

STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION  
RALEIGH, N.C.

PROPOSAL

DATE AND TIME OF BID OPENING: **OCTOBER 20, 2015 AT 2:00 PM**

CONTRACT ID C203627  
WBS 55063.3.F1

FEDERAL-AID NO. CMS-0710(29)  
COUNTY GUILFORD  
T.I.P. NO. C-5558  
MILES 80.000  
ROUTE NO.  
LOCATION CITY OF HIGH POINT.

TYPE OF WORK COMPUTERIZED SIGNAL SYSTEM.

**NOTICE:**

ALL BIDDERS SHALL COMPLY WITH ALL APPLICABLE LAWS REGULATING THE PRACTICE OF GENERAL CONTRACTING AS CONTAINED IN CHAPTER 87 OF THE GENERAL STATUTES OF NORTH CAROLINA WHICH REQUIRES THE BIDDER TO BE LICENSED BY THE N.C. LICENSING BOARD FOR CONTRACTORS WHEN BIDDING ON ANY NON-FEDERAL AID PROJECT WHERE THE BID IS \$30,000 OR MORE, EXCEPT FOR CERTAIN SPECIALTY WORK AS DETERMINED BY THE LICENSING BOARD. BIDDERS SHALL ALSO COMPLY WITH ALL OTHER APPLICABLE LAWS REGULATING THE PRACTICES OF ELECTRICAL, PLUMBING, HEATING AND AIR CONDITIONING AND REFRIGERATION CONTRACTING AS CONTAINED IN CHAPTER 87 OF THE GENERAL STATUTES OF NORTH CAROLINA. NOTWITHSTANDING THESE LIMITATIONS ON BIDDING, THE BIDDER WHO IS AWARDED ANY FEDERAL - AID FUNDED PROJECT SHALL COMPLY WITH CHAPTER 87 OF THE GENERAL STATUTES OF NORTH CAROLINA FOR LICENSING REQUIREMENTS WITHIN 60 CALENDAR DAYS OF BID OPENING.

**BIDS WILL BE RECEIVED AS SHOWN BELOW:**

**THIS IS A SIGNAL PROPOSAL**

**5% BID BOND OR BID DEPOSIT REQUIRED**

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**PROPOSAL FOR THE CONSTRUCTION OF  
CONTRACT No. C203627 IN GUILFORD COUNTY, NORTH CAROLINA**

Date \_\_\_\_\_ 20\_\_\_\_

**DEPARTMENT OF TRANSPORTATION,  
RALEIGH, NORTH CAROLINA**

The Bidder has carefully examined the location of the proposed work to be known as Contract No. C203627; has carefully examined the plans and specifications, which are acknowledged to be part of the proposal, the special provisions, the proposal, the form of contract, and the forms of contract payment bond and contract performance bond; and thoroughly understands the stipulations, requirements and provisions. The undersigned bidder agrees to be bound upon his execution of the bid and subsequent award to him by the Board of Transportation in accordance with this proposal to provide the necessary contract payment bond and contract performance bond within fourteen days after the written notice of award is received by him. The undersigned Bidder further agrees to provide all necessary machinery, tools, labor, and other means of construction; and to do all the work and to furnish all materials, except as otherwise noted, necessary to perform and complete the said contract in accordance with *the 2012 Standard Specifications for Roads and Structures* by the dates(s) specified in the Project Special Provisions and in accordance with the requirements of the Engineer, and at the unit or lump sum prices, as the case may be, for the various items given on the sheets contained herein.

The Bidder shall provide and furnish all the materials, machinery, implements, appliances and tools, and perform the work and required labor to construct and complete State Highway Contract No. C203627 in Guilford County, for the unit or lump sum prices, as the case may be, bid by the Bidder in his bid and according to the proposal, plans, and specifications prepared by said Department, which proposal, plans, and specifications show the details covering this project, and hereby become a part of this contract.

The published volume entitled *North Carolina Department of Transportation, Raleigh, Standard Specifications for Roads and Structures, January 2012* with all amendments and supplements thereto, is by reference incorporated into and made a part of this contract; that, except as herein modified, all the construction and work included in this contract is to be done in accordance with the specifications contained in said volume, and amendments and supplements thereto, under the direction of the Engineer.

If the proposal is accepted and the award is made, the contract is valid only when signed either by the Contract Officer or such other person as may be designated by the Secretary to sign for the Department of Transportation. The conditions and provisions herein cannot be changed except over the signature of the said Contract Officer.

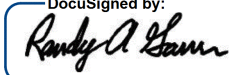
The quantities shown in the itemized proposal for the project are considered to be approximate only and are given as the basis for comparison of bids. The Department of Transportation may increase or decrease the quantity of any item or portion of the work as may be deemed necessary or expedient.

An increase or decrease in the quantity of an item will not be regarded as sufficient ground for an increase or decrease in the unit prices, nor in the time allowed for the completion of the work, except as provided for the contract.

Accompanying this bid is a bid bond secured by a corporate surety, or certified check payable to the order of the Department of Transportation, for five percent of the total bid price, which deposit is to be forfeited as liquidated damages in case this bid is accepted and the Bidder shall fail to provide the required payment and performance bonds with the Department of Transportation, under the condition of this proposal, within 14 calendar days after the written notice of award is received by him, as provided in the *Standard Specifications*; otherwise said deposit will be returned to the Bidder.



State Contract Officer

DocuSigned by:  
  
A7079FC32A09478... 9/9/2015

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**PROJECT SPECIAL PROVISIONS****GENERAL****CONTRACT TIME AND LIQUIDATED DAMAGES:**

(7-1-95) (Rev. 12-18-07)

108

SP1 G10 B

The date of availability for this contract is **November 30, 2015**.

The completion date for this contract is **February 15, 2019**.

The liquidated damages for this contract are **One Thousand Five Hundred Dollars (\$ 1,500.00)** per calendar day.

**INTERMEDIATE CONTRACT TIME NUMBER 1 AND LIQUIDATED DAMAGES:**

(2-20-07)

108

SP1 G14 A

The Contractor shall complete the required work of installing, maintaining, and removing the traffic control devices for lane closures and restoring traffic to the existing traffic pattern. The Contractor shall not close or narrow a lane of traffic on **US 311/I-74, I-85 Business/US 29/US70, I-85, ramps and loops** during the following time restrictions:

**DAY AND TIME RESTRICTIONS**

<b>Monday through Friday</b>	<b>6:00 AM to 8:00 PM</b>
<b>Saturday</b>	<b>8:00 AM to 8:00 PM</b>
<b>Sunday</b>	<b>10:00 AM to 8:00 PM</b>

In addition, the Contractor shall not close or narrow a lane of traffic on **US 311/I-74, I-85 Business/US 29/US70, I-85, ramps and loops**, detain and/or alter the traffic flow on or during holidays, holiday weekends, special events, or any other time when traffic is unusually heavy, including the following schedules:

**HOLIDAY AND HOLIDAY WEEKEND LANE CLOSURE RESTRICTIONS**

1. For **unexpected occurrence** that creates unusually high traffic volumes, as directed by the Engineer.
2. For **New Year's Day**, between the hours of **6:00 AM** December 31st and **8:00 PM** January 2nd. If New Year's Day is on a Friday, Saturday, Sunday or Monday, then until **8:00 PM** the following Tuesday.
3. For **Easter**, between the hours of **6:00 AM** Thursday and **8:00 PM** Monday.
4. For **Memorial Day**, between the hours of **6:00 AM** Friday and **8:00 PM** Tuesday.

5. For **Independence Day**, between the hours of **6:00 AM** the day before Independence Day and **8:00 PM** the day after Independence Day.

If **Independence Day** is on a Friday, Saturday, Sunday or Monday, then between the hours of **6:00 AM** the Thursday before Independence Day and **8:00 PM** the Tuesday after Independence Day.

6. For **Labor Day**, between the hours of **6:00 AM** Friday and **8:00 PM** Tuesday.
7. For **Thanksgiving Day**, between the hours of **6:00 AM** Tuesday and **8:00 PM** Monday.
8. For **Christmas**, between the hours of **6:00 AM** the Friday before the week of Christmas Day and **8:00 PM** the following Tuesday after the week of Christmas Day.
9. For **the ACC and NCAA Basketball Tournaments** occurring at **the Greensboro Coliseum Complex**, between the hours of **6:00 AM** the day before the start of the tournament and **8:00 PM** the day after the end of the tournament.

Holidays and holiday weekends shall include New Year's, Easter, Memorial Day, Independence Day, Labor Day, Thanksgiving, and Christmas. The Contractor shall schedule his work so that lane closures will not be required during these periods, unless otherwise directed by the Engineer.

The time of availability for this intermediate contract work shall be the time the Contractor begins to install all traffic control devices for lane closures according to the time restrictions listed herein.

The completion time for this intermediate contract work shall be the time the Contractor is required to complete the removal of all traffic control devices for lane closures according to the time restrictions stated above and place traffic in the existing traffic pattern.

The liquidated damages are **Five Hundred Dollars (\$ 500.00)** per **15** minute time period.

**INTERMEDIATE CONTRACT TIME NUMBER 2 AND LIQUIDATED DAMAGES:**

(2-20-07)

108

SPI G14 A

The Contractor shall complete the required work of installing, maintaining, and removing the traffic control devices for lane closures and restoring traffic to the existing traffic pattern. The Contractor shall not close or narrow a lane of traffic on **any road other than US 311/I-74, I-85 Business/US 29/US70, I-85**, during the following time restrictions:

DAY AND TIME RESTRICTIONS

**Monday through Friday      6:00 AM to 9:00 AM**  
**and**  
**4:00 PM to 7:00 PM**

In addition, the Contractor shall not close or narrow a lane of traffic on **any road other than US 311/I-74, I-85 Business/US 29/US70, I-85**, detain and/or alter the traffic flow on or during holidays, holiday weekends, special events, or any other time when traffic is unusually heavy, including the following schedules:

HOLIDAY AND HOLIDAY WEEKEND LANE CLOSURE RESTRICTIONS

1. For **unexpected occurrence** that creates unusually high traffic volumes, as directed by the Engineer.
2. For **New Year's Day**, between the hours of **6:00 AM** December 31st and **8:00 PM** January 2nd. If New Year's Day is on a Friday, Saturday, Sunday or Monday, then until **8:00 PM** the following Tuesday.
3. For **Easter**, between the hours of **6:00 AM** Thursday and **8:00 PM** Monday.
4. For **Memorial Day**, between the hours of **6:00 AM** Friday and **8:00 PM** Tuesday.
5. For **Independence Day**, between the hours of **6:00 AM** the day before Independence Day and **8:00 PM** the day after Independence Day.  
  
If **Independence Day** is on a Friday, Saturday, Sunday or Monday, then between the hours of **6:00 AM** the Thursday before Independence Day and **8:00 PM** the Tuesday after Independence Day.
6. For **Labor Day**, between the hours of **6:00 AM** Friday and **8:00 PM** Tuesday.
7. For **Thanksgiving Day**, between the hours of **6:00 AM** Tuesday and **8:00 PM** Monday.
8. For **Christmas**, between the hours of **6:00 AM** the Friday before the week of Christmas Day and **8:00 PM** the following Tuesday after the week of Christmas Day.
9. For **High Point University Baseball games**, occurring at **Willard Stadium**, **four (4) hours before the start of the game and four (4) hours after the end of the game**. (This note only applies to E. Lexington Avenue, N. College Drive, N. Centennial Street and Montlieu Avenue.)
10. For **High Point University Soccer and Lacrosse games**, occurring at **Vert Stadium**, **four (4) hours before the start of the game and four (4) hours after the end of the game**. (This note only applies to E. Lexington Avenue, N. College Drive, N. Centennial Street and Montlieu Avenue.)
11. For **High Point University Basketball games**, occurring at **Mills Center**, **two (2) hours before the start of the game and two (2) hours after the end of the game**. (This note only applies to E. Lexington Avenue, N. College Drive, N. Centennial Street and Montlieu Avenue.)

12. For the **Holiday Shopping Period at Oak Hollow Mall**, between the hours of **9:00 AM** and **9:00 PM** on Saturdays and Sundays after the weekend of Thanksgiving and before the weekend of Christmas. (This note only applies to E. Hartley Drive and Eastchester Drive.)

Holidays and holiday weekends shall include New Year's, Easter, Memorial Day, Independence Day, Labor Day, Thanksgiving, and Christmas. The Contractor shall schedule his work so that lane closures will not be required during these periods, unless otherwise directed by the Engineer.

The time of availability for this intermediate contract work shall be the time the Contractor begins to install all traffic control devices for lane closures according to the time restrictions listed herein.

The completion time for this intermediate contract work shall be the time the Contractor is required to complete the removal of all traffic control devices for lane closures according to the time restrictions stated above and place traffic in the existing traffic pattern.

The liquidated damages are **Two Hundred and Fifty Dollars (\$ 250.00)** per **15** minute time period.

**INTERMEDIATE CONTRACT TIME NUMBER 3 AND LIQUIDATED DAMAGES:**

(2-20-07) (Rev. 10-15-13)

108

SP1 G14 E

The Contractor shall complete the required work of installing, maintaining and removing the traffic control devices for road closures and restoring traffic to the existing traffic pattern. The Contractor shall not close **any road** during the following time restrictions:

**DAY AND TIME RESTRICTIONS**

**Monday through Sunday  
6:00 AM to 9:00 PM**

The maximum allowable time **for installation of cables across any road** is **20** minutes. The Contractor shall reopen the travel lanes to traffic until any resulting traffic queue is depleted.

The time of availability for this intermediate contract time will be the time the Contractor begins to install traffic control devices required for the road closures according to the time restrictions stated herein.

The completion time for this intermediate contract time will be the time the Contractor is required to complete the removal of traffic control devices required for the road closures according to the time restrictions stated herein and restore traffic to the existing traffic pattern.

The liquidated damages are **One Thousand Dollars (\$ 1,000.00)** per **20** minute time period.



**CONSTRUCTION MORATORIUM:**

(7-15-14)

SP1 G18A

The Contractor shall not perform any work along roadways or within the core area of downtown High Point, as established by the ITS Provision, from 6:00 AM the Monday before the start of the High Point Market through 8:00 PM the Friday after the end of the High Point Market. This moratorium shall be in effect during the Spring and Fall High Point Markets of any year.

**MAJOR CONTRACT ITEMS:**

(2-19-02)

104

SP1 G28

The following listed items are the major contract items for this contract (see Article 104-5 of the 2012 Standard Specifications):

<b>Line #</b>	<b>Description</b>
47	Controller With Cabinet (2070E, 332, Base Mounted)

**SPECIALTY ITEMS:**

(7-1-95)(Rev. 1-17-12)

108-6

SP1 G37

Items listed below will be the specialty items for this contract (see Article 108-6 of the 2012 Standard Specifications).

<b>Line #</b>	<b>Description</b>
14	Long-Life Pavement Markings

**SCHEDULE OF ESTIMATED COMPLETION PROGRESS:**

(7-15-08) (Rev. 5-19-15)

108-2

SP1 G58

The Contractor's attention is directed to the Standard Special Provision entitled *Availability of Funds Termination of Contracts* included elsewhere in this proposal. The Department of Transportation's schedule of estimated completion progress for this project as required by that Standard Special Provision is as follows:

2016	(7/01/15 - 6/30/16)	<b>26</b> % of Total Amount Bid
2017	(7/01/16 - 6/30/17)	<b>37</b> % of Total Amount Bid
2018	(7/01/17 - 6/30/18)	<b>26</b> % of Total Amount Bid
2019	(7/01/18 - 6/30/19)	<b>11</b> % of Total Amount Bid

The Contractor shall also furnish his own progress schedule in accordance with Article 108-2 of the 2012 Standard Specifications. Any acceleration of the progress as shown by the Contractor's progress schedule over the progress as shown above shall be subject to the approval of the Engineer.

**DISADVANTAGED BUSINESS ENTERPRISE:**

(10-16-07)(Rev. 12-17-13)

102-15(J)

SP1 G61

**Description**

The purpose of this Special Provision is to carry out the U.S. Department of Transportation's policy of ensuring nondiscrimination in the award and administration of contracts financed in whole or in part with Federal funds. This provision is guided by 49 CFR Part 26.

**Definitions**

*Additional DBE Subcontractors* - Any DBE submitted at the time of bid that will not be used to meet the DBE goal. No submittal of a Letter of Intent is required.

*Committed DBE Subcontractor* - Any DBE submitted at the time of bid that is being used to meet the DBE goal by submission of a Letter of Intent. Or any DBE used as a replacement for a previously committed DBE firm.

*Contract Goal Requirement* - The approved DBE participation at time of award, but not greater than the advertised contract goal.

*DBE Goal* - A portion of the total contract, expressed as a percentage, that is to be performed by committed DBE subcontractor(s).

*Disadvantaged Business Enterprise (DBE)* - A firm certified as a Disadvantaged Business Enterprise through the North Carolina Unified Certification Program.

*Goal Confirmation Letter* - Written documentation from the Department to the bidder confirming the Contractor's approved, committed DBE participation along with a listing of the committed DBE firms.

*Manufacturer* - A firm that operates or maintains a factory or establishment that produces on the premises, the materials or supplies obtained by the Contractor.

*Regular Dealer* - A firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials or supplies required for the performance of the contract are bought, kept in stock, and regularly sold to the public in the usual course of business. A regular dealer engages in, as its principal business and in its own name, the purchase and sale or lease of the products in question. A regular dealer in such bulk items as steel, cement, gravel, stone, and petroleum products need not keep such products in stock, if it owns and operates distribution equipment for the products. Brokers and packagers are not regarded as manufacturers or regular dealers within the meaning of this section.

*North Carolina Unified Certification Program (NCUCP)* - A program that provides comprehensive services and information to applicants for DBE certification, such that an applicant is required to apply only once for a DBE certification that will be honored by all

recipients of USDOT funds in the state and not limited to the Department of Transportation only. The Certification Program is in accordance with 49 CFR Part 26.

*United States Department of Transportation (USDOT)* - Federal agency responsible for issuing regulations (49 CFR Part 26) and official guidance for the DBE program.

### **Forms and Websites Referenced in this Provision**

*DBE Payment Tracking System* - On-line system in which the Contractor enters the payments made to DBE subcontractors who have performed work on the project.  
<https://apps.dot.state.nc.us/Vendor/PaymentTracking/>

*DBE-IS Subcontractor Payment Information* - Form for reporting the payments made to all DBE firms working on the project. This form is for paper bid projects only.  
<http://www.ncdot.org/doh/forms/files/DBE-IS.xls>

*RF-1 DBE Replacement Request Form* - Form for replacing a committed DBE.  
<http://connect.ncdot.gov/projects/construction/Construction%20Forms/DBE%20MBE%20WBE%20Replacement%20Request%20Form.pdf>

*SAF Subcontract Approval Form* - Form required for approval to sublet the contract.  
<http://connect.ncdot.gov/projects/construction/Construction%20Forms/Subcontract%20Approval%20Form%20Rev.%202012.zip>

*JC-1 Joint Check Notification Form* - Form and procedures for joint check notification. The form acts as a written joint check agreement among the parties providing full and prompt disclosure of the expected use of joint checks.  
<http://connect.ncdot.gov/projects/construction/Construction%20Forms/Joint%20Check%20Notification%20Form.pdf>

*Letter of Intent* - Form signed by the Contractor and the DBE subcontractor, manufacturer or regular dealer that affirms that a portion of said contract is going to be performed by the signed DBE for the amount listed at the time of bid.  
<http://connect.ncdot.gov/letting/LetCentral/Letter%20of%20Intent%20to%20Perform%20as%20a%20Subcontractor.pdf>

*Listing of DBE Subcontractors Form* - Form for entering DBE subcontractors on a project that will meet this DBE goal. This form is for paper bids only.  
[http://connect.ncdot.gov/municipalities/Bid%20Proposals%20for%20LGA%20Content/08%20DBE%20Subcontractors%20\(Federal\).docx](http://connect.ncdot.gov/municipalities/Bid%20Proposals%20for%20LGA%20Content/08%20DBE%20Subcontractors%20(Federal).docx)

*Subcontractor Quote Comparison Sheet* - Spreadsheet for showing all subcontractor quotes in the work areas where DBEs quoted on the project. This sheet is submitted with good faith effort packages.  
<http://connect.ncdot.gov/business/SmallBusiness/Documents/DBE%20Subcontractor%20Quote%20Comparison%20Example.xls>

**DBE Goal**

The following DBE goal for participation by Disadvantaged Business Enterprises is established for this contract:

Disadvantaged Business Enterprises **4.0 %**

- (A) *If the DBE goal is more than zero*, the Contractor shall exercise all necessary and reasonable steps to ensure that DBEs participate in at least the percent of the contract as set forth above as the DBE goal.
- (B) *If the DBE goal is zero*, the Contractor shall make an effort to recruit and use DBEs during the performance of the contract. Any DBE participation obtained shall be reported to the Department.

**Directory of Transportation Firms (Directory)**

Real-time information is available about firms doing business with the Department and firms that are certified through NCUCP in the Directory of Transportation Firms. Only firms identified in the Directory as DBE certified shall be used to meet the DBE goal. The Directory can be found at the following link. <https://partner.ncdot.gov/VendorDirectory/default.html>

The listing of an individual firm in the directory shall not be construed as an endorsement of the firm's capability to perform certain work.

**Listing of DBE Subcontractors**

At the time of bid, bidders shall submit all DBE participation that they anticipate to use during the life of the contract. Only those identified to meet the DBE goal will be considered committed, even though the listing shall include both committed DBE subcontractors and additional DBE subcontractors. Additional DBE subcontractor participation submitted at the time of bid will be used toward the Department's overall race-neutral goal. Only those firms with current DBE certification at the time of bid opening will be acceptable for listing in the bidder's submittal of DBE participation. The Contractor shall indicate the following required information:

- (A) Electronic Bids

Bidders shall submit a listing of DBE participation in the appropriate section of Expedite, the bidding software of Bid Express<sup>®</sup>.

- (1) Submit the names and addresses of DBE firms identified to participate in the contract. If the bidder uses the updated listing of DBE firms shown in Expedite, the bidder may use the dropdown menu to access the name and address of the DBE firm.

- (2) Submit the contract line numbers of work to be performed by each DBE firm. When no figures or firms are entered, the bidder will be considered to have no DBE participation.
  - (3) The bidder shall be responsible for ensuring that the DBE is certified at the time of bid by checking the Directory of Transportation Firms. If the firm is not certified at the time of the bid-letting, that DBE's participation will not count towards achieving the DBE goal.
- (B) Paper Bids
- (1) *If the DBE goal is more than zero,*
    - (a) Bidders, at the time the bid proposal is submitted, shall submit a listing of DBE participation, including the names and addresses on *Listing of DBE Subcontractors* contained elsewhere in the contract documents in order for the bid to be considered responsive. Bidders shall indicate the total dollar value of the DBE participation for the contract.
    - (b) If bidders have no DBE participation, they shall indicate this on the *Listing of DBE Subcontractors* by entering the word "None" or the number "0." This form shall be completed in its entirety. **Blank forms will not be deemed to represent zero participation.** Bids submitted that do not have DBE participation indicated on the appropriate form will not be read publicly during the opening of bids. The Department will not consider these bids for award and the proposal will be rejected.
    - (c) The bidder shall be responsible for ensuring that the DBE is certified at the time of bid by checking the Directory of Transportation Firms. If the firm is not certified at the time of the bid-letting, that DBE's participation will not count towards achieving the corresponding goal.
  - (2) *If the DBE goal is zero,* entries on the *Listing of DBE Subcontractors* are not required for the zero goal, however any DBE participation that is achieved during the project shall be reported in accordance with requirements contained elsewhere in the special provision.

### **DBE Prime Contractor**

When a certified DBE firm bids on a contract that contains a DBE goal, the DBE firm is responsible for meeting the goal or making good faith efforts to meet the goal, just like any other bidder. In most cases, a DBE bidder on a contract will meet the DBE goal by virtue of the work it performs on the contract with its own forces. However, all the work that is performed by the DBE bidder and any other DBE subcontractors will count toward the DBE goal. The DBE

bidder shall list itself along with any DBE subcontractors, if any, in order to receive credit toward the DBE goal.

For example, if the DBE goal is 45% and the DBE bidder will only perform 40% of the contract work, the prime will list itself at 40%, and the additional 5% shall be obtained through additional DBE participation with DBE subcontractors or documented through a good faith effort.

DBE prime contractors shall also follow Sections A and B listed under *Listing of DBE Subcontractor* just as a non-DBE bidder would.

### **Written Documentation – Letter of Intent**

The bidder shall submit written documentation for each DBE that will be used to meet the DBE goal of the contract, indicating the bidder's commitment to use the DBE in the contract. This documentation shall be submitted on the Department's form titled *Letter of Intent*.

The documentation shall be received in the office of the State Contractor Utilization Engineer or at DBE@ncdot.gov no later than 12:00 noon of the sixth calendar day following opening of bids, unless the sixth day falls on an official state holiday. In that situation, it is due in the office of the State Contractor Utilization Engineer no later than 12:00 noon on the next official state business day.

If the bidder fails to submit the Letter of Intent from each committed DBE to be used toward the DBE goal, or if the form is incomplete (i.e. both signatures are not present), the DBE participation will not count toward meeting the DBE goal. If the lack of this participation drops the commitment below the DBE goal, the Contractor shall submit evidence of good faith efforts, completed in its entirety, to the State Contractor Utilization Engineer or DBE@ncdot.gov no later than 12:00 noon on the eighth calendar day following opening of bids, unless the eighth day falls on an official state holiday. In that situation, it is due in the office of the State Contractor Utilization Engineer no later than 12:00 noon on the next official state business day.

### **Submission of Good Faith Effort**

If the bidder fails to meet or exceed the DBE goal, the apparent lowest responsive bidder shall submit to the Department documentation of adequate good faith efforts made to reach the DBE goal.

A hard copy and an electronic