPTIC CABLE
CONTACT TELEPHONE NUMBER: 919-942-8541
WARNING
TOWN OF CARRBORO 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.

E. 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.

16.3. 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 are 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 each optical fiber that may be cut or otherwise affected 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.

16.4. 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.

Plenum rated 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 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 (36 Fiber) ..... Linear Foot

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

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

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

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

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

Plenum Rated Communications Cable (144 Fiber).....Linear Foot

Drop Cable (6 Fiber).....Linear Foot

17. FIBER-OPTIC SPLICE CENTERS

17.1. 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.

17.2. MATERIALS

A. General

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

B. Interconnect Center

For locations where a single drop cable or two 12-fiber cables enter and terminate inside a cabinet, 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.

For locations where more than two 12-fiber cables enter and terminate inside a cabinet, furnish large, modular interconnect centers designed to mount inside equipment cabinets. Furnish large interconnect centers with sufficient number of modules. Furnish large interconnect centers that are rack-mountable. Design and size large 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 a factory assembled PC-ST connector on one end. Ensure that the SMFO pigtails meet the operating characteristics of the SMFO cable with which it is to be coupled.

Furnish SMFO jumpers that are a minimum of 3 feet in length with factory assembled PC-ST

connectors on each end. Ensure that SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

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.

17.3. CONSTRUCTION METHODS

A. General

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

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

Fusion splice and secure SMFO cable in splice trays inside the splice enclosure. Ensure all buffer tubes are contained within splice trays so no bare fibers are outside tray.

Do not exceed 0.05 dB of attenuation per splice.

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

Do not damage fiber of violate the minimum bending radius of the fiber.

B. Termination and Splicing within Interconnect Center

Terminate and splice all fibers including unused fibers as called for in the Splice Diagrams.

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.

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.

C. Termination and Splicing within Splice Enclosure

Fusion splice all fibers as called for in the Splice Diagrams. Do not cut fibers designated to pass-through splice enclosure (expressed).

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 the splicing procedure and before the 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 that is located within 10 feet of the equipment cabinet.

For underground, manhole, and junction box facility installations, place the enclosure along with required spare cables in the facility in a neat and workmanship like manner and insure that no standing water remains in junction box. Do not place the splice enclosure in bottom of junction box. Do not damage cable or violate the minimum bending radius of the cable.

D. Testing

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

segments following installation. Test all existing fibers prior to reuse. Provide any software necessary to view and print OTDR test results at no cost to the Department.

After splicing is completed and before enclosure is sealed, 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 on a compact disk. Furnish the manufacturer's make, model number, and software version of the OTDR used for testing.

E. 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.

17.4. MEASUREMENT AND PAYMENT

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

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

Interconnect centers to be located in equipment racks in buildings are incidental to the building modifications and shall not be paid for separately.

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, and testing, as these will be considered incidental to furnishing and installing fiber optic interconnect centers and aerial splice enclosures.

Payment will be made under:

Interconnect Center ..... Each

Interconnect Center (Large) ..... Each

Splice Enclosure ..... Each

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

18. FIBER OPTIC TRANSCEIVERS

18.1. DESCRIPTION

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

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

18.2. MATERIALS

A. General

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

B. Shelf Mounted Transceivers

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

Furnish shelf mounted transceivers that transmit and receive RS-232/optical pulse signals to and from the head-end and to each remote field cabinet.

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

- Input Power: 115 VAC
- Minimum Loss Budget: 17 dB with corresponding receiver
- Operating Distance: 10 miles, minimum
- Operating Wavelength: 1310 or 1550 nm
- Optical Connector: ST
- Signal Connector: Female Plug Type

- Temperature Range: 0 to 150 degrees F

C. Rack Mounted Transceivers

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

Furnish rack mounted transceivers that transmit and receive RS-232/optical pulse signals to and from the head-end and to each remote field cabinet. Rack mounted transceivers shall be fully compatible with the shelf mounted transceivers installed in field cabinets.

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

- Input Power: 115 VAC
- Minimum Loss Budget: 17 dB with corresponding receiver
- Operating Distance: 10 miles, minimum
- Operating Wavelength: 1310 or 1550 nm
- Optical Connector: ST
- Signal Connector: Female Plug Type
- Temperature Range: 0 to 150 degrees F

D. Video Transceivers

The video optical transceiver with control data (VOTR-D) shall consist of a pair of electronic units referred to as the video optical transmitter with control data (VOT-D) and video optical receiver with control data (VOR-D). When interconnected by means of a single-mode fiber optic cable the units shall communicate real-time National Television Standards Committee (NTSC) compliant video from input to output and shall support full duplex RS-232 digital status and control signal communications. The VOT-D shall be interfaced to an NTSC video signal by means of a

BNC connector with 75 ohms impedance. The VOR-D shall provide NTSC RS-250B compatible electrical signal at the BNC output connector driving a 75 ohm impedance. The NTSC output signal level shall be 1 volt peak-to-peak.

The function of the VOTR-D pair shall be to communicate NTSC video, associated status, and control data from a closed-circuit television (CCTV) camera location to the TOC using one single-mode fiber.

Variable optical attenuators to accommodate a flexible separation distance between each VOT-D and VOR-D pair shall be provided and shall be incidental to the cost of the VOTR-D devices. The equipment shall not cause rapid aging of the optical receiver, nor allow the optical receiver to reach optical or electrical saturation thereby causing high bit errors.

The VOTR-D shall have a Mean Time Between Failure of 43,800 hours when operated as a pair.

D.1. Optical/Electrical Parameters

An ST type connector on each of the transmitter and receiver units shall provide the optical interface. The optical interface shall accommodate a single mode fiber operating at 1310 nm and/or 1550 nm. The VOTR-D shall accommodate a minimum link loss budget of 25 dB at 1310 nm and/or 18 dB at 1550 nm including a 3 dB safety margin. The optical dynamic range shall be equal to or exceed the link loss budget. When a signal complying with NTSC standards and EIA-250C is applied to the transmitter inputs, the output of the receiver shall provide an undistorted, NTSC and EIA-250C standard signal output when link loss budget is not exceeded. The optical transmitter shall use high reliability laser diodes and optical sensors.

D.1.1. Video Communications

When operated within its power, link loss budget and environmental specifications the VOTR-D pair shall comply with EIA-250C, medium haul video transmission standards. The VOTR-D shall provide a 10 MHz (3 dB) minimum video bandwidth. The transmission technique use between the receiver and transmitter shall be frequency modulation. Differential gain and differential phase shall comply with EIA-250C medium haul video requirements. Video linearity shall be 3% percent maximum. Output voltage shall be one volt peak-to-peak per EIA-170. Signal-to-noise shall comply with requirements specified in EIA-250C when measured at the output of the VOR-D with input signals to the VOT-D in compliance with EIA-250C and fiber interconnected to accommodate signal loss within specified link budget. Signal-to-noise (S/N) shall be 60 dB minimum at the receiver electrical output with an equal or greater S/N of the input signal to the video optical transmitter.

D.1.2. RS-232/RS-422 Communications

The VOTR-D shall provide a communications reliability of one error in 109 bits minimum when operated within link loss budgets, power tolerances and operating environment as specified. Full duplex RS-232 communications shall be accommodated at data rates of 1200, 2400, 4800, 9600 and 19.2 kbps.

D.1.3. Modulation and Multiplexing

Frequency multiplexing and frequency modulation and demodulation shall be utilized.

D.1.4. Electrical Interfaces

Video Electrical Signal – The transmitter shall contain a BNC connector that will accepts an NTSC color video signal complying with EIA-250C signal standards. Input impedance shall be 75 ohms. Receiver shall contain a UG-88 BNC connector and shall provide a 75 ohm impedance. Output signal level shall comply with NTSC and associated EIA-250C video standards.

Camera Control Digital Signal – The VOTR-D shall accommodate an RS-232 and RS-422 interfaces with dip switch selectability. Input and output signals shall comply with EIA standards. When the dip-switch is in RS-422 mode, the VOT-D shall convert the RS-422 format to RS-232 and then to an optical format for transmission to the VOR-D and vice-versa. The VOR-D shall provide both, via dip-switch selection, RS-232 and RS-422 signal formats and the selection of this format shall be independent of the format selected on the VOT-D. A standard RJ-45 or DB-25 connector shall be provided to accommodate this interface. Any necessary cable adapter and cables necessary to interface with the CCTV field equipment and the communications server shall be provided and shall be incidental to the cost of the VOTR-D devices.

D.2. Physical Requirements

Connectors shall be located on the transceivers for convenient cable attachments. Strain relief shall be included on all cables provided with the transceivers. Signal indicators shall be easily viewable when the transceivers are mounted in equipment cabinets and in the TOC. All connectors and indicators shall be marked. All replaceable components shall be marked, and all markings shall conform to supplied documentation, including schematics and parts lists. The transceivers' external markings shall include the product name, model number, part number, serial number, manufacturer's name, and manufacturer's address.

Construction and materials selection for the transceivers shall prevent fungus growth and cathodic action.

Standalone, shelf mountable, VOT-D devices are to be provided at field CCTV camera locations.

VOT-D devices shall be external to the new CCTV equipment. Furnish standalone transceivers in an aluminum housing that has been treated to prevent corrosion. The standalone VOT-D devices shall be interchangeable between field cabinets. For this reason, the transceivers shall conform to standard mounting and interconnection provisions within the field cabinet. The mounting plate for the transceivers shall have mounting holes manufactured to tolerances to assure interchangeability of units within field cabinets.

Rack-mounted chassis shall be used to house the VOR-D devices installed in the TOC. VOR-D rack-mounted chassises shall be provided and shall be incidental to the cost of the VOR-D devices. The chassis shall be fabricated of anodized aluminum, designed for mounting in a 19-inch rack, not exceed three (3) standard mounting units in height (5.25 inches). The chassis shall contain a power converter compatible with VOR-D card power requirements. The chassis shall include provisions for interconnecting cabling. The chassis shall be designed to accommodate a minimum of ten (10) VOR-D cards that shall be easily mountable and removable from the chassis. When installed in the chassis, VOR-D cards shall be securable. The front panel shall include functional identification markings in compliance with EIA 606.

D.3. Power Requirements

The VOTR-D power input circuitry shall be designed to protect the electronics from damage from a power surge or an under voltage condition without causing damage to electronics. Over and under voltage condition is considered to be a power failure and therefore the VOTR-D does not have to perform to specification during this condition. The VOTR-D shall automatically recover from an over or under voltage condition when the prime power has returned to values defined by this specification.

Standalone VOT-D devices shall receive the power from a step-down transformer supplied with the unit. The transformer shall receive 120 VAC ±15%, 60 Hz ±10% prime power from a utility power strip within a field cabinet. A three-prong, DB-9 power connector shall be provided with the transformer. The power cable from the transformer to the transceiver shall be 6 feet (minimum) and terminated with a compatible female connector or with leads prepared for easy attachment to a terminal block on the VOT-D. Open power terminals shall not be used. Power input requirements (voltage and current) shall be marked on the transceiver housing.

The VOR-D chassis shall be capable of receiving 115 VAC ±10 percent, 60 Hz ±5 percent power, and have the means to convert the input power as needed to support the power requirements of the VOR-D electronics. Provisions shall be included in the design to prevent damage from lightning, caused by any metallic cable interconnect with the VOR-D. The VOR-D chassis shall

include AC-to-DC power conversion, power filtering and regulation to accommodate internal circuit requirements. Power interconnect to the VOR-D chassis shall be through a DB-9 power connector or screw terminals on the electronics unit. Open power terminals are unacceptable.

D.4. Environmental Requirements

The VOTR-D shall conform to performance specification when operated in the following environment:

- Temperature: -22°F to +160°F
- Humidity: 0 to 98 percent relative humidity with minimal condensation

No cooling air flow shall be required for VOTR-Ds in field cabinets. The unit shall be sealed to prevent damage by blowing sand and dust within a field cabinet. Units shall be shipped with protective covers over all connectors.

E. Video Optical Transmitter Multiplexer

Furnish new, digitally encoded, SMFO video optical transmitter multiplexer (VOTMUX) designed to transmit a minimum of 16 channels of NTSC, PAL, and SECAM baseband video over a single optical fiber. The VOTMUX shall transmit video output from video sources units as shown in the Plans

Furnish VOTMUX that is modular in design. VOTMUX may mount in a rack-mounted chassis or be rack-mountable as a stand-alone unit. If the unit is chassis-mounted in video transceiver rack, it shall be "hot swappable" into and out of chassis unit with no risk of damage to the unit or the rack. Furnish VOTMUX that is manufactured by the same vendor as the video optical receiver demultiplexer and is optically, electrically, and operationally compatible with the VORDEMUX.

Furnish VOTMUX that meets or exceeds the following specifications:

- Input channels 16 (minimum)
- System Bandwidth 5Hz - 10MHz
- Digital Encoding 8 bit (minimum)
- Input Power 115 or 230 VAC
- Input/output Impedance 75 ohms
- Input/output Level 1 V p-p, NTSC composite
- Signal-to-noise Ratio 47 dB or greater at maximum optical attenuation

- Minimum Loss Budget — 20 dB with corresponding receiver
- Operating Wavelength — 1300 nm
- Differential Gain — Less than 5% at 10-90% APL
- Differential Phase — Less than 5 degrees at 10-90% APL
- Gain Control — Automatic (AGC)
- Optical Connector — ST type
- Signal Connector — BNC
- Temperature Range — -4 Degrees F to 122 Degrees F
- MTBF — 50,000 Hours

F. Video Optical Receiver Demultiplexer

Furnish new, digitally encoded, SMFO video optical receiver demultiplexer (VORDEMUX) designed to receive a minimum of 16 channels of NTSC, PAL, and SECAM baseband video over a single optical fiber. The VORDEMUX shall output video inputs from to video output units as shown in the Plans

Furnish VORDEMUX that is modular in design. VORDEMUX may mount in a rack-mounted chassis or be rack-mountable as a stand-alone unit. If the unit is chassis-mounted in video transceiver rack, it shall be "hot swappable" into and out of chassis unit with no risk of damage to the unit or the rack. Furnish VORDEMUX that is manufactured by the same vendor as the video optical receiver multiplexer and is optically, electrically, and operationally compatible with the VORMUX.

Furnish VORDEMUX that meets or exceeds the following specifications:

- Output channels — 16 (minimum)
- System Bandwidth — 5Hz - 10MHz
- Digital Encoding — 8 bit (minimum)
- Input Power — 115 or 230 VAC
- Input/output Impedance — 75 ohms
- Input/output Level — 1 V p-p, NTSC composite
- Signal-to-noise Ratio — 47 dB or greater at maximum optical attenuation

- Minimum Loss Budget — 20 dB with corresponding receiver
- Operating Wavelength — 1300 nm
- Differential Gain — Less than 5% at 10-90% APL
- Differential Phase — Less than 5 degrees at 10-90% APL
- Gain Control — Automatic (AGC)
- Optical Connector — ST type
- Signal Connector — BNC
- Temperature Range — -4 Degrees F to 122 Degrees F
- MTBF — 50,000 Hours

18.3. CONSTRUCTION METHODS

A. Shelf and Rack Mounted Transceivers

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

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

Install transceiver rack mount chassis(es) as required into rack cabinet in TOC as shown in the Plans to accommodate all transceiver units. Integrate units with the communication server. Clearly label all data transceiver units and associated jumper cables by their respective channel number.

B. Video Transceivers

Furnish, install, and fully integrate VOT-D units in the CCTV cabinets in the field as shown in the Plans.

Furnish, install, and fully integrate VOR-D units into the rack cabinet at the TOC. Integrate control data from VOR-D with video server and integrate video from VOR-D with video matrix switch. Furnish all cables required to connect transceivers with communications network. Clearly label all video transceiver units and associated jumper cables by their respective CCTV camera number used in the Plans.

Furnish and install video transceiver rack chassis(es) into the rack cabinet at the TOC. Furnish jumpers of sufficient length to connect the transceivers to the fiber termination panel.

C. Video Multiplexers

Install two (2) video optical transmitter multiplexer units into rack cabinet in TOC as shown in the Plans. Integrate with UPS, video matrix switch, and fiber optic interconnect center and connect to two optical fibers designated for the NCDOT TRTMC.

Install one (1) video optical receiver demultiplexer unit into video equipment cabinet in the TOC rack cabinet as shown in the Plans. Integrate with UPS, video matrix switch, and fiber optic interconnect center and connect to an optical fiber designated for the NCDOT TRTMC.

Install one (1) video optical transmitter multiplexer unit into existing rack cabinet at the NCDOT TRTMC. Use rack cabinet designated by the Engineer. Integrate with existing UPS, existing video matrix switch, and existing fiber optic interconnect center. Do not perform any work at the NCDOT TRTMC without prior permission from the Engineer.

Install two (2) video optical receivers demultiplexer units into existing rack cabinet at the NCDOT TRTMC. Integrate with existing UPS, existing video matrix switch, and existing fiber optic interconnect center. Do not perform any work at the NCDOT TRTMC without prior permission from the Engineer. Do not perform any work that will take off-line any other equipment in the TRTMC.

18.4. MEASUREMENT AND PAYMENT

Fiber Optic Transceiver, Drop & Repeat will be measured and paid for the actual number installed, integrated, 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).

Video Optical Transceiver with Data will be measured and paid for the actual number installed, integrated, 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).

Video optical transmitter multiplexer will be measured and paid for the actual number installed, integrated, and accepted.

Video optical receiver demultiplexer will be measured and paid for the actual number installed, integrated, and accepted.

Payment will be made under:

Fiber Optic Transceiver, Drop & Repeat.....Each

Video Optical Transceiver with Data .....Each

Video Optical Transmitter Multiplexer .....Each

Video Optical Receiver Demultiplexer.....Each

19. DELINEATOR MARKERS

19.1. DESCRIPTION

Furnish and install delineator markers with all necessary hardware.

19.2. MATERIALS

A. Post Mount Markers (Type 1)

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:

For all markers of signal system or UNC cable, use the following text:

WARNING	**FIBER OPTIC CABLES**
BEFORE EXCAVATING OR IN AN EMERGENCY CALL 919-968-2833	
TOWN OF CHAPEL HILL	

For all markers of Chapel Hill IT cable, use the following text:

WARNING	FIBER OPTIC CABLES
BEFORE EXCAVATING OR IN AN EMERGENCY CALL 919-968-2712	
TOWN OF CHAPEL HILL	

For all markers of Carrboro IT cable, use the following text:

WARNING	FIBER OPTIC CABLES
BEFORE EXCAVATING OR IN AN EMERGENCY CALL 919-942-8541	
TOWN OF CARRBORO	

B. Flush Mount Markers (Type 2)

Furnish flush mount above ground delineator markers constructed of a Type III high density polyethylene material. Provide markers with a 7 inch diameter disk and 13 inch barb stake.

Provide text, including the contact number, printed in black on an orange reflective background material that will not fade or deteriorate over time.

For all markers of signal system or UNC cable, use the following text:

WARNING
TOWN OF CHAPEL HILL **BURIED FIBER OPTIC CABLES**
BEFORE EXCAVATING OR IN AN EMERGENCY **CALL TOWN OF CHAPEL HILL 919-968-2833**

For all markers of Chapel Hill IT cable, use the following text:

WARNING
TOWN OF CHAPEL HILL **BURIED FIBER OPTIC CABLES**
BEFORE EXCAVATING OR IN AN EMERGENCY **CALL TOWN OF CHAPEL HILL 919-968-2712**

For all markers Carrboro IT cable, use the following text:

WARNING
TOWN OF CARRBORO **BURIED FIBER OPTIC CABLES**
BEFORE EXCAVATING OR IN AN EMERGENCY **CALL TOWN OF CARRBORO 919-942-8541**

19.3. 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.

19.4. MEASUREMENT AND PAYMENT

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

Payment will be made under:

Delineator Marker (1) ..... Each

Delineator Marker (2) ..... Each

20. CABLE TRANSFERS

20.1. DESCRIPTION

Remove and reinstall communications cable for pole relocations.

20.2. 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.

20.3. 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

21. BUILDING MODIFICATIONS AND FIBER OPTIC CABLE TERMINATION

21.1. DESCRIPTION

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

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 creating a new entrance or integrating with an existing entrance) and making internal provisions for terminating cables are covered under these building modification pay items.

21.2. MATERIALS

A. General

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

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

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

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 from the Corning LANscape line of equipment, or as approved by the Engineer. 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 for interconnect centers installed in all facilities except Town of Carrboro facilities. At Town of Carrboro facilities, provide connector panels with LC-type connectors.

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

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

21.3. CONSTRUCTION METHODS

A. General

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

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

Whenever possible, use 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.

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

Install interconnect centers with connector panels, splice trays, storage for slack cable or fibers, mounting and strain relief hardware, and all necessary hardware. As shown in the plans, some locations call for interconnect centers to be installed in existing rack cabinets. Coordinate with Engineer or Agency representative on exact placement for interconnect center within rack as existing conditions may have changed from that shown in the Plans.

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.

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

B. Traffic Operations Center

Install equipment and route cables into Town Operations Center (Building 2) as shown in the Plans.

Upgrade the existing electrical service to the TOC as shown on the building details in the Plans. Do not perform any electrical work in the Town Operations Center without permission. Contact Mr. John Newark, the Town of Chapel Hill Buildings Program Supervisor, at 919-969-5132 at least 24 hours prior to beginning any electrical work for permission. Perform all work in accordance with NESC regulations and guidelines.

For the TOC computer room, upgrade the electrical service to provide three (3) 30A 120V receptacles for the equipment rack cabinets. At the appropriate electrical panels, install three (3) 30A single pole circuit breakers in the empty slots, or replace the existing 20A circuit breakers with 30A circuit breakers. All circuit breakers installed shall be Square D-QOB models. Route new #4 AWG wire from receptacle to electrical panel. If the circuit breaker or receptacle terminals do not accept #4 AWG wire, install new electrical junction box on the wall or in ceiling at both ends of the circuit to pigtail the wires to accommodate the terminals. The Contractor shall confirm all wire sizes and circuit breaker configurations prior to beginning any electrical work as conditions may have changed since these Project Special Provisions were written.

C. Remote Traffic Operations Center

Install equipment and route cables into the Emergency Operations Center (EOC) in Fire Station 1 as shown in the Plans. Where new cables are to be installed in existing conduit, the Contractor shall blow pull-rope in the conduit prior to installation to insure conduit can be re-used.

Integrate signal system client applications on the new workstation in the facility. Integrate client applications to properly communicate with new LAN switch on signal system fiber optic communications network.

D. Police Departments

At the Chapel Hill Police Department and UNC Public Safety install equipment and route cables as shown in the Plans.

Integrate fiber terminations and new LAN switch to form a remote access point for the signal system network switch located in the TOC.

Refer to Section 28 for requirements related to providing CCTV system client applications.

E. Town IT Facilities

Route and terminate cables as shown in the Plans.

21.4. MEASUREMENT AND PAYMENT

Building Modifications 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:

Carrboro Town Hall Building Modifications ..... Lump Sum

Carrboro Fire Station Building Modifications ..... Lump Sum

Carrboro Century Center Building Modifications ..... Lump Sum

Chapel Hill Town Hall Building Modifications ..... Lump Sum

Chapel Hill Fire Station #1 (EOC) Building Modifications ..... Lump Sum

Chapel Hill Fire Station #2 Building Modifications ..... Lump Sum

Chapel Hill Fire Station #3 Building Modifications ..... Lump Sum

Chapel Hill Fire Station #4 Building Modifications ..... Lump Sum

Chapel Hill Fire Station #5 Building Modifications ..... Lump Sum

Community Center Building Modifications ..... Lump Sum

Hargraves Community Center Building Modifications ..... Lump Sum

Public Library Building Modifications ..... Lump Sum

Parking Services Building Modifications ..... Lump Sum

Housing Office Building Modifications ..... Lump Sum

Eubanks Park-n-Ride Building Modifications.....Lump Sum

Southern Village Park-n-Ride Building Modifications .....Lump Sum

Friday Center Park-n-Ride Building Modifications .....Lump Sum

Chapel Hill Town Operations Center (Building 1) Building Modifications .....Lump Sum

Chapel Hill Town Operations Center (Building 2) Building Modifications .....Lump Sum

Chapel Hill Police Department Building Modifications.....Lump Sum

UNC Public Safety Building Modifications .....Lump Sum

22. SIGNAL CABINET FOUNDATIONS

22.1. 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.

22.2. 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 inches from the front and back of the cabinet, and 3 inches from the sides of the cabinet.

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

Provide preformed cabinet pad foundations with opening not to exceed the maximum conduit spread for the cabinet mounting configuration on that foundation as shown in the Plans. Ensure that no more than four 3/4 inch holes are cast or drilled in each pad.

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

22.3. 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.

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. Remove Foundation, Cabinet, Controller

At locations where a new signal controller and cabinet is installed in a different site than the existing signal controller and cabinet, the Contractor shall remove the existing controller, cabinet, and foundation and restore the surface to the condition of the surrounding area. If the removed foundation is in the sidewalk, this shall include filling in the entire concrete panel in kind with new sidewalk, using the same type of concrete. If the removed foundation is in a bricked sidewalk, this shall include filling in the area with brick pavers that match the surrounding area, as approved by the Engineer. The controller, cabinet, and foundation should be disposed of by the Contractor in a manner approved by the Engineer. Comply with the requirements for the removal of existing material in Section 1 of these Project Special Provisions.

22.4. MEASUREMENT AND PAYMENT

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

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.

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.

Remove existing cabinet foundation will be measured and paid as the actual number removed, disposed of, and accepted.

Remove existing controller and cabinet will be measured and paid as the actual number removed, disposed of, and accepted.

Payment will be made under:

Signal Cabinet Foundation.....Each

Conduit Entrance into Existing Foundation.....Each

Modify Foundation for Controller Cabinet.....Each

4" Concrete Sidewalk ..... Square Yard

Brick Pavers ..... Square Foot

Remove Existing Cabinet Foundation .....Each

Remove Existing Controller and Cabinet .....Each

23. CABINET BASE ADAPTER/EXTENDER

23.1. DESCRIPTION

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

23.2. MATERIALS

Fabricate base adapters and extenders from the same materials and with the same finish as the intended matching cabinet housing. Refer to Section 24.2.E.7 for a list of locations where cabinet and any base adapters or extenders shall be painted. 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.

23.3. CONSTRUCTION METHODS

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

Install cabinet base extender at locations of a new Model 332A 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.

23.4. 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

24. CONTROLLERS WITH CABINETS

24.1. 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 Town traffic engineering, signal timing, and maintenance personnel on controller and cabinet assemblies as called for in Section 37 of these Project Special Provisions.

24.2. 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, transceivers, 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

Frequency (Hz)	Minimum Insertion Loss (dB)
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 332A base mounted cabinets with PDAs #2 and configured for 8 vehicle phases, 4 pedestrian phases, and 4 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 transceivers, modems, etc.; install a UL listed, industrial, heavy-duty type power outlet strip with a maximum rating of 15 A / 125 VAC, 60 Hz. Provide a strip that has a minimum of 3 grounded outlets. Ensure the power outlet strip plugs into one of the controller unit receptacles located on the rear of the PDA. Ensure power outlet strip is mounted securely; provide strain relief if necessary.

Connect detector test switches for cabinets as follows:

336S Cabinet		**332A 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 3 1/2 feet 20 wire ribbon cable which mates on the other end to a connector (3M-3428-5302 or equivalent) installed in the front of the Type 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, except at locations listed below where a painted finish is required.

- 07-0183 Manning Drive & Hibbard Drive
- 07-0218 Franklin Street & Porthole Alley Crosswalk
- 07-0500 Main Street & Rosemary Street
- 07-0507 Manning Drive & West Drive
- 07-0511 Franklin Street & Columbia Street
- 07-0512 Franklin Street & Henderson Street
- 07-0513 Franklin Street & Raleigh Street
- 07-0514 Franklin Street & Graham Street
- 07-0515 Franklin Street& Boundary Street
- 07-0517 Columbia Street & Rosemary Street
- 07-0519 Columbia Street & South Road
- 07-0520 Columbia Street & Manning Drive
- 07-0522 South Road & Country Club Road
- 07-0523 South Road & Raleigh Street
- 07-0524 South Road & Bell Tower Drive
- 07-0534 Franklin Street & Merritt Mill Road
- 07-0573 Columbia Street & Mason Farm Road
- 07-0902 Franklin Street & Morehead Plntrm Crosswalk
- 07-0909 Merritt Mill Road & Cameron Avenue
- 07-1010 Manning Drive & Ridge Road

- 07-1101 Franklin Street & Church Street
- 07-1222 Columbia Street & Fraternity Ct Crosswalk
- 07-1534 Manning Drive & Craige Drive
- 07-1825 Manning Drive & New East Drive
- 07-2054 Manning Drive & Old East Drive
- CH-0107 Rosemary Street & Roberson Street
- CH-0108 Rosemary Street & Church Street
- CH-0110 Rosemary Street & Henderson Street
- CH-0111 Rosemary Street & Hillsborough Street
- CH-0202 Cameron Avenue & Ransom Street
- CH-0205 Cameron Avenue & Raleigh Street
- CH-0220 Country Club Road & Gimghoul Road

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

- Any required base adapter or extender shall have a shop painted finish coat.
- All steel components (including nuts, bolts, screws, etc.) shall have a shop painted finish coat.
- The color shall be a dark green (RAS 6012) and as approved by the Engineer.
- The finish coating shall be an electrostatically applied, heat curable, thermosetting powdered coating. The material to be painted shall be pre-treated and the coating shall be cured according to manufacturers' recommendations.

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.

24.3. 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. 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. Railroad Preemption

Comply with the railroad preemption requirements detailed in Section 1 of these Specifications. Furnish and install new preemption and blankout panel (Control Technologies part number 2299-101 or approved equivalent), hardware, harnesses, and wires as required to interface with new signal controller and cabinet. Inspect new railroad preemption in accord with the Standard Specifications and these Project Special Provisions. The Contractor shall perform all work necessary to ensure all railroad preemption functionality remains after installation of the new controller and cabinet.

24.4. 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).

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.

No measurement or payment will be made of conflict monitors, grounding systems, AC/DC isolators, preemption systems, school flasher integration and new hardware required to integrate school flasher, entrances for pole mounted cabinet configurations, and painting of cabinets, as these will be considered incidental to furnishing and installing controllers with cabinets.

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.

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

Payment will be made under:

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

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

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

Detector Card (Model 222) ..... Each

Auxiliary Output File ..... Each

Terminal Splice Box ..... Each

25. ELECTRICAL SERVICE

25.1. DESCRIPTION

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

25.2. 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.

Provide an external electrical service disconnect at all new and existing cabinet locations shown on the plans. Provide a service disconnect with a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit rating in a lockable NEMA 3R enclosure. Provide a ground bus and neutral bus with a minimum of four terminals with a minimum wire capacity of number 14 through number 4.

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

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

B. External Electrical Service Disconnect

Furnish external electrical service disconnects with a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure service disconnects are 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 (60 μm). Provide ground bus and neutral bus with a minimum of four terminals with a minimum wire capacity range of number 14 through number 4.

Furnish NEMA Type 3R meter base rated 100 Ampere minimum that meets the requirement 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 a 4 terminal, 600 volt, single phase, 3 wire meter base that complies with the following:

- Line, Load, and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire
- With or without horn bypass
- Made of galvanized steel
- Listed as meeting the UL Standard UL-414
- Overhead and underground service entrance

Ensure that the meter bases have an electrostatically applied dry powder paint finish, light gray in color, with a minimum thickness of 2.4 mils (60 μm), unless otherwise called for in the Plans, Project Special Provisions, or as directed by the Engineer.

Furnish 1-inch watertight hub for threaded rigid conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is 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.

25.3. 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.

25.4. 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.

Payment will be made under:

New Electrical Service.....Each

Modify Existing Electrical Service.....Each

26. CELLULAR MODEM

26.1. DESCRIPTION

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

26.2. MATERIALS

A. General

Furnish new cellular modems that are compatible with existing cellular modems deployed in the Town of Chapel Hill for traffic signal communications. Furnish cellular modems from the Aptelnet InvisiConnect product line or approved equivalent.

B. Modem

Furnish cellular modems for central (to connect to the server) and field (to connect to the signal controller) communications. Furnish modems of both types that meet the following specifications at a minimum:

- GSM cellular service, 850 MHz
- Internal quad-band antenna
- IP compatible
- DES based encryption
- 'AT' command emulation
- RS-232 asynchronous serial data
- 1 port, screw type terminal strips for input and outputs
- Cable glands for strain relief of external cables
- Wall mountable 120 VAC to 12Vdc power pack with wire terminations
- Wall mountable polycarbonate OEM enclosure, NEMA 4X rated
- Outer dimension maximum of 7 inch x 10 inch x 2 inch with weight of 3 lbs
- Operating temperature of -25 degrees C to +70 degrees C
- Certifications: GSM Phase 2+ Compliant; PTCRB approved, FCC part 15 (class B) parts

22 and 24

All modems furnished shall not be manufacturer activated. The Engineer will provide AT&T SIM cards for all modems to be installed.

C. Application Software

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

26.3. CONSTRUCTION METHOD

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

Install central cellular modem at the TOC as shown in the Plans. Fully integrate with communications server using single RS-232 connection.

Install application software on the signal system communications server as shown in the Plans. Integrate software with server operating system to create virtual COM ports as needed.

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

26.4. 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 (Central) pay item.

Payment will be made under:

Cellular Modem (Field) ..... Each

Cellular Modem (Central) ..... Each

27. CCTV FIELD EQUIPMENT

27.1. DESCRIPTION

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

27.2. 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.

Furnish Pelco Spectra III/Spectra IV high performance dome equipment or approved equivalent.

B. Camera and Lens

B.1. Cameras

Furnish new charged coupled device (CCD) color cameras. The cameras shall provide automatic gain control (AGC) for clear images in varying light levels. The cameras shall meet the following minimum requirements:

- Video signal format: NTSC composite color video output, 1 volt peak to peak
- Automatic Gain Control (AGC): 0-20 dB, peak-average adjustable
- Automatic focus: Automatic with manual override
- White balance: Automatic through the lens and manual adjustable from remote controller.
- Electronic-Shutter: dip-switch selectable electronic shutter with speed range from 1/60 of a second (off) to 1/30,000 of a second
- Overexposure protection: The camera shall have built-in circuitry or a protection device to prevent any damage to the camera when pointed at strong light sources, including the sun
- Sensitivity: 1.5 lux at 90% scene reflectance
- Signal to noise ratio: Greater than 48-dB
- Video output Connection: 1-volt peak to peak, 75 ohms terminated, BNC connector

- Power: 24 VAC or less

B.2. Zoom Lens

Furnish each camera with a motorized zoom lens with automatic iris control with manual override and neutral density spot filter. Furnish lenses that meet the following optical specifications:

- Focal length: 0.16" – 3.45", 22X optical zoom, 8X electronic zoom
- Preset positioning: 64 Presets

The lens shall be capable of both automatic and remote manual control iris and focus override operation. The lens shall be equipped for remote control of zoom and focus, including automatic movement to any of the preset zoom and focus positions. Mechanical or electrical means shall be provided to protect the motors from overrunning in extreme positions. The operating voltages of the lens shall be compatible with the outputs of the camera control.

C. Camera Housing

Furnish new dome style enclosure for the CCTV assemblies. Equip each housing with mounting assembly for attachment to the CCTV camera pole. The enclosures shall be equipped with a sunshield and be fabricated from corrosion resistant aluminum and finished in a neutral color of weather resistant enamel. The enclosure shall meet or exceed NEMA 4X ratings. The viewing area of the enclosure shall be tempered glass.

D. Pan and Tilt Unit

Each new dome style assembly shall be equipped with a pan and tilt unit. The pan and tilt unit shall be rated for outdoor operation, provide dynamic braking for instantaneous stopping, prevent drift, and have minimum backlash. The pan and tilt units shall meet or exceed the following specifications:

- Pan: continuous 360 Degrees
- Tilt: up/down 180 degrees minimum
- Input voltage: 24 VAC 50/60 Hz
- Motors: Two phase induction type, continuous duty, instantaneous reversing
- Preset Positioning: 64 PTZ presets per camera

E. Control Receiver/Driver

Each new camera unit shall contain control receiver/driver that are integral to the CCTV dome assembly. The control receiver/driver shall receive serial asynchronous data initiated from a camera

control unit, decode the command data, perform error checking, and drive the pan/tilt unit, camera controls, and motorized lens. As a minimum, the control receiver/drivers shall provide the following functions:

- Zoom in/out
- Automatic focus with manual override
- Tilt up/down
- Automatic iris with manual override
- Pan right/left
- Minimum 64 preset positions for pan, tilt, and zoom

In addition, each control receiver/driver shall accept status information from pan/tilt unit and motorized lens for preset positioning of those components. The control receiver/driver shall relay pan, tilt, zoom, and focus positions from the field to remote camera control units. The control receiver/driver shall accept "goto" preset commands from the camera control unit, decode the command data, perform error checking, and drive the pan/tilt and motorized zoom lens to the correct preset position. The preset commands from the camera control unit will consist of unique values for the desired pan, tilt, zoom, and focus positions.

F. 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 at 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 wood or metal CCTV poles, design, fabricate, and furnish an attachment assembly for the CCTV camera unit. Use stainless steel banding approved by the Engineer for attachment.

Furnish CCTV attachment to pole via the stainless steel banding that allows for the removal and replacement of the CCTV enclosure as well as providing a weatherproof, weather tight, seal that does not allow moisture to enter the enclosure.

Furnish CCTV Camera Attachment Assembly that is able to withstand a wind load of 80 miles per hour (mph) with a 30 percent gust factor and can support a minimum camera unit dead load of 45 pounds.

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 24 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 24.

27.3. CONSTRUCTION METHODS

A. General

Install CCTV assemblies at locations as shown in the Plans.

Mount CCTV camera units at 40 feet above ground level on new poles.

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 camera 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 and enter the bottom of a pole mounted cabinet shall be rigid metallic conduit.

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

27.4. 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, 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.

Payment will be made under:

CCTV Camera Assembly ..... Each

28. SYSTEM SOFTWARE

28.1. 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 version of NCDOT's OASIS software package)

28.2. 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 OASIS communications protocol 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 29 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, Computer Aided Design (CAD), and the Microsoft Office Suite of 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 Base-T Ethernet, local area network (LAN) shall support the distributed client/server architecture. The requirements for the LAN are in Section 30 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 Towns of Chapel Hill and Carrboro that gives them the right to copy and use the distributed processing and CCTV 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 the TOC, Chapel Hill Town Hall, Carrboro Town Hall, Chapel Hill Police Department, UNC Public Safety, Durham City Hall, NCDOT Division 5, NCDOT Division 7, or at any other offices in the State of North Carolina that the Town and State, or their authorized agent, may establish for the purpose of traffic signal monitoring and control of the Chapel Hill-Carrboro 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 copy written COTS software, a copy of the source code (both hardcopy and un-compiled digital commented as described in the preceding paragraph) shall be held in an escrow account by an independent agent agreed to prior to final acceptance of the system by the Department. The version

of the source code in the escrow account shall be updated as modifications, fixes, enhancements, and improvements are made to the software and implemented on the software products used by the Department. In the event the provider of COTS software product(s) defaults, discontinues support of the software product(s) furnished under this project, goes out of business, or otherwise is unavailable to support the software product(s), the software source code contained in the escrow account shall immediately become the property of the Department.

Provide any third party software licenses to the Department and the Towns of Chapel Hill and Carrboro for software that may be used. Example: report-configuring, diagnostic, or monitoring software.

A.3. Operating System

The operating system for all software provided under this project shall be Microsoft Windows Server 2008 and Microsoft Windows Vista. The release used shall be the latest revision available as recommended by the supplier of the system software.

The network operating system (NOS) shall be Microsoft Windows Server 2008 or approved equal and must be compatible with the traffic signal system software.

The NOS and software operating system shall be compatible and work seamlessly with the traffic signal system software 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 version of NCDOT's OASIS 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, except for modems, data concentrators or communications concentrators 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.

If an unplanned shutdown due to power failure occurs, the software shall be configurable to re-boot to the log-in screen upon the restoration of primary power.

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 remote dialup facilities, or Ethernet access through a secured firewall, using Microsoft Terminal Services. The remote user shall be allowed to perform any functions, permitted by Terminal Services, 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 provide auto-dial, numeric paging. The alarm conditions that initiate a page shall be user-programmable, as shall be the telephone numbers to be auto-dialed in response to a particular type of alarm. The pager shall provide a numeric message that informs the user of the type of error and its location.

The paging system shall be configurable to the extent that each alarm can initiate a call to a unique specified phone number, and also be configured to call different numbers at different periods. A third-party commercial off-the-shelf software product may be used for this operation, and any license required for this software shall be furnished by the system provider with the signal system. The paging system shall not require an internet service provider (ISP) to be operational. The Paging system shall use the dial-up modem called for on the Signal System server computer.

B.8. Field Communications

Within the Chapel Hill-Carrboro computerized signal system, traffic signal controllers will be

arranged in multi-drop communications channels capable of supporting a minimum (10) traffic signal controllers on a dedicated communications channel at a minimum data baud rate of 19,200 kilobytes per second. Each controller is connected to the system via a pair of optical fibers and repeating fiber optical transceivers. A channel consists of two fibers: one transmitting and the other receiving. Each repeating channel is configured to receive or transmit a message from any transceiver on the channel and repeat the message at each device on the channel.

Each multi-drop, cellular, and dial-up communications channel with its boundaries and the controllers 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 Town. Otherwise, default intersection timing data and standard intersection maps will be utilized when configuring intersections onto the system.

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. The polled communications rate shall be dependent upon the number of controllers per data concentrator and the channel baud rate.

B.11. Database Backup and Restoration

The system shall include tape backup, or simple means of copying the database files from the hard disk to a magnetic tape storage device. All files required to restore the system to operation without the need to manually re-enter data shall be included on the magnetic tape.

Files containing records of logged events and detector data shall be saved on hard disk. The system shall enable an operator to copy all logged events, within a user-specified date range, to the tape backup drive. The system shall enable an operator to copy all selected detector data, to the tape drive.

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.

Action bar menus shall support a set of keyboard equivalent accelerators, arrow key navigation of the menu bar or individual pull-down menus. Some menu selections shall not have accelerator functionality.

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 (OASIS).

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 packages such as ARCGIS and MAPINFO. These images shall be used as the display layers of real-time graphics displays. The graphics for the entire system shall be developed in the ESRI map objects embedded environment, or approved equivalent.

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 ESRI-based system-wide map 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 ("Rubik's Cube")

- 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, as one of the 8 outer cubes of the "Rubik's Cube". The intersection control status shall be displayed as either the background color on the intersection plan icon or the center section of the "Rubik's Cube". 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

Control section maps shall provide a more detailed display of selected zones or areas of the system. Control section shall be able to be called from the system map display via a double mouse click. A minimum of fifteen (15) control section displays shall be capable of being simultaneously displayed while the system map is open and the maximum number intersection display windows are open. The control section map interface shall be an integrated portion of the distributed processing system software and shall not be a stand-alone package.

The control section map shall provide a dynamic display of the signal system, including landmarks, streets, signalized intersections, interstate highways (if applicable), railroads (if applicable), system detectors, system detector actuation. Labels for these items shall also be displayed. All labeling shall be approved by the Engineer. The graphic shall also dynamically display the status of the controllers in the sub-area (e.g., coordination, emergency vehicle preemption, railroad preemption transition, free operation, flashing, failed, intersection phase status). Volume and occupancy level shall be displayed as color bars on the map. Intersection phase status (green, yellow, and red) shall be displayed in real-time using arrow icons. Link status shall be shown as green for free flow or near free flow conditions. Yellow shall be shown for moderate congestion or transition conditions. Red shall be shown for congested conditions, and flashing red shall be used to indicate severe congestion or major delays. The control section display shall be capable of being

dynamically sized by a workstation user. Resizing the window shall not reduce the amount of data displayed on a workstation monitor, and the same aspect ratio shall be monitored as before the resizing. The control section map graphic shall include a user-definable control section map title. North shall either be at the top or right side of the monitor when displaying a control sub-area. Vertical and horizontal scroll bars may be provided if the size of the sub-area is such that it cannot be displayed on a monitor at a scale (as determined by the Engineer) that is adequate for viewing by the operator. The Engineer will provide to the Contractor the final control sections boundaries for each control section display to be developed by the Contractor. There will be a maximum of 30 Control Section Map displays.

B.12.4. Intersection Display

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 a 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 OASIS phasing.

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 OASIS 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 OASIS controller. This monitoring shall include force off points, and permissive periods for each phase.

B.13.9. Clock Updates

Intersection clocks shall be updated at a minimum of once per day. At a user programmable interval, the software loaded on the communications server shall provide for the automatic updating of the universal time by means GPS receiver or Internet time sync. 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.

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 local and master 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 database system shall use structured query language (SQL) and conform to Microsoft's open database standards.

The software shall provide user-friendly database facilities that allow changes to be put into effect while the system remains fully operational. The system shall provide the following database

management features.

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 OASIS local controller. The software shall similarly provide for downloading (copying) the database, and logical segments thereof, to a 2070 controller using OASIS firmware 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 use structured query language (SQL) to retrieve data and develop custom reports. The user shall be able to define the format of those reports. **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:

B.16.1. Communications Status Failure Report

The communications status failure report shall display the collected data for the communications

concentrators and show failures. Such a report shall show the concentrator number, the port number, the logical port number, the status, communication attempts, errors and percent of failures.

B.16.2. System Error Report

The system error report shall display the collected data of the system errors. Such a report shall show the error date and time, the user ID number, user login name, workstation ID number, error, error description, application ID number, Module name and procedure name.

B.16.3. System Events Report

The system event report shall display the collected data of system events. Such a report shall display the date and time of the event, user ID number, user login name, asset ID number, Main Street, Cross Street, event description, workstation Id number.

B.16.4. System Status Report

The system status report shall display the various conditions of the entire system. Such a report shall show the date and time, the control section, the asset ID number, the Main street, Cross Street, asset type and status, communications status, timing plan, cycle length, present offset, and master ID number.

B.16.5. Detector Status Report

The detector status report shall display the operation of detectors. The user shall be able to select from all detectors in the entire system, for each section, for an individual asset or an individual detector. In addition the operator shall be given a choice of start and end dates to display detector data. Such a report shall show the section ID number, section name, Intersection ID number, Main Street, Cross Street, link ID number, link name, detector ID number, detector name, detector direction, detector, phase, time and date, detector activity, status, and specific failures

B.16.6. Measures of Effectiveness Reports

Measures of effectiveness (MOE) reports shall permit the operator to gauge the effectiveness of the local controller's timing and coordination settings. At a minimum, the following MOE shall be available:

- **Smoothed Volume** – The smoothed volume report shall display smoothed volumes calculation of system detectors. The user shall be able to select from all detectors in the entire system, for each section, for an individual asset or an individual detector. In addition the operator shall be given a choice of start and end dates to display the smooth data. Such a report shall show Section ID number, Section Name, Intersection ID number, Main Street, Cross Street, Link ID number, Link name, Detector number,

detector name, detector direction, detector phase, date and time, sample length, class 1-4 volume, and smoothed volume.

- **Smoothed Occupancy** – The smoothed occupancy report shall display smoothed occupancy calculation of system detectors. The user shall be able to select from all detectors in the entire system, for each section, for an individual asset or an individual detector. In addition the operator shall be given a choice of start and end dates to display the smooth data. Such a report shall show Section ID number, Section Name, Intersection ID number, Main Street, Cross Street, Link ID number, Link name, Detector number, detector name, detector direction, detector phase, date and time, sample length, class 1-4 volume, and smoothed occupancy.
- **Smoothed Queues** – The smoothed queues report shall display smoothed queues calculation of system detectors. The user shall be able to select from all detectors in the entire system, for each section, for an individual asset or an individual detector. In addition the operator shall be given a choice of start and end dates to display the smooth data. Such a report shall show Section ID number, Section Name, Intersection ID number, Main Street, Cross Street, Link ID number, Link name, Detector number, detector name, detector direction, detector phase, date and time, sample length, class 1-4 volume, and smoothed queues.
- **Smoothed Intersection Level of Service (LOS)** – The Intersection LOS report shall display the LOS calculation from the intersection detectors factoring in waiting, delays and stops. The user shall be able to select from all detectors in the entire system, for each section, for an individual asset or an individual detector. In addition the operator shall be given a choice of start and end dates to display the smooth data. Such a report shall show Section ID number, Section Name, Intersection ID number, Main Street, Cross Street, Link ID number, Link name, Detector number, detector name, detector direction, detector phase, date and time, sample length, class 1-4 volume, intersection Level of Service.
- **Smoothed Approach LOS** – The approach LOS report shall display the LOS calculation from the intersection detectors factoring in waiting, delays and stops for each approach. The user shall be able to select from all detectors in the entire system, for each section, for an individual asset or an individual detector. In addition the operator shall be given a choice of start and end dates to display the smooth data. Such a report shall show Section ID number, Section Name, Intersection ID number, Main Street, Cross Street, Link ID number, Link name, Detector number, detector name, detector direction, detector phase,

date and time, sample length, class 1-4 volume, approach Level of Service.

- **Pedestrian Calls** – The pedestrian call report shall display the number and date when pedestrian calls have occurred on an intersection basis. The user shall be able to select on an intersection basis. In addition the operator shall be given a choice of start and end dates to display the smooth data. Such a report shall show Asset ID number, Main Street, Cross Street, Asset Description, Time and date, Pedestrian Calls, Detector Reference, and Count.

B.16.7. Links Report

The Links report shall display the link information and the detectors that have been assigned to that link. Such a report shall show the Asset ID number, the Main Street, Cross Street, Link ID number, Link name, and detector ID number.

B.16.8. Intersection Status Report

The intersection status report shall display operations parameters of the intersection selected. Such a report shall show in a header the Intersection ID number, Section ID number, Main Street, Cross Street, Cycle Length, On-line/Off-line, Timing Plan, Offset, Status, and Control Mode.

B.16.9. Intersection Operation Report

The intersection operation report shall display the operation status of any intersection. This report shall be filtered by intersection (asset ID number and by date. Such a report shall show the following information as a header:

The asset ID number, Main Street, Cross Street, Asset Type, Master ID number, Section ID Number, plan, cycle, offset.

Under the header shall be displayed six (6) tabs used to select additional information as follows:

- **Detector Tab** – The detector tab shall display the detector information for the previously selected intersection. Such a report shall show Section Id number, section name, intersection ID number, Link ID number, detector ID number, detector name, detector direction, detector phase, time and date, sample length, class 1-4 volumes, occupancy, average stops, average wait, average. speed, status, and detector active
- **Event Tab** – The event tab shall display the status and information of the events for the select intersection. Such a report shall show date and time, user ID number, user login name, asset ID number, event description
- **Command Tab** – The command tab shall display the status of the commands associated

with the select intersection. Such a report shall show date and time, command type, type description, command code, code description, asset ID number, section ID number, section name, detector ID number, detector name, detector type, detector phase, detector direction, communication status.

- **Failure Tab** – The failure tab shall display system failures for the intersection selected. Such a report shall show the date and time, section ID number, section name, asset ID number, failure code, failure description, serial number, detector name, detector type, detector phase, detector direction, and port number.
- **Plan Tab** – The plan tab shall display the status of the plan operational at the intersection. Such a report shall show the time and date, section ID number, section name, asset ID number, plan number, plan number description, and plan reason description.
- **Phase Tab** – The phase tab shall display the phase green and other parameters of the phase operation for the intersection selected. Such a report shall show phase ID number, Direction, minimum green, maximum green and initial variable allowed.

B.16.10. Active Intersection Report

The active intersection report shall display the intersections that are active in the system. Such a report shall show the Concentrator address, logical port, physical port, asset ID number, Main Street, Cross Street, and activity.

B.16.11. Inactive Intersection Report

The inactive intersection report shall display the intersections that are not active in the system. Such a report shall show the Concentrator address, logical port, physical port, asset ID number, Main Street, Cross Street, and activity.

B.16.12. Split Monitor Report

Splits and offsets shall be displayed in a graphical format to facilitate the fine-tuning of timing plans. The software shall also include a program that shall run in stand-alone or background mode to access the system database and output time-space diagrams of stored timing plans for selected intersections. Provisions shall be included in the program to output these diagrams to a networked laser printer.

The split monitor report shall display as a graphic the actual green times for each phase of the selected intersection versus the actually timing at the controller. The user shall be able to select from an individual asset and be given a choice of start and end dates to display the split monitor report.

The graphics shall display as a minimum the actual split times, the programmed split times, and additional times not used by each phase.

Under the graphics shall be a table that shall show the following data collected and updated once per cycle; plan, cycle length, primary phase, primary extended green, secondary phase, secondary extended green, and phase 1-16 greens used.

B.16.13. Time of Day Scheduler Report

The time of day scheduler report shall display the actual operation of the scheduler. Such a report shall show the date and time, section ID number, section name, asset ID number, Main Street, Cross Street, plan number, plan number description, plan reason code, and plan reason description.

B.16.14. System Operations Summary Report

The system operation summary shall display four separate reports that describe:

- **Equipment and communication Failures** – The system operational summary for equipment and communication shall display a list of equipment failures and communications within the system. The user shall be able to select from all in the entire system, for each section, or an individual asset. In addition the operator shall be given a choice of start and end dates to display detector data. Such a report shall show date and time, asset ID number, and failure description.
- **Controller Failures** – The system operational summary for controller failures shall display failures for controllers. The user shall be able to select from all in the entire system, for each section, or an individual asset. In addition the operator shall be given a choice of start and end dates to display detector data. Such a report shall show date and time, section name, asset ID number, asset description, Main Street, Cross Street, and failure description.
- **Detector Failures** – The system operational summary for detector failures shall display failures for detectors. The user shall be able to select from all in the entire system, for each section, or an individual asset. In addition the operator shall be given a choice of start and end dates to display detector data. Such a report shall show date and time, asset ID number, detector ID number, failure, special failures, phase, direction, Main Street, and Cross Street.
- **System activity Logs** – The system operational activity logs shall display which events have been activated. Such a report shall show event date and time, asset ID number, parent event, event type, and event description.

B.16.15. Schedule Upload of Field Tables Report

The schedule upload of filed tables report shall display the time and assets that are scheduled to have their data base uploaded and compared to the database for accuracy.

Such a report shall show upload times, asset ID number, Main Street, Cross Street, asset type, upload status, compare status, and table status.

B.17. Security

In addition to the network security features provided by the Windows 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. Local Controller Software

Local controller software shall be the latest version of the NCDOT approved controller software. 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.

D. CCTV System Software

Furnish a network-ready, client-server CCTV system software package that operates over the LAN. The software shall be integrated into the signal systems software.

Furnish CCTV system software that allows the user to:

- Select CCTV field units
- Control selected CCTV units via software based graphical controls and, for workstations so equipped, a fully functional CCTV control keypad

- Assign field CCTV images and component device output (e.g. DVR) to monitors, workstation video capture cards, and component device inputs

At the user's discretion, either a control panel (joystick) or graphical user interface may be used for CCTV control functions.

D.1. Operator Access Privileges

Provide up to 36 unique operator identification passwords. Operator privileges shall be definable by the system administrator. At a minimum, the following privileges shall be definable (yes/no) for each operator:

- Video switch control
- Pan, tilt, zoom camera control
- Programming control
- DVR control

In addition, the software shall allow these privileges to be assigned by TOD/DOW/DOY.

D.2. Programming Control

Provide user-defined programming of up to 100 timed events. Provide the user with the option to associate an alphanumeric name with each event. Provide 7-day, 24-hour programming ability. At a minimum, programmed events shall include:

- Video switch, and camera to any monitor (including remote monitors)
- Command pan/tilt unit to a defined pre-set
- Initiate a video tour
- Activate (or deactivate) a relay to turn the DVR on or off

The software shall allow for up to four (4) events to be initiated per timed event.

The software shall permit the manual override of the scheduled events.

D.3. Graphical User Interface

The graphical user interface (GUI) shall provide a graphic of the overall project area with icons representing camera locations. This graphic shall be identical to the map used for the signal system software. Selecting an icon will provide the user with camera control, unless the camera is in use by another user. If the selected camera is in use by another user, a message identifying the current user shall be displayed. In addition, a display showing the camera's current user defined preset position

will be shown. At the operator's discretion, the GUI or the camera control panel (joystick) may be used to control all camera functions.

D.4. Video Switch

Clicking on an icon in the CCTV system software shall produce a scrollable, drop-down list that contains the name of all video outputs (such as monitors, DVR, CODEC, etc.) that are connected to the video switch. A subsequent click on the appropriate video output name shall select the device on which the video is to be displayed or transmitted. Output devices presently in use shall not be available for use until they have been de-selected.

E. Regional ITS Graphical User Interface Software

E.1. General

The North Carolina Department of Transportation (NCDOT) using Federal ITS integration funds has developed a regional ITS graphical user interface (GUI). The purpose of the regional ITS GUI is to provide a common interface among the various traffic operations and management centers in the Triangle Region to launch each others various traffic management applications from computer workstations local to their respective centers. The ITS regional GUI assumes the following:

- When a field device on the GUI is actuated, that client software for the application is present on the workstation from where the application is launched,
- The user on the launching workstation has network level rights to log onto the application server where the ITS devices native software resides
- The user on the launching workstation has application level security rights to use the application software for the devices actuated

E.2. System Graphics

Add all CCTV units newly installed under this project to the Regional ITS Graphical User Interface map display in their geographically correct location. The Regional ITS GUI map is located on the Regional ITS GUI server at the TRTMC.

E.3. Graphical User Interface (GUI)

Ensure all CCTV icons are able to launch native CCTV system software from each client workstation that has the client Regional ITS Graphical Interface software installed at the TRTMC.

Ensure all CCTV icons are able to launch native CCTV central software applications from each client workstation that has the client Regional ITS Graphical Interface software installed on workstations in the Chapel Hill-Carrboro Signal System.

Install a client version of the Regional ITS GUI software onto each of the operator workstations in the Chapel Hill-Carrboro Signal System. Perform all work and create all network linkages required to allow for CCTV client software for CCTV units that terminate at the TRTMC and the video matrix switcher at the TRTMC to be operated from the client workstations in the Chapel Hill-Carrboro Signal System.

Install client versions of the Chapel Hill-Carrboro CCTV software onto each of the client workstations at the TRTMC.

Install client versions of the NCDOT CCTV central software onto each of the client workstations in the Chapel Hill-Carrboro Signal System.

Perform all work and create all network linkages required to allow for CCTV client software for CCTV units that terminate at the TRTMC and the video matrix switcher at the TRTMC to be operated from the client workstations in the Chapel Hill-Carrboro Signal System.

Perform all work and create all network linkages required to allow for CCTV units that terminate at the Chapel Hill-Carrboro TOC, and the TOC Video Matrix Switcher to be operated from the client workstations at the TRTMC.

Perform all work in accord with the software low level design (LLD)document prepared for the "Integration Of City Of Raleigh Traffic Operations Center With Triangle Regional Transportation Management Center" (TIP # U-4431) project. Obtain LLD document from the Triangle Regional ITS Engineer.

E.4. Unified Device Database

Modify Regional ITS Graphical Interface Software unified device database to include all CCTV installed or integrated under this project.

F. Other Software

F.1. Signal Timing Software

Furnish Synchro Plus SimTraffic, version 7.0 (or latest version that is compatible with the computer operating system provided on the computer workstations furnished under this project) as offered by Trafficware Corporation.

Furnish TS/PP-Draft, version 8.0 (or latest version that is compatible with the computer operating system provided on the computer workstations furnished under this project) as offered by any authorized distributor.

Furnish two (2) Garmin eTrex Legend GPS Receivers, or approved equivalent, with Cigarette

Lighter Adapters (#010-10203-00) for each receiver. The GPS receivers shall be considered necessary accessories and incidental to furnishing the TS/PP-Draft software.

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.

F.2. Productivity Software

Furnish a network version of the latest release of the Microsoft Office Suite, Professional Edition, including Excel, Access, Word, and PowerPoint. A license shall be provided for each workstation and notebook furnished with the project. Furnish and install a copy of the latest release of Microsoft Office Suite, Professional Edition, on each workstation and notebook computer furnished.

F.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.

28.3. INSTALLATION AND INTEGRATION

A. General

Install and fully integrate distributed processing signal system software on Distributed Processing Signal System server called for in Section 29 of these Project Special Provisions. Install and fully integrate distributed processing signal system software on each workstation and notebook computer in the Chapel Hill-Carrboro signal system.

Install and fully integrate distributed processing signal system software on Distributed Processing Signal System Communications server called for in Section 29 of these Project Special Provisions as required.

Install and fully integrate CCTV central software on CCTV server called for in Section 29 of these Project Special Provisions as required.

Install all software furnished for the system in accordance with the procedures recommended by the software supplier.

Install a copy of the distributed processing traffic signal system software and all communications software necessary to achieve dial-up, remote operations on the notebook computers.

Register all software products furnished with this project with the software supplier. The Town of Chapel Hill and the NCDOT shall be identified as the registered owner of all software.

A.1. Operating System

Install and integrate the operating system and all necessary utilities.

B. Distributed Processing Signal System Software

Install and integrate the distributed processing traffic control applications software and all other software with the communications system and local controllers to provide a traffic signal system that provides the functionality required by these Project Special Provisions. A Windows Server 2008 based installation program shall be provided for installing the software on the file server. Provide a separate Windows Vista based installation program for installing the client software on workstations.

Load all parameters necessary to implement coordinated signal operations. The Engineer will furnish the timing parameters in standard traffic engineering format (cycle, split, and offset) prior to the initiation of the 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

Program all new system detectors installed under this project, and all existing system detectors being reused, in the signal system software. Install all associated graphics related to system detectors.

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 Town 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 2070 controllers are existing, and will not be replaced under this project, upgrade the local controller software to the current version of the NCDOT approved software being installed in new controllers under this project. All controllers in the final Signal System shall have identical local software.

D. CCTV System Software

Install and integrate the CCTV system software with the field hardware. Install CCTV system software onto CCTV server. Install CCTV client software onto workstations and notebook computers at the TOC and EOC.

Install up to four (4) seat licenses of the CCTV system client application at the Chapel Hill Police Department. Verify that the software is fully operable on Chapel Hill Police Department workstations and laptops designated by the Engineer.

Install up to four (4) seat licenses of the CCTV system client application at the UNC Public building. Verify that the software is fully operable on UNC Public Safety workstations and laptops designated by the Engineer.

E. Modify Regional ITS Graphical User Interface Software (GUI)

Obtain the Regional ITS GUI software low level design (LLD) document prepared for the "Integration Of City Of Raleigh Traffic Operations Center With Triangle Regional Transportation Management Center" (TIP # U-4431) from the Triangle Regional ITS Engineer. Update the document to detail the software and database architecture as modified to accommodate the Chapel Hill-Carrboro applications.

Update the document to detail the software and database architecture as modified to accommodate the addition of ITS Regional GUI client software to the operator workstations in the Chapel Hill-Carrboro Signal System. All database tables and their associated fields shall be discussed. The LLD document shall discuss the objects implemented and their associated properties and methods. The document shall be detailed enough to allow a different vendor to support and modify this software. The LLD document shall also make recommendations on how to enhance the software to support dynamic display of the ITS elements if future vendors provide a software interface.

Modify and test Regional ITS GUI software in accord with the updated LLD. Install the modified Regional ITS GUI software on each client workstation at the TRTMC. Install the modified Regional ITS GUI server software on the Regional ITS GUI server at the TRTMC. Update and test all network links and connections to insure all clients workstations can access, log in, and launch all applications on the Regional ITS GUI.

F. Other Software

Install the signal timing software, productivity software, and utility software on all workstations and notebook computers provided with the project.

28.4. 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 36)
- 60-Day Observation Period (as called for in Section 1 and Section 36

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 Chapel Hill-Carrboro System. All transportation, lodging and per diem costs for NCDOT and Town personnel to witness the system demonstration will be borne by NCDOT or the Town.

28.5. 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, 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, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to install the software, complete system integration, and provide a complete operating system. Partial payment for this item will be made as follows: 50% of the lump sum price upon delivery and installation of the software and 50% of the lump sum price upon successful completion of the Observation Period. No payment will be made for providing software license and source code as required in these Project Special Provisions.

Regional Graphical User Interface Software 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 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 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 for the TS/PP-Draft software will not be paid for separately but will be considered incidental. No payment will be made for providing software license and source code as required in these Project Special Provisions.

All other software and hardware otherwise required to accomplish the functionality required by

the Project Special Provisions will not be paid for separately but will be considered incidental. No payment will be made for providing software license and source code as required in these Project Special Provisions.

Testing will not be paid for separately but will be considered incidental to equipment installation.

Payment will be made under:

Signal System Software ..... Lump Sum

CCTV System Software ..... Lump Sum

Regional Graphical User Interface Software ..... Lump Sum

System Support Software ..... Lump Sum

29. COMPUTER HARDWARE AND PERIPHERALS

29.1. DESCRIPTION

Furnish and install server computers, workstation computers, laptop computers, and peripheral equipment in the TOC at the Chapel Hill Town Operations Center and the EOC in Fire Station 1 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 31 of these Project Special Provisions.

Install all computer hardware and peripherals as shown in the Block Diagram contained in the Plans.

29.2. 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 Chapel Hill-Carrboro 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:

- Minimum monitor size shall be 15", 14" viewable, 1,024 × 768 resolution, SVGA.
- 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 (with expansion capacity to 1GB).
- 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 500 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.
- One 90mm 1.44MB floppy disk drive.
- 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, exclusive of the modem.

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 distributed 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 Distributed File Server shall be furnished will 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.2.5. Tape Back-up

The tape back-up drive shall be a fast, standards-based, back-up solution that utilizes the LTO-4 standard. The Drive shall meet or exceed the following specifications:

- Max Dimensions (2.5" (H) x 10.5" (W) x 11" (D)) ("Half Height") (External)
- Rack mountable with rack mounting accessories
- Support LTO-4, 800 GB removable, re-readable, re-writeable media
- Be equipped with minimum five (5) removable media
- Be supplied with Server adaptors and interfaces for connection to server
- Be supplied with back-up management software that supports the scheduled and unscheduled backup of all servers and workstations on the LAN. Support software shall be minimum Symantec Exec or approved equal
- Be supplied with all software and hardware to back-up all software applications on the

signal system LAN

- Have a transfer write speed of at least 432 GB per hour

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 28 of these Project Special Provisions, including once-per-second polling of all traffic signal controllers.

C.3.1. Features

Furnish Communications Server that has the same features as the Signal System Server as well as those that follow.

Furnish Communications Server that is rack mountable in standard EIA 19" equipment rack.

Furnish sever that is expandable to 64 ports through addition of PCI 16 port expansion modules or through use of USB port-based modules.

Furnish serial port expansion modules that have the following features:

- PCI or USB compatible
- Provide minimum data transfer rates of 38.4 Kbps to all ports at all times
- Support data transfer rates up to 115.2 Kbps
- Contain 16 EIA-232 asynchronous serial ports: with DB-25 connectors, USB connectors, or connectors as approved by the Engineer
- Support full modem control and full hardware hand-shaking (CTS, RTS, DSR, DTR and DCD) on all channels
- Can be configured using the server operating system and sever applications that support the use of configured serial ports

Furnish an initial two expansion modules (for a total of 32 serial ports) to mate with communications channel central fiber optic transceivers.

C.4. CCTV Video Server

Furnish a Video Server to process video from and control CCTV cameras in the field.

C.4.1. Features

Furnish video server that has the same features as the Signal System Server as well as those that follow.

- Rack mountable in standard EIA 19" equipment rack.

C.5. Remote Access Server

Furnish Remote Access Server to host remote access software and allow up to eight simultaneous users to access all services on the LAN via dial-up modem, ISDN connection, fractional or full T-1 connection, DSL connection, Cable modem connection, or full bandwidth Ethernet connection. Furnish minimum six client licenses of remote access software compatible with notebook computers to be installed under this project.

C.5.1. Features

Furnish Remote Access Server with same features as the Signal System Server with the following exceptions:

- five (minimum) EIA 232/EIA 422 serial ports

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 95 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, KVM switch, and servers)
- Shall require no more than 64 Mb of RAM to support each user
- Provide security and user authentication features and functionality
- Utilize Windows XP Remote Desktop functionality or approved equal.

Furnish server with all required operating system and third party support software to fully operate remote access server.

D. Keyboard Video Mouse Switch

Furnish Keyboard-Video-Mouse (KVM) switch that allows a single keyboard, mouse, and RGB monitor to access and switch between multiple application servers in the TOC rack cabinet. Furnish KVM switch unit that has the following features:

- Rack mountable with a maximum height of 1.75 inches
- Control of a minimum of 8 servers using a single unit
- Multiple switching methods including front panel, keyboard, or on-screen display
- Compatible with servers furnished under this project
- Compatible with keyboard, monitor, and pointing device supplied with rack cabinets under this project

Furnish all necessary cabling to integrate KVM switch.

E. Computer Workstations

Each microcomputer workstation shall be upgradeable and shall meet the following minimum requirements:

- Minimum monitor size shall be 20" , 18.5" viewable with a 1,600 × 1,200 resolution and shall include all necessary cabling for dual-monitor configuration
- 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
- 1.44MB floppy
- 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 Vista. 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.

F. Notebook Computers

Provide notebook computers with Windows Vista 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 diskette drive that will accept 3.5-inch, 1.44 MB diskettes (internal or external),
- one internal 24X CD-RW/DVD-ROM drive,
- one parallel port,
- one RS-232 serial port,
- 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.

Provide modems that comply with the following:

- Data Compatibility: V.34, V.FC, V.32, V.32bis, V.22, V.22bis, V.90, V.92
- Fax Compatibility: V.17, V.29, V.27ter
- Error Control and Data Compression: V.42/MNP 2-4 error control (hardware based), V.42bis/MNP 5 data compression (hardware based)
- Ethernet: IEEE 802.3

G. Printer

Furnish color laser printers with the following features:

- Utilizes the PCL 6 printer language featuring commands for fully integrated HP-GL/2 vector graphics and advanced imagery/special effects printing with a minimum of 80 internal, scalable fonts.
- Utilizes the latest version of Windows print typefaces.
- Provides a minimum of 16 MB of RAM.
- Provides modular input/output (I/O) and Ethernet 10/100/1000 Base-T network communications protocols.
- Comes equipped with an Ethernet 10/100/1000 Base-T network interface card and an RS-232 serial (9-pin) interface, bi-directional IEEE 1284 ECP-compliant parallel interface, one (1) USB port, and one (1) open EIO expansion slot.
- Prints a minimum 40 pages per minute (ppm) for both color and black and white prints.
- Provides 1,100 sheet capacity and 3 input trays supporting 8.5 x 11 inch, 8.5 x 14 inch, and 11 x 17 inch media.
- Prints a print resolution of a minimum 1200 x 600 DPI.

H. GPS Antenna

Furnish global positioning system (GPS) antenna for precise timing and synchronization

applications. Furnish GPS antenna with the following minimum features:

- GPS receiver and antenna in a single environmentally sealed enclosure
- Generates a pulse-per-second (PPS) output synchronized to UTC within 50 nanoseconds (one sigma), outputting a time tag for each pulse
- RS-422/485 communications

Furnish the following accessories with the GPS antenna. These items are considered incidental to furnishing, installing, and integrating the GPS antenna.

- Mounting pole with standard 1"-14 straight thread
- RS-422 Interface cable of sufficient length (but not greater than 400 feet) to route from GPS antenna to server, including all required connectors and adapters
- RS-422 to RS-232 converter, including all cables to connect with server
- Windows-based software program for monitoring GPS operations and communications
- DC Power supply

Furnish GPS antenna that is Trimble Acutime 2000 model or approved equivalent.

29.3. CONSTRUCTION METHODS

A. General

Furnish and install the central hardware required to support the software functions called for in Section 28 of these Project Special Provisions.

Furnish and install the hardware at the TOC and remote video operation facilities 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 equipment rack cabinet at TOC as shown in the Plans. Integrate with LAN switch, KVM switch, and UPS. Integrate with signal system communications server using direct serial, parallel, USB, or network connection. Fully configure server to operate distributed system processing software.

C.2. Signal System Communications Server

Install signal system communications server into equipment rack at TOC as shown in the Plans. Integrate with LAN switch, KVM switch, and UPS. Integrate with distributed processing signal server using a direct serial, parallel, USB, or network connection. Integrate with fiber optic communications system using serial communications ports and fiber optic transceivers. Fully configure server and ports to facilitate signal system communications.

C.3. CCTV Video Server

Install video server into equipment rack at TOC as shown in the Plans. Integrate with LAN switch, KVM switch, and UPS. Integrate with video matrix switch and digital video recorder (DVR).

C.4. Remote Access Server

Install remote access server into LAN equipment rack cabinet at the TOC. Integrate with LAN switch, KVM switch, and UPS.

Install and configure software with usernames, passwords, and Remote Access Windows desktop that allows client user gaining access to the LAN via the server, has complete access to all software applications on the LAN, available to a local user. Configure new notebook computers and up to two additional dial-up remote users as designated by the Engineer for remote dial-in access. Install all third party software and drivers required to create fully functional remote access server. Install all client software on new notebook computers and dial up remote workstations (as designated by the Engineer) required for operation of all software services available on the LAN.

D. Keyboard Video Mouse Switch

Install KVM switch into LAN equipment rack cabinet at the TOC. Integrate with all application servers in the TOC and rack cabinet drawer monitor, keyboard, and mouse.

E. Computer Workstations

Install one (1) dual-monitor computer workstation in operator work center at the TOC as shown in the Plans. Integrate with LAN switch, UPS, and KVM switch. Integrate monitor card with local monitors and large screen display system. Fully configure microcomputer workstations with all client software to operate all signal system subsystems including distributed processing signal system and CCTV subsystem.

Install one (1) single-monitor computer workstation in the EOC in Fire Station 1 as shown in the Plans. Integrate with LAN switch. Integrate monitor card with local monitor and LCD monitor. Fully configure microcomputer workstation with all client software to operate all signal system subsystems including distributed processing signal system and CCTV subsystem.

F. Notebook Computers

Furnish four (4) notebook microcomputers. Deliver notebooks to the TOC prior to the start of the scheduled training. Fully configure notebook computers with all client software to operate all signal system and subsystems, including distributed processing signal system and the CCTV subsystem. Configure notebook computers with client version of local intersection software to enable direct connection of notebook computer to the local distributed processing intersections for upload, download, monitoring, and manipulation of local intersection controller databases. Fully configure notebook computers such that when plugged into a network outlet on the Chapel Hill-Carrboro Signal System LAN, the user is able to login to the system as though he/she were logging in from any other workstation on the LAN.

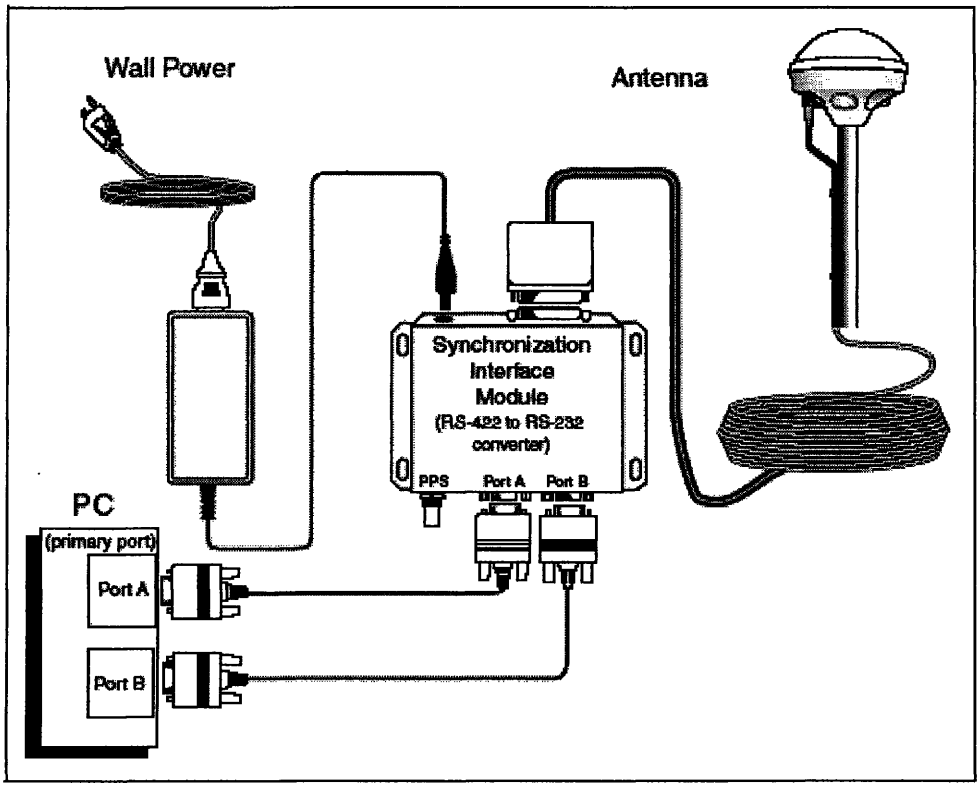
G. Printer

Install one (1) printer in the TOC and one (1) printer in the signal shop. Integrate with the LAN.

H. GPS Antenna

Install GPS antenna on side of Town Operations Center building or other location approved by the Engineer. Mount antenna using method approved by the Engineer such that the antenna has an unobstructed view of the sky and is not within close proximity to other transmitting antennas such as radars, satellite communication equipment, and cellular communication equipment. Ensure that antenna is properly grounded in accordance with the Standard Specifications and the manufacturer's recommendations to insure all electronic components downstream of the antenna, including the synchronization interface module and the signal system computer hardware, are isolated from electrical transients and surges. Route interface cable from antenna to signal system server as shown in the Plans using methods approved by the Engineer.

Integrate GPS antenna with server such that the software can perform clock synchronization tasks. The following diagram details all of the required connections.



I. Computer Hardware Integration

Fully integrate computer hardware equipment to form complete and operational systems as called for in these Project Special Provisions and shown on the block diagram in the plans. Install and configure all central computer hardware at the TOC and remote video operation facilities 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.

29.4. MEASUREMENT AND PAYMENT

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

KVM switch will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Dual-monitor computer workstation will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Single-monitor 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.

Printer will be measured and paid as the actual number furnished, installed, integrated, and accepted.

GPS antenna will be measured and paid as the actual number furnished, installed, integrated, and accepted. All required installation accessories, including but not limited to cables, converters, mounting equipment, power supply, and software, shall be considered incidental and will not be paid for separately.

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 TOC and at the remote video operation facilities.

All cabling required, sockets, port adapters, or other accessories required to configure, integrate, and interconnect computer equipment shall be considered incidental and shall not be paid for separately. This shall include provision of the surge suppression power strips and uninterrupted power supplies.

Payment will be made under:

Signal System Processing Server.....Each

Signal System Communications Server.....Each

CCTV Video Server.....Each

Remote Access Server.....Each

KVM Switch ..... Each

Dual-Monitor Computer Workstation ..... Each

Single-Monitor Computer Workstation ..... Each

Notebook Computer ..... Each

Printer ..... Each

GPS Antenna ..... Each

Computer Hardware Integration ..... Lump Sum

30. LOCAL AREA NETWORK

30.1. DESCRIPTION

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, printers, and CCTV central equipment (including DVR, Video Matrix Switch, and large screen display devices). Furnish LAN connections as shown on the block diagram between equipment at the TOC and the remote video operation facilities and between equipment at the TOC and TRTMC. LAN connections within facilities shall be made with TIA/EI 568B Category 5E 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. Furnish and integrate new DSL connection at the TOC to serve as the gateway from the Internet for remote users that is physically separate from the gateway to the Internet for the Town-maintained wide area network.

Furnish and integrate remote access points for the LAN at the Chapel Hill Police Department and UNC Public Safety buildings.

30.2. MATERIALS

A. General

Furnish equipment for the LAN that complies with IEEE standard 802. Furnish Ethernet LAN switches and routers manufactured by the same vendor and fully compatible and interoperable with the network monitoring software and network hardware operating system software.

Furnish network hardware that operates in a 32 to 122 degree Fahrenheit environment at 5 to 95 percent relative humidity. Furnish network hardware with that operates from at 115 VAC ±10 percent at 60 Hz power feeds.

B. Network Performance Management Software

Furnish network performance management and remote monitoring (RMON) software. Furnish the license(s) and additional copies of the software to allow it to be installed on all the notebook computers furnished with the project.

The software shall use a GUI to configure, manage, and monitor the local network. At a minimum, the software shall provide the following functions:

- Automatically detect all devices in the network and display them in a graphic map

- Detect bottlenecks
- Detect card failures
- Detect switch failures
- Detect router failures
- Detect hub failures
- Detect cable failures
- Provide network performance information

In addition, furnish network management performance software that:

- Allows the configuration and backup of configurations currently running on the device
- Uses SNMP logging, paging and email alert capabilities
- Support TFTP transfers
- Supports Secure SNMP Version 3 or latest approved equal that runs under Windows Vista, or other approved operating system
- Supports full RMON-1 application, automatic baseline alarms, MIB expressions, email/pager event notification, advanced event actions, real time tabular/graphical displays, device specific applications, programming interfaces, optional WEB/Printed Reports, and recording of historical data to a log
- Supports and implements full Cisco IOS Firewall feature set (latest release) including data encryption for data passing through a router

C. Ethernet LAN Switches

Furnish LAN switches with the functionality and features described herein.

C.1. General

Furnish a Managed Ethernet LAN switch connectivity point for networked hardware. LAN switch shall feature each of the following attributes:

- A switch fabric/back plane capable of providing maximum transmission bandwidth, simultaneously to the number of ports required.
- Be modular and expandable to accommodate additional ports up to 50% of the initial bandwidth.

- A 10 Base-T network management port and software that supports simple network management protocol (SNMP) Management Information Base (MIB) II, SNMP MIB extensions, bridging MIB (RFC 1493) and remote monitoring (RMON). This port shall allow a notebook computer with network management software to monitor traffic over all switched segments of the network.
- Fault-tolerant power supplies. Failed power supply shall be hot swappable. Only one power supply shall be required for operation. Failed power supply shall be automatically detected and reported to the network management software.
- Be rack mountable in a standard 19" equipment rack.
- Power control switch
- Power on/off indicator

As a minimum, the front panel shall include the following per-port status LED indications:

- Link Integrity
- Disabled
- Activity
- Speed
- Full-Duplex

Use RJ-45 type connectors for all interface ports.

Furnish equipment that meets the IEEE standard 802.3. Furnish equipment manufactured by Cisco Systems unless otherwise approved by the Engineer.

Furnish LAN Switch with 120 VAC power and network management port for remote network management via IBM compatible PC.

C.2. Central LAN Switch (24-Port, Fiber)

Furnish LAN switch with a minimum of twenty four (24) 10/100/1000 Ethernet ports and a minimum of eight (8) fiber optic ports with LC connectors. Furnish all required jumper cables with matching LC connectors.

C.3. Remote LAN Switch (4-Port, Fiber)

Furnish LAN switch with a minimum of four (4) 10/100 Ethernet ports and a minimum of two (2) fiber optic ports with LC connectors. Furnish all required jumper cables with matching LC

connectors.

D. Router

Furnish rack-mountable Ethernet routers to serve as network gateway between the LAN at the TOC and the TRTMC. Furnish modular router with minimum two (2) expansion ports. Furnish router with expansion modules that provide minimum two (2) 10BaseT/100BaseT Ethernet auto-sensing ports. Furnish router that can isolate LAN services at the TOC and the external LAN services at the TRTMC such that only network traffic required to provide remote access to the CCTV server at the TOC from workstation computers at each facility is passed. Furnish router with LED or other approved indicators for the following functions:

- Transmit
- Receive
- Full duplex/collision
- Flow control
- Link
- Speed

Furnish router with RJ-45 type connector interface ports, maximum 1 RU height, and mountable in standard 19" equipment rack. Furnish equipment that meets the IEEE standard 802.3.

Furnish Router with 120 VAC power and network management port for remote network management via IBM compatible PC.

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. DSL Service

Furnish a new DSL connection at the TOC from the local telephone provider. Coordinate with the Town Telecommunications Engineer and utility company on proper termination point in TOC.

Furnish DSL modem that is compatible with DSL connection, VPN Firewall, and remote access server being provided under this project.

G. Cable and Wall Information Outlets

Furnish coaxial, Category 5E network cable, RS-232, monitor cabling, and all other cabling in the lengths required to interconnect devices as called for in the plans, specifications, and manufacturers requirements. Furnish quality and grade of cable capable of being operable at up to twice the distance installed on this project. Furnish cabling meeting all manufacturers' requirements and all applicable standards for performance and safety.

Furnish wall information outlets as required, with RG-45, RJ-11, BNC, or other connectors as required to terminate cabling in walls and floors for connection to devices and components.

H. LAN Patch Panel

Furnish LAN Patch Panels in the locations shown in the Plans. Patch panels shall be rack-mounted.

Furnish patch panels that meet or exceed Category 5E transmission requirements of TIA/EIA-568A supporting bandwidths up to 100 MHz. Furnish patch panels that are UL-listed. Furnish patch panels that provide for rear punchdown termination of horizontal cables from the office workspaces, provide at least 48 ports and occupy no more than 2 RUs mounting height EIA standard 19" equipment rack. All ports shall provide 8-position modular jacks for jumper cables and they shall be accessible from the front of the patch panel. Jumper cables shall be neatly arranged using cable management guides or an approved equivalent.

30.3. CONSTRUCTION METHODS

A. LAN Integration

Fully integrate switches, routers, firewall, and external modems, with computer and central

system hardware to form a complete local area network that allows users from the TOC and remote video operation facilities as shown on the block diagram in the Plans to access applications on application servers and the CCTV central hardware. Fully integrate network to allow the notebook computer users to be able to connect to the network via the LAN port on the notebook computer using a network cable.

Prior to installing and configuring the LAN, develop a LAN architecture and design document that shows the entire LAN topology, the bandwidth of the links, the IP addressing schema to be used, and the actual network hardware that will be used, listed by port number. The report will describe the network topology in text and using graphics.

Fully integrate LAN equipment to provide virus protection, user authentication, and security functions to prevent unauthorized users and data from entering the signal system LAN.

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. Ethernet LAN Switches

Install 24-port Central LAN switch into equipment rack cabinet in TOC as shown in the Plans. Integrate with UPS. Fully integrate with application servers, video matrix switch equipment, computer workstations, printer, and plotter. Fully configure switch with performance monitoring software and operating system software/firmware.

Install 4-port Remote LAN switch with fiber optic ports in the signal shop, EOC, Chapel Hill Police Department, and UNC Public Safety buildings as shown in the Plans. Integrate with the UPS if present. Fully configure switch with performance monitoring software and operating system software/firmware.

C. Router

Perform work required to install one Ethernet router, in the communications rack cabinet in the TOC, and one (1) Ethernet router in the communications rack at the TRTMC. All work performed at the TRTMC shall be approved by the Engineer prior to commencing any work at the TRTMC. No access to the TRTMC shall be permitted without prior approval of the Engineer for each visit. Fully document all planned modifications and adjustments to TRTMC system hardware and software prior to beginning any work at the TRTMC. Configure routers to allow Chapel Hill-Carrboro users to access the TRTMC CCTV server, CCTV video matrix switch, and Regional Graphical Interface server. Assign level of rights at a minimum below all NCDOT users. Configure

routers to allow TRTMC users access to the CCTV Server and the Video Matrix Switch. Integrate one fiber optic media converter with each router to accomplish LAN to LAN connection between the TOC and the TRTMC

D. VPN Firewall

Install two (2) VPN firewall switches at the TOC. Integrate one VPN firewall with LAN switch at TOC to allow only authorized remote users to access the signal system LAN. Install one VPN firewall for future connection to Town of Chapel Hill WAN. Do not configure or integrate with WAN. Install VPN software as required on all notebook computers provided under this project.

E. DSL Service

Procure DSL service at TOC. Integrate with VPN firewall and remote access server according to the block diagram in the Plans.

F. Cable and Wall Information Outlets

Route Category 5E network cabling in raised floors, drop ceilings, existing cable raceways, and locations approved by the Engineer at the TOC, to interconnect networked devices.

G. LAN Patch Panel

Install LAN patch panel into communications rack cabinet at the TOC. Integrate LAN cabling with patch panel and network devices.

30.4. MEASUREMENT AND PAYMENT

(____) LAN switch will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Router will be measured and paid as the actual number furnished, installed, integrated, and accepted.

VPN firewall will be measured and paid as the actual number furnished, installed, integrated, and accepted.

DSL service 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 price for LAN integration including configuration and integration of LAN hardware, firmware, and software to complete the LAN architecture.

Payment for all cabling, adapters, sockets, and other hardware shall be considered incidental and

no separate payment will be made.

Payment will be made under:

Central LAN Switch ..... Each

Remote LAN Switch ..... Each

Router ..... Each

VPN Firewall ..... Each

DSL Service ..... Each

LAN Integration ..... Lump Sum

31. CENTRAL VIDEO SYSTEM

31.1. DESCRIPTION

Provide the central video hardware and software at the TOC necessary to control and monitor the closed circuit television (CCTV) cameras installed at locations shown in the Plans. The central video equipment shall include (but not be limited to) a video matrix switch, video monitors, camera control panels, and digital video recorder (DVR).

Provide the traffic monitoring equipment and software necessary at the remote video operation facilities to allow users to control and view the video from the CCTV cameras located in the field. Control shall be over the LAN from any workstation connected to the LAN. Furnish and integrate CCTV control panels with all workstations in the TOC and EOC.

Provide video hardware and integration to upgrade the existing video matrix switch at NCDOT's Triangle Regional Transportation Management Center (TRTMC) to accommodate the additional cameras being installed under this project and to share existing camera feeds with the TOC.

31.2. MATERIALS

A. General

All central video equipment shall operate at 115 VAC (+/- 10 percent) at 60 Hz (+/- 10 percent). The equipment shall operate in a +32 to +120 degree F environment at 20 to 80 percent relative humidity.

Control consoles, with an integrated joystick device, shall be furnished and installed in the TOC and the remote video operation facilities. The console shall enable an operator to control, on a one-camera-at-a-time basis, using a joystick device, any connected remote camera's pan, tilt, zoom, and iris functions. Control of any connector camera's pan, tilt, zoom, and iris functions shall also be available through the system software. Pan, tilt, zoom, and iris functions shall be facilitated through the use of presets in the CCTV software.

B. CCTV Control Panel

Furnish desktop camera control panels at each workstation in the TOC and remote video operation facilities 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 CODEC

C.1. Functional Requirements

Furnish card-based and chassis installed video encoder units 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 initially 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 initially 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 initially 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
- Speed (10/100 Mbps)

C.2. 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.

C.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.

C.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 LAN Ethernet Switch and standard serial data cables to connect the Video Encoder to the video optical transceiver for pan-tilt-zoom functions and local configuration administration.

D. Video Matrix Switch

The video matrix switch (VS) shall enable the selective routing of video signals complying with National Television Standards Committee (NTSC), CCTV, and composite video signals. Selective signal routing shall be accomplished by switching video input signals to one or more video output ports. The number of input and output ports shall be modular, facilitating expansion of video switching capacity by the addition of input and output modules. Switching control shall be accomplished by an Electronic Industries Association (EIA) RS-232 control interface to the video switch.

The VS shall receive EIA RS-250B or short haul and medium haul video signals at its input and shall not compromise the RS-250 video transmission specification at the video output port.

The VS output signals shall supply inputs to local monitors, video capture cards, video recorders as well as video optical transmitters. The VS shall support wrap-around video where an output is switched to a special video processor and the output of the video processor is "wrapped around" to the input of the VS, allowing selection of processed or unprocessed video for local display, recording, and distribution to remote sites. The VS shall support synchronous switching of the video channels (and companion audio channels) provided in NTSC form by the cable television provider.

The video switch at the TOC shall be provided with a minimum of eighty (80) inputs and a minimum of eighty (80) outputs. Any input shall be selectable for switch connection to any, or to multiple, outputs. The video switch shall be expandable, within the chassis up to 200 inputs and 100 outputs by adding additional video input and/or output cards.

The VS shall contain all circuitry necessary to convert prime AC power into DC power required by circuitry. Internal power circuitry shall protect the internal logic from "hard" circuit failures during under- and over-voltage conditions normally experienced with commercial power. The power shall be provided to the VS chassis through a disconnectable power cord with a standard, 3-prong power utility outlet compatible, male connector and a locking type female connector that attaches to the VS's electronic chassis's male connector. Either a screw on type or twist lock type of connector is suitable, allowing power to be disconnected. Connectors and power cable shall comply with National Electrical Code and shall support additional power, which may be required for modular, expanded switch operation power.

D.1. Electrical Signal Interface

D.1.1. Input Signals/Video

The VS shall accept NTSC video inputs attached by means of BNC-type connectors. The

interconnect impedance shall be 75 ohms, unbalanced-to-ground, terminating. Video input signal accommodation shall be 1.0 volts, peak-to-peak (p p), ±3 dB. The input shall reject a "common mode" input signal in the frequency range of 0 to 4.2 MHz by a minimum of 40 dB. Return loss shall be a minimum of 40 dB over a frequency range of 0 to 5.0 MHz.

D.1.2. Output Signals/Video

The output signals of switched inputs shall be through BNC connectors, with output being dual, 75-ohm source terminated. Return loss of a video output shall be a minimum of 40 dB over a frequency range of 20 Hz to 5 MHz. Output video level shall comply with RS-250B requirements of 1-volt p-p. Output gain of any video channel shall be adjustable to unity from an input reference (+0.05 dB). Gain stability shall be 0 to +0.05 dB. The switched input signal as provided at the video output channel shall not be distorted by the switching process other than switching delays as specified herein.

D.1.3. Electrical Signals Control

The external switching control signals shall be interfaced by an RS-232 communications cable attached to a DB-15S or DB-25S connector. Data rate for control shall be selectable from 2400, 4800, 9600, or 19.2 kbps. Normal operation shall be 19.2 kbps, and any factory settings for the interface shall be at 19.2 kbps. Full duplex communications shall be accommodated over the link. The RS-232 interface shall communicate over a minimum distance of 100 feet without the need for short haul modems. The interface used shall be compatible with the video controller utilized in the system. Interface protocol and message structure shall be operationally compatible between the video switch and the video controller. A non-proprietary protocol and message structure shall be used.

D.2. Signal Transfer and Switching Specifications

The electrical signal transfer and switching functions shall comply with the following specifications:

- Video Channel Isolation (Cross Talk): 50 dB over a 25 MHz bandwidth; 40 dB to 50 MHz bandwidth from 25 MHz
- Differential Delay: ±0.5o at 5 MHz
- Minimum Channel Bandwidth (-3 dB) : 25 MHz
- Group Delay: Less than 5 msec at from 100 KHz to 5 MHz
- Differential Gain: 0.15%, 10 to 90% APL, over a 5 MHz bandwidth

- Differential Phase: 0.15o, 10 to 90% APL over a 5 MHz bandwidth
- Transit Response than 5%: Rise/fall time less than 3.0 msec and overshoot less
- Hum and Noise: 80 dB RMS below 1 V p-p over a 10 MHz bandwidth
- Switching Time Control: Vertical blank interval (per SMPTE RP 168) with vertical timing reference present
- Switching Time: Less than 2 microseconds
- Variation in Switching Time with Single Input Signal to Multiple Output Channels: Differential delay shall not exceed 10 msec
- Slew Rate: 150 volts per microsecond
- End-to-End and Signal-to-Noise (S/N) Ratio (assuming input signal is compliant): 57 dB

The VS shall conform to waveform distortion and non-linearity chrominance-to-luminance delay, envelop delay, and other time based specifications as defined in RS-250B related to short haul video transmission. Input signal differences, when selected for distribution on a number of output channels, shall not vary by more than the specified amounts stated herein. Signal distortion, delays, and signal-to-noise shall be independent of the number of output channels assigned to a given input channel.

D.3. Physical

The VS shall be compatible with a standard, 19-inch EIA electronic mounting rack. The panel height shall not exceed 10.5 inches. Depth shall not exceed 20 inches.

All connectors, switches, indicators and replaceable components shall be clearly marked. Switches and indicators shall have functional markings. Connectors shall include jack number and function (such as video source 1). Markings shall be permanent and shall not deteriorate through normal use.

D.4. Maintainability

The VS shall include built-in test (BIT) features and shall generate failure messages communicated to the video controller. The VS shall contain indicators on the front panel to support maintenance activities. Controls to support diagnostic and maintenance shall be included. As a minimum the front panel shall contain:

- Switch(es): Power on/off with power status indicator
- Indicators: BIT fail

Design shall be modular allowing easy replacement of modular components. The VS shall provide video loss detection.

D.5. Video Annotation

The VS shall provide the following video annotation capabilities:

- Camera identification number
- System date and time
- 40-character site description message
- Black or white character display on a per camera basis

E. Video Monitor Processor Unit

Furnish video monitor processor units that shall be server class computers that serve to software decode MPEG 4 and if furnished, MPEG 2 digital video for display on the LCD monitors and the video projection unit.

Furnish video monitor processor units that software decode up to 16 MPEG 2 or 16 MPEG 4 digital video streams at 25 frames per second, D1 resolution.

Furnish video monitor process units with 10/100/1000 MB network interface card.

F. Video Distribution Amplifier

Furnish rack-mounted master distribution amplifiers (MDA) for the splitting, amplification, and title generation of incoming video signals. Furnish 16 channel input/64 channel output MDA unit with the following features/functionality:

- Ability to accept time and date strings from the video matrix switch.
- Ability to be programmed using existing video matrix switch keyboard controller or the existing matrix switch CPU keyboard
- Provide 16 ground isolated video input units
- Provide 4 independent video outputs per video input channel
- Ability to assign time-date string; time-date and title string; or no character generation for each output
- Split and amplify video inputs
- Allow title string of at least 24 ASCII characters

Comply with the following video specifications

- Video inputs 0.5 to 2.0 Volts, peak-to-peak; each input
- 1 volt, peak-to-peak; each output
- Input/output impedance; 75 ohms, terminated
- Differential gain: 1%
- Differential phase: <1/2 degree
- Signal-to-noise ratio: -45 dB
- Character size: 7x9 TV line (minimum)
- Individually adjusted brightness (digital)
- Individually adjusted position (digital)

Comply with the following mechanical specifications:

- 16 BNC video inputs
- 4 BNC video outputs per video input
- Rack mounted in standard EIA 19" equipment rack
- 5.25" maximum height

Comply with the following communication specifications:

- RJ-45 connection for communications input and output to video matrix switch CPU
- Selectable data rates (1200, 2400, 4800, or 9600 baud)
- Communication formats (RS-232, RS-422, or RS-485)

Comply with the following environmental specifications:

- 32 to +132 degree Fahrenheit environment at 20 to 80 percent relative humidity.

G. Video Multiplexer

Furnish and install 16-channel video multiplexer that provides frame-to-frame combining of up to sixteen color video signals.

Furnish video multiplexer with the following characteristics:

- Receive, as inputs, sixteen (16) NTSC color video signals

- Utilize standard BNC connectors for input and output
- Synchronize the video input frames to a clock signal generated internally to the video multiplexer
- Digitally combine up to sixteen video signals to create a single NTSC video output signal.
- Provide one, four, nine, or sixteen separate images on a single monitor.
- Have a RS-232 input for control and configuration via an external computer
- Have MS Windows based software, that when loaded onto a computer that is connected to the multiplexer via its serial port, allows for the configuration and control of the unit.
- Furnish unit that has Ethernet LAN connectivity, is IP addressable, and has software that permits unit control by users on the LAN.
- Furnish unit that may be controlled via the Central video software called for to be furnished under this project
- Have published, available communications protocol and command strings for integration into a control interface developed by third party source
- Be mountable in a standard 19" equipment rack and have a height of no more than 3.5 inches (2 RU)
- Operating temperature Range: 14 Degrees F to 131 Degrees F
- Humidity: 0%-95%, non-condensing
- Size: less than 3.5" (2 RU) tall
- Power: 120 VAC
- Video Input: 1 volt peak to peak
- Video Output: 1 volt peak to peak
- End-to-End and Signal-to-Noise (S/N): 60 dB

The output signal of the video multiplexer shall be wrapped around as an input to the video switch.

H. Digital Video Recorder (DVR)

Furnish and install digital video recorder (DVR) to archive video from CCTV cameras in the

field. Furnish DVR that is compatible with the video matrix switch and CCTV software.

Furnish and install DVR unit with the following minimum features:

- Minimum 80 GB of memory
- MPEG or M-JPEG compression format
- Minimum image resolution of 720x480 (NTSC) and 720x578 (PAL)
- One (1) BNC video input
- One (1) video output (analog or SVGA)
- Rack mountable and no larger than 4 RU (7 inches)

Furnish unit that has Ethernet LAN connectivity, is IP addressable, and has software that permits unit control by users on the LAN.

I. LCD Video Monitors

Furnish new minimum 40" LCD video wall monitor. The video monitors will be used in a 24/7/365 environment at the TOC and 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 display cabinet should be no more than 12" deep, 49" wide, and 31" high.

Each LCD video display panel shall operate from 115 V +/- 10%, 60 Hz +/- 5% VAC input power. Power consumption shall be no more than 550W per display panel. Each video display panel shall be supplied with all the necessary hardware needed for mounting to wall as directed by the engineer.

Furnish monitor 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.

J. 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.

K. Video Wall

Furnish video monitor framing system to hold eight (8) 40" video monitors of the size and weight called for in these specifications and a 80" diagonal large screen for projection of the large screen display system as shown in the Plans.

Furnish video framing system that is constructed of wood or other approved material and is finished with scratch resistant paint or other approved surface. Furnish system that permits full view of all contained monitor units and full access to all knobs, buttons, and dials on front and sides of monitor units. Furnish system that allows 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 system that allows for the placement and removal of monitor units without use of tools. Furnish system that is secured to the wall. Furnish system that has slots, grommet holes, and cable raceways, for the discrete placement of cabling such that no cabling is visible from the front or sides of the system. Furnish unit that fits into the TOC operator room.

Prior to construction of the video monitor framing system, develop shop drawings and submit to Engineer for approval prior to commencement of construction of the system.

L. TRTMC Video Switch Expansion

Furnish equipment at the TRTMC to expand the existing Pelco 9760 video matrix switcher to accommodate an additional 16 NTSC video outputs and 32 NTSC video inputs. Furnish equipment to facilitate an Ethernet based, LAN connection to allow for remote control of the matrix switcher at the TRTMC by remote users at the TOC and to allow for remote control of the matrix switcher at the TOC by remote users at the TRTMC. Furnish equipment to accomplish the described functionality including:

- Matrix switching bays
- Video matrix switcher input modules
- Video matrix switcher output modules

- Components to accomplish remote access of TOC switch by users at the TRTMC via the Ethernet LAN
- Components to accomplish remote access of the TRTMC switch by users at the TOC via the Ethernet LAN

31.3. CONSTRUCTION METHODS

A. General

Install and test all central video equipment in accordance with the manufacturer's recommendations.

Route all cabling in ceiling, floor, conduit, or cable raceways unless otherwise approved by the Engineer.

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. 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.

C. Video CODEC

Install thirty (30) video codec units in the rack cabinet at the TOC to encode NTSC outputs from the video matrix switch into MPEG-4 digital video for distribution over the LAN.

D. Video Matrix Switch

Install new video matrix switcher into equipment rack cabinet in TOC as shown in the Plans. Integrate all matrix switcher sub-components to create a fully operational matrix switcher. Fully integrate new video monitors, workstation video capture cards, DVR, video multiplexer, matrix switcher network interface, and video feeds from field CCTV units into new matrix switcher. Integrate with the UPS.

E. Video Monitor Processor Unit

Install one (1) video monitor processor unit at the EOC. Fully integrate with LAN switch and video monitor.

F. Video Distribution Amplifier

Install two (2) master distribution amplifiers (MDA) units into the video equipment cabinet at the TOC. Assign active video feeds from CCTV units from the field and from NCDOT TRTMC video feeds to the master distribution amplifier inputs directly from the CCTV video optical receivers and the 16 channels optical video demultiplexer. Insert the video feeds into the MDAs upstream of the video matrix switch. Route one output from each of the MDA input channels to the video matrix switch. Program each input utilized on the MDA to obtain the time and date from the matrix switcher CPU. Program and input a title for each input used on the MDA for an active video feed. Obtain title string from the Engineer.

Route one of the four output video feeds for each video input to a port on the video CODEC unit.

G. Video Multiplexer

Install video multiplexer into video equipment cabinet at the TOC. Route 16 outputs from the video matrix switcher to the video multiplexer 16 input channels. Route the video multiplexer output to an input on the video multiplexer. Integrate video multiplexer control to allow for unit control via client software resident on all of the workstations and notebook computers in the system. Integrate with UPS.

H. Digital Video Recorder (DVR)

Install digital video recorder into video equipment rack in TOC and integrate with video matrix switch to provide digital recording of all video streams from CCTV cameras in the field. The schedule and nature of the video recording shall be user-defined and accomplished by integrating DVR with LAN switch. Furnish software to control DVR and view video over the LAN on all workstations and notebook computers provided under this project.

I. LCD Video Monitor

Install eight (8) 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 new monitor with the video matrix switch. This includes installation of cabling and connection of monitors to power source. Route cabling in ceiling, floor, and raceways as approved by the Engineer.

Install one (1) LCD video monitor on the wall in the EOC as shown in the Plans. Insure that monitor is installed securely and in a fashion that allows for its removal for maintenance and access to monitor display controls. Connect, configure, and fully integrate new monitor with the video server. This includes installation of cabling and connection of monitors to power source. Route

cabling in ceiling, floor, and raceways as approved by the Engineer.

J. Video Projection Unit

Install Video Projection unit on ceiling of TOC. Position to allow for clear resolution, 80" diagonal image on the video wall.

K. Video Wall

Install video wall as shown in the Plans. Fully integrate with LCD video monitors and video project unit. Fully integrate with UPS or surge protection as shown in the Plans or described in these Project Special Provisions.

L. TRTMC Video Switch Expansion

Modify existing matrix switcher at the TRTMC. Install additional matrix switcher sub-components into new video equipment cabinet at the TRTMC. Integrate all matrix switcher sub-components to create a fully operational matrix switcher that allows for control of any CCTV unit input to the switcher to be controlled remotely by users at the TOC and to be assigned to any monitor at the TOC. CCTV control shall be accomplished via the LAN. Fully integrate new video feeds from TOC into modified matrix switcher. Configure matrix switcher CPU and NCDOT CCTV server to recognize the TOC video feeds.

31.4. MEASUREMENT AND PAYMENT

CCTV control panel will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Video CODEC unit will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Video matrix switch 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.

Video distribution amplifier will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Video multiplexer will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Digital 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.

Video wall will be measured and paid as the actual number furnished, installed, integrated, and accepted.

TRTMC video matrix switch expansion will be measured and paid as a lump sum. No measurement or payment will be made for input or output cards, as they will be considered incidental to this pay item.

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 Codec Unit.....Each

Video Matrix Switch.....Each

Video Monitor Processor Unit.....Each

Video Distribution Amplifier.....Each

Video Multiplexer.....Each

Digital Video Recorder.....Each

LCD Video Monitor.....Each

Video Projection Unit.....Each

Video Wall.....Each

TRTMC Video Matrix Switch Expansion ..... Lump Sum

32. EQUIPMENT RACK CABINET

32.1. DESCRIPTION

Furnish, install, and integrate rack cabinets at locations shown in the Plans.

32.2. MATERIALS

A. General

Furnish equipment cabinets with railings and sockets for mounting of EIA 19" mountable equipment. Furnish units with removable and adjustable shelves and pull out drawers capable of holding 1.5 times the heaviest component required to be placed on shelf or drawer (when fully extended). Furnish Rack cabinets that are modular with removable side panels with open front and back sections. Furnish racks with cable management and raceways to facilitate neat and orderly organization of all cables routed to equipment on the rack. Furnish rack cabinets with accessories to ensure cables are not kinked or pinched and that all minimum bend radii of cables are preserved. Furnish rack cabinet units that may be aggregated into single units of up to four bays wide. Furnish units made of quality, non-corrosive materials and non-peeling paint. Furnish rack cabinets that are same color and same manufacturer.

B. Half Rack Cabinets

Furnish equipment rack cabinets for installation within buildings as shown in the Plans. Furnish units with maximum height of 48 inches. Add UPS to each rack.

C. Full Rack Cabinets

Furnish equipment rack cabinets for installation within buildings as shown in the Plans. Furnish units with ventilation fans audible no more than 46 dba at a distance of 4 feet from the unit. Furnish units with each bay a width of no more than 24" and a minimum of 84" of continuous useable rack space beginning no more than 6" above the floor. Furnish rack cabinets with maximum height of no more than 12" less than the ceiling of the room they are to be installed in. Add UPS to each rack.

For rack cabinets furnished that contain a KVM switch, supply drawer style, retractable keyboard with collapsing LCD, 14.1" monitor that consumes no more than 1 RU of rack space. Retractable keyboard/monitor shall be installed at 4.5' high and shall come equipped with keyboard, video, and mouse cables that allow it to be connected to the local analog port on the KVM switch.

D. Uninterruptible Power Supply

Furnish UPS units that are capable of detecting a power failure and providing back-up power to

the listed components within twenty (20) milliseconds. The transition to the UPS source from primary power shall occur without loss of data or damage to the equipment being provided with back-up power.

Furnish UPS units that are sized such that each is capable of providing back-up power for the total load of all equipment connected to the UPS plus an additional load of twenty-five percent of the total load for at least thirty (30) minutes of operation. It is anticipated that this will require a minimum 3000VA UPS, but the Contractor shall confirm this calculation before furnishing and installing the unit, based on the specifications of the equipment being installed in the rack cabinet. The UPS units shall be capable of interfacing with the Distributed System Software such that upon sensing a loss of power, a system shutdown can be initiated and completed within the specified UPS span of operation.

The UPS unit shall include:

- Commercial 115 VAC, 60 Hz power interconnection and power loss sensing and alarm report via the Distributed System Software
- Power protection and filtering
- Power conversion for battery charging
- Batteries to support thirty (30) minutes of operation with loss of power
- Battery status sensing and low battery alarm reporting via the System Software
- Battery charging and charge management
- Battery power conversion and filtering as necessary for interface compatibility with installed equipment

UPS units shall be connected to commercial power. The UPS units and power interconnect shall comply with article 645 of the National Electric Code (NEC).

32.3. CONSTRUCTION METHODS

A. Rack Cabinets

Install rack cabinets at locations shown on the plans and as approved by the Engineer. Install half rack cabinets in EOC and UNC Public Safety building. Install full rack cabinets at all other locations, including the TOC. Install cabinets such that access to both the front and back of cabinet is available. Route cabling in cabinets using raceways.

In the TOC rack cabinet, integrate keyboard, mouse, and retractable monitor with KVM switch.

B. Uninterruptible Power Supply

Install uninterruptible power supply (UPS) units in each equipment rack cabinet at the TOC to supply uninterrupted power in the event of a failure of primary power to supply 30 minutes of backup power for all devices that will ultimately populate the rack bay under this project. Integrate with equipment in rack bay. Balance electrical load of all equipment across the UPS units installed in rack bay as evenly as possible. It is acceptable to integrate a piece of equipment to a UPS unit installed in an adjacent rack. Configure UPS unit servicing the LAN Switch and Router for access via LAN and dial up modem and integrate with LAN and dial-up modem. Configure and integrate all other UPS units for remote access via the LAN.

32.4. MEASUREMENT AND PAYMENT

Half rack cabinet will be measured and paid as the actual number furnished, installed, integrated, and accepted.

Full rack cabinet will be measured and paid as the actual number furnished, installed, integrated, and accepted.

UPS units and retractable keyboard and monitor shall be considered incidental and shall not be paid for separately.

Payment will be made under:

Half Rack Cabinet.....Each

Full Rack Cabinet .....Each

33. SUBMITTAL DATA

33.1. 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.

33.2. 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, Transceivers, Multiplexers, Cellular Modems
- Group E –LAN Equipment
- Group F – Computer Hardware and Peripherals
- Group G –CCTV Camera Assemblies
- Group H – Central Video System (hardware and software)
- Group I – 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.

33.3. 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.

34. DOCUMENTATION

34.1. DESCRIPTION

This section specifies the documentation to be provided by the Contractor.

34.2. 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

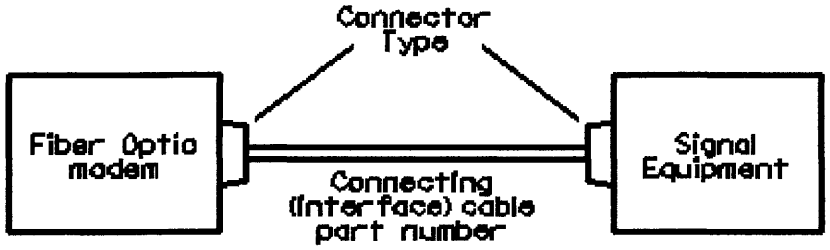
draft as-built plans in hard copy format for review. Provide draft hard copy as-builts on 22x34 inch bond plan sheets.

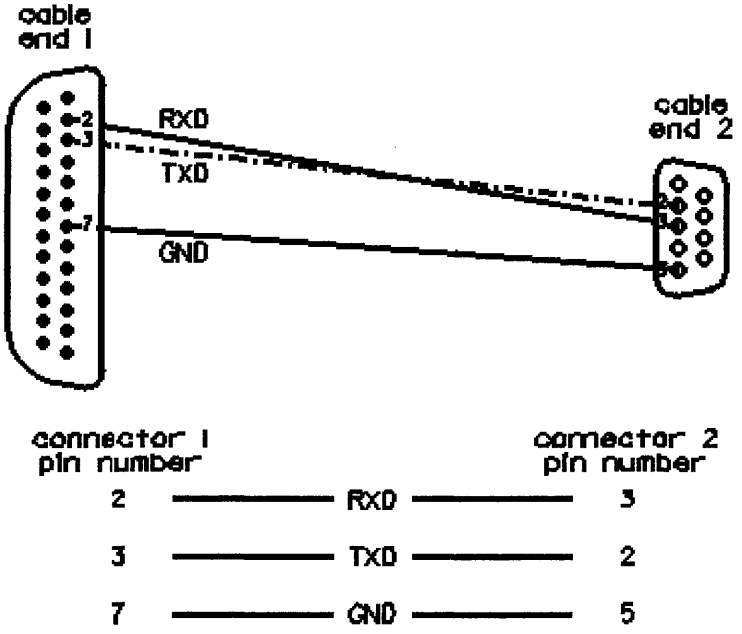
Correct any comment to the draft as-built plans upon review by the Engineer prior to the acceptance of the project. Submit final as-built plans in electronic and hard copy format. Provide electronic plans in MicroStation (latest release in use by the Department) format on CD. Submit hard copy as-builts 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. 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.





Provide one electronic copy of the wiring diagrams in MicroStation and AutoCAD formats.

D. 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.

E. Manuals and Equipment Documentation

E.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 Town.
- 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.

E.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

E.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.

E.4. Distributed Signal System Software

Provide and submit to the Engineer for written approval, full and complete documentation for all of the Distributed Signal System Software that has been furnished and installed as part of this project.

New flow charts and descriptive graphics shall be prepared and furnished as necessary, indicating connection to and relationship to existing program modification, additions and changes to the base software and their programs or routines.

Prepare and supply complete and fully debugged listings of all source coding provided with and used in the development of this system. Three (3) copies of the source code shall be provided on CD-ROM.

Supply three (3) copies of the distributed processing traffic signal system software documentation 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.

E.5. 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.

34.3. 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.

35. SYSTEM SUPPORT AND TEST EQUIPMENT

35.1. 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:

- Four (4) 2070L signal controllers as installed and accepted under this project
- Two (2) 336 cabinets as installed and accepted under this project
- Two (2) 332 cabinets as installed and accepted under this project
- Four (4) DC isolators and four (4) AC isolators as installed and accepted under this project
- Eight (8) detector cards as installed and accepted under this project
- Four (4) conflict monitors as installed and accepted under this project
- One (1) controller tester as specified below
- One (1) signal monitor tester as specified below
- Four (4) 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
- Six (6) 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 (fiber optic and cellular) 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, excluding Town IT cables and plenum-rated cables
- Five (5) fiber optic interconnect centers as installed and accepted under this project
- Two (2) aerial 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 (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 transceivers as installed and accepted under this project
- Two (2) VOT-D units as installed and accepted under this project
- Two (2) VOR-D units 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

Furnish new, unused communication system support equipment to the Town of Carrboro in the quantities shown below:

- One (1) reel with 7,000 feet of continuous 72-fiber Carrboro (CB) cable installed and accepted under this project

- One (1) reel with 4,000 feet of continuous 144-fiber Carrboro (CB) cable installed and accepted under this project

Deliver Town of Carrboro system support equipment to the following address:

Public Works Facility

100 Public Works Dr.

Carrboro, NC 27510

D. CCTV Camera System Support Equipment

Furnish new, unused CCTV camera system support equipment to the Engineer in the quantities shown below.

- One (1) CCTV camera assembly as installed and accepted under this project
- One (1) CCTV Camera Test Monitor as specified below

E. Central Video System Support Equipment

Furnish new, unused central video system support equipment to the Engineer in the quantities shown below.

- Three (3) chassis mounted video CODEC units as installed and accepted under this project

35.2. 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 Econolite's Oasis 2070 controller software as given in this specification.

Provide rubber "feet" to minimize slippage on bench top.

B.1.2. Output Display

Provide a LED for each controller output. Ensure that each of the 8 vehicle phases, pedestrian phase, and four overlap LED indicators are of appropriate color, and are identified with the appropriate C1 pin number.

Provide LEDs that are the bright, wide angle viewing type. Ensure the color of the LED can be distinguished without power applied to the output display (diffused type).

Provide a display that is phase oriented with LEDs arranged in vertical rows. Phase function shall be indicated (1, 2, 3, etc.). Each overlap shall be indicated (A, B, C, D). Other C1 outputs should be placed in an area separate from the intersection display and overlap display. C11 outputs shall be in an area separate from all other outputs.

Ensure each LED output indicator is identified with the appropriate C1 pin number. Ensure that the functions of the outputs are labeled per Econolite's Oasis 2070 controller software, version 3.00.11 (found in the chart below). No other vendor specific functionality shall be present on the display panel:

C1 Connector	Oasis Function
35	2PY
36	6PY
37	4PY
38	8PY
83	-
84	-
91	-
93	-
100	-
101	FLASH
102	DETECTOR RESET
103	WATCHDOG

B.1.3. Input Panel

Provide "on-off-momentary" toggle action switches for all inputs. Ensure switches lock into position when the user pushes the switch "up", and is momentary when the user pushes the switch "down".

Ensure each switch is labeled as per the functions of the default program for Econolite's Oasis 2070 controller software, version 3.00.11. Ensure the switch is also identified with the appropriate C1 pin number. No other vendor specific functionality shall be present on the input panel. The Oasis defaults for inputs are listed in the chart located on the following page.

C1 Connector	Oasis Function
56	Det. 1 / Ø1
39	Det. 2 / Ø2
58	Det. 3 / Ø3
41	Det. 4 / Ø4

C1 Connector	Oasis Function
55	Det. 5 / Ø5
40	Det. 6 / Ø6
57	Det. 7 / Ø7
42	Det. 8 / Ø8
60	Det. 11 / Ø1
43	Det. 12 / Ø2
62	Det. 13 / Ø3
45	Det. 14 / Ø4
59	Det. 15 / Ø5
44	Det. 16 / Ø6
61	Det. 17 / Ø7
46	Det. 18 / Ø8
63	Det. 32 / Ø2
65	Det. 34 / Ø4
64	Det. 36 / Ø6
66	Det. 38 / Ø8
76	Det. 42 / Ø2
78	Det. 44 / Ø4
77	Det. 46 / Ø6
79	Det. 48 / Ø8
47	Det. 22 / Ø2
49	Det. 24 / Ø4
48	Det. 26 / Ø6
50	Det. 28 / Ø8

C1 Connector	Oasis Function
67	2 Ped
69	4 Ped
68	6 Ped
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 TOC 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 transceiver. The test cabinet shall also contain two (2) AC Isolators, two (2) DC Isolators and a Rail Road preempt test panel. Rail Road preempt test panel should be of the same type provide for Rail Road crossing locations in the field. The test cabinet and panel shall be fully labeled.

B.3.1. Construction

The test cabinet shall have a heavy-duty aluminum dolly base with heavy duty casters. The base shall accommodate a fully equipped base-mounted cabinet/controller. A pole or pedestal shall be attached to the base to support a display panel, which shall be located beside the cabinet convenient for use by maintenance personnel. The panel shall have all indicators and switches on the front, and shall have a suitable aluminum enclosure. The panel shall be fully labeled.

B.3.1.1 Indicators

The panel shall contain indicators to display the outputs of all the cabinet's traffic signal load switches. Red, yellow, and green indicators shall be used to display the outputs of the traffic signal load switches. In addition, indicators shall be provided for four (4) pedestrian displays and four (4) special functions. The indicators shall use incandescent bulbs or LED's that are user replaceable.

B.3.1.2 Controls

The panel shall be equipped with controls which are connected to simulate all of the inputs, for test purposes, to the controller which are not already accommodated by switches in the controller cabinet.

B.3.1.3 Harnesses

The panel shall be connected to the controller cabinet by means of harnesses. The harnesses shall be concealed in the pedestal or pipe supporting the panel and shall enter the cabinet from the bottom.

B.3.2. Connection to System

The test controllers will be connected to the system on dedicated communication channels. Furnish and install a jumper cable sixteen (16) feet (minimum). This jumper cable shall be used to connect the test cabinet's fiber optic transceiver to the communication system. (The connection point will be the fiber termination panel at the TOC).

C. 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

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.

35.3. 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 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 CB 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 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 Fiber Optical Transceiver will be measured and paid as the actual number furnished and accepted.

Furnish Video Optical Transmitter with Data will be measured and paid as the actual number furnished and accepted.

Furnish Video Optical Receiver with Data 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 CCTV Test Monitor 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 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 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 (36-Fiber) .....Linear Foot

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

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

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

Furnish Fiber Optic Interconnect Center .....Each

Furnish Splice Enclosure .....Each

Furnish ST Splice Connector .....Each

Furnish SC Splice Connector .....Each

Furnish ST Jumpers .....Each

Furnish SC Jumpers .....Each

Furnish ST Pigtails .....Each

Furnish SC Pigtails .....Each

Furnish Fiber Optical Transceiver .....Each

Furnish Video Optical Transmitter with Data .....Each

Furnish Video Optical Receiver with Data .....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 CCTV Test Monitor .....Each

Furnish Video CODEC Unit.....Each

36. TESTING & ACCEPTANCE

36.1. DESCRIPTION

Test all equipment, cable and software furnished and installed under this Contract. Conduct this testing in the presence of the Engineer. **The Department reserves the right to perform any inspections deemed necessary to assure that the equipment conforms to the requirements specified herein.**

Perform factory and field testing (both pre- and post-installation) on the local and master controllers, cabinets, and related hardware.

Cable provided under this contract shall have been pre-tested in accordance with the EIA/TIA Fiber Optic test procedures and as required by Bellcore GR-20-CORE. Supply proof of successful testing, including documentation of test results.

36.2. 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 Towns of Chapel Hill or Carrboro. 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 Chapel Hill-Carrboro. Load all local phase

timings and coordinated system parameters onto the controllers prior to beginning the test period.

Test controllers and cabinets for proper operation, color sequence, flashing operations (including late night flash) and phase timings. Demonstrate that malfunction management programming cards are properly programmed before installation at intersections. Demonstrate that simultaneous inputs to conflicting phases will cause the malfunction management unit to revert the cabinet to flashing operation.

Connect and test each unit to ensure that controllers and cabinets operate without malfunction for at least eight (8) hours in the workshop before installation at an intersection. Following this test, and prior to installation, the Engineer will inspect the equipment in operation to insure conformance to the requirements of the Plans and these Project Special Provisions. These inspections by the Engineer will be made in minimum size lots of five (5) cabinets.

Demonstrate to the Engineer that all of the equipment furnished, installed or modified at each location operates in full compliance with the Plans and these Project Special Provisions.

36.3. 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.

Upon acceptance of the cable test results by the Engineer, the fiber optic communications network shall be available for use by the Town of Chapel Hill and Town of Carrboro IT Departments. The Contractor shall give 5 days advance notice to these agencies of any planned downtimes in the communications network.

36.4. INTERSECTION OPERATIONAL TESTS

The Department will conduct complete intersection inspections and operational tests for each project intersection. These inspections and tests will determine whether all the field equipment at each location is installed and permanently labeled properly, and that all functions are in conformance with the Contract Documents. The intersection operational tests will be a non-central controlled functional test of the local controller, including the time-base coordination, emergency vehicle preemption and railroad preemption functions, system detectors, and the full operation of the intersection. All work at the intersection except fiber optic cable installation and termination must be completed for the operational test. This work includes the installation of risers, conduit, junction boxes, conduit entrance into the existing foundation, fiber optic interconnect center, and fiber optic transceiver.

36.5. 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, video equipment, including multiplexers, screen splitters, and control panels.

Submit a system acceptance test procedure to the Engineer for review and approval before any tests are to be conducted.

Submit a System Operational test plan a minimum of sixty (60) days prior to the scheduled start of the test. 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, the TRTMC, 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

36.6. OBSERVATION PERIOD

Upon successful completion of the System Operational Test and the correction of all known deficiencies, including minor construction items and punch-list items developed by the Engineer, a sixty (60) day Observation Period shall commence. The purpose of this period is to determine that all components of the signal system function in accordance with the Plans and these Project Special Provisions over an extended length of time.

System or component failures that occur during the sixty (60) day Observation Period shall be responded to by the Contractor within two (2) hours, and corrected within twenty-four (24) hours. Failures that affect any of the major system components defined below for more than seventy-two (72) hours shall suspend the timing of the sixty (60) day Observation Period beginning at the time when the failure occurred. After the cause of such failures has been corrected, timing of the sixty (60) day observation period shall resume. System or component failures that necessitate a redesign of any component, and failures in any of the major system components exceeding a total of three (3) like major system components in any thirty (30) day period for the entire complement of major system components, shall terminate the sixty (60) day Observation Period and shall cause the sixty (60) day Observation Period to be restarted from zero when the redesigned component has been installed and/or the failures corrected. The major system components are:

- Local controllers and cabinets
- Fiber Optic Communication Network, including transceivers
- System hardware and software
- CCTV System
- Local Area Network

The sixty (60) day Observation Period is considered to be a part of the work included in the total contract time and must be completed prior to acceptance of the Project. All documentation required by Section 34 and elsewhere in these Project Special Provisions shall be completed prior to the end of the sixty (60) day Observation Period.

Final Acceptance will occur at the successful completion of the sixty (60) day Observation Period and after all documentation requirements have been fully satisfied.

36.7. FINAL ACCEPTANCE

After all equipment and software comprising the system has been accepted, satisfactory completion of the system acceptance test, and after the training is complete, a 60-day observation period begins. This observation period shall serve to evaluate full-scale operation of the system under normal conditions. The Town of Chapel Hill will be responsible for operating the system during this period. The goal of the observation period is to demonstrate that the system has been properly installed and integrated, performs properly, and complies with the Contract Documents.

Upon successful completion of the observation period, the Department will accept the system, providing that all errors and omissions in documentation supplied have been fixed, and all other requirements of the Contract Documents have been met. Final acceptance will be in writing from the Department.

36.8. 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.

37. TRAINING

37.1. DESCRIPTION

Provide training for the installation, operation and maintenance of the computerized traffic system.

37.2. 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 Town 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 Towns of Chapel

Hill or Carrboro 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
Computer Hardware, Traffic Control Center LAN and Peripherals – Session 1	1 Day
Computer Hardware, Traffic Control Center LAN and Peripherals – Session 2	1 Day
Traffic Control Applications Software – Session 1	1 Day
Traffic Control Applications Software – Session 2	2 Days
Traffic Control Applications Software – Session 3	3 Days
Traffic Control Applications Software – Session 4	1 Day
Traffic Control Applications Software – Session 5	2 Days
2070L Controller Programming, TBC Operation, TR Operation, Controller Hardware and Cabinet Hardware Assemblies, Utility Software (for Signal Timing Personnel and Maintenance Personnel)	3 Occurrences at 5 Days Each
Fiber Optic Communications System	2 Occurrences at 3 Days Each
Central Communications Equipment	3 Days
CCTV System – Session 1	1 Day
CCTV System – Session 2	1 Day

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. Computer Hardware, Control Center LAN and Peripherals

The training session shall consist of classroom training and workshops regarding the operation of each of the traffic control system hardware elements and the operator interface. Conduct training by experienced vendor personnel.

The first session shall involve the operation and maintenance procedures for each element of the traffic control system hardware. As part of this session, stress the precautions that must be observed when operating the equipment. As a minimum, cover the following subjects in this segment of the training session:

- Overview of equipment functions and interactions.
- Computer system operation; restart, cold start.
- Functional operation of the servers, Ethernet Control Center LAN and DAT backup system (including maintenance, paper replacement, etc.)
- Traffic Control Center and Signal Shop workstation and printer operation, maintenance, paper replacement, etc.
- Central communication operation.
- Troubleshooting and problem identification of equipment.

At a minimum, the second session shall consist of the following:

- Operating system, including network operating system
- Operating system commands, including loading and executing programs, and archiving data to the backup system
- Detection of abnormal conditions within the operating system and hardware
- File management and disk organization
- Techniques for creating and editing files, including those used for the traffic control system databases

Each of these two training sessions shall have a minimum duration of one (1) day (lectures and/or workshops).

C.3. Traffic Control Applications Software

These two (2) sessions of training for NCDOT and Town 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:

C.3.1. Session 1

The first session shall cover the fundamentals of the traffic control software supplied by the Contractor. This shall include, but not be limited to:

- Time-of-day operation and event scheduling
- Traffic responsive pattern selection algorithms

The first session of this training course shall consist primarily of lectures and shall have a minimum duration of one (1) day.

C.3.2. Session 2

The second session shall include, but not be limited to:

- Reporting capabilities
- Interactive database manipulation
- Theory and application of traffic responsive operation
- Special function features

The second session shall include a mixture of lectures and workshops and shall have a minimum of duration of two (2) days.

C.3.3. Session 3

The third session shall consist of an overview of the two previous sessions. The training shall emphasize operation of the system including recommended procedures. Allow sufficient time to answer NCDOT and Town 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.

C.3.4. Session 4

The fourth session shall cover the development and modification of screens used in the graphics display of the traffic control applications software. This fourth session shall include lecture and classroom exercises and shall have a minimum of duration of one (1) day. Course material shall include the software documentation and the system user's manuals.

C.3.5. Session 5

The fifth session shall cover the creation, placement and operation of the dynamic portions of the graphics display of the traffic control applications software. Upon completion of this session the NCDOT and Town 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 Town, NCDOT, and the Contractor.

C.4. 2070L Controller Programming

Hold three identical controller training sessions for maintenance personnel. Each of the identical training sessions shall consist of five (5) consecutive days, beginning on a Monday. **Conduct one of these training sessions prior to the installation of any new controllers and cabinets on the project.**

These three sessions include training for NCDOT and Town traffic engineering, signal timing, and maintenance personnel on controller and internal TBC operation and cabinet assemblies.

C.4.1. Controller and TBC Operation

The controller training session for signal timing engineers and technicians shall consist of formal classroom presentation of the functional operation of the 2070L controller furnished by the Contractor, followed by a "hands-on" workshop focusing on actual entry of timing data. The formal presentation and workshop shall have a combined duration of two (2) days. This session shall be taught by experienced vendor personnel who thoroughly understand both the traffic engineering aspects of signal timing and the entry of timing into the controller and internal TBC's. This session shall cover the entry and editing of:

- All local intersection timing parameters
- All coordination timing parameters
- All parameters and threshold levels associated with traffic responsive operation.

Conduct this session after the system software and test controller are operational and include opportunities for "hands-on" entry and editing of the timing and use of local controller utility software.

C.4.2. Controller and Cabinet Assemblies

A field service specialist(s) employed by the traffic signal controller manufacturer shall conduct the classes. Each maintenance training class shall consist of a formal classroom presentation which covers routine maintenance and troubleshooting procedures for each type of controller and cabinet assembly furnished by the Contractor, followed by a "hands-on" workshop wherein maintenance personnel will troubleshoot simulated controller and cabinet assembly faults to the component level.

The controller maintenance training shall include a session on signal monitors and a session on detector amplifiers. The signal monitor training shall include the following:

- Theory of operation,
- Routine maintenance
- Troubleshooting procedures
- Periodic testing to verify that conflict conditions are reliably detected.

The detector training shall include the following:

- Functional operation
- Routine maintenance
- Troubleshooting procedures for the detector hardware furnished under this contract by the Contractor, including the detector sensor units, lead-in cables, and the loop wire.

The training shall include "hands-on" experience in troubleshooting simulated detector problems including malfunctioning sensor units, lead-in cable problems, and roadway loop problems. The training shall include a full description of the detector test procedures.

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. Central Communications Equipment

Provide a training session, conducted by experienced vendor personnel and consisting of both operation and maintenance training of the Central Communication Equipment for the signal system. As a minimum, this session shall include the following subjects:

- Operational theory
- Operational procedures
- Troubleshooting procedures
- Communications validation
- Local Area Network Hardware/Software

Provide a workshop session to reinforce the lectures and demonstrate troubleshooting and problem identification of equipment to the component level as well as validation of communications.

This lecture/workshop training session shall have a minimum duration of three (3) days.

C.7. CCTV Central and Field Equipment

Provide two sessions for the CCTV central and field equipment training. The first session shall address the maintenance of the CCTV equipment. The training shall address the preventative maintenance and troubleshooting procedures for all the field and central equipment including the video transceivers.

This session shall consist of a mixture of lecture and hands-on workshops and shall have a minimum duration of one (1) day.

The second session shall address the operational theory and procedures of the CCTV system. This training shall be oriented towards users of the system (including Police). The training shall address the use of, but not limited to, the following devices:

- Video Server

- Camera control software
- Camera control panel
- Video switch

Include "hands-on" training workshop with a minimum duration of one (1) day as part of this session. The CCTV training sessions shall be presented by field service specialist(s) employed by the suppliers of the CCTV system components.

37.3. MEASUREMENT AND PAYMENT

Training will be paid for as contract lump sum price.

Payment will be made under:

Training.....Lump Sum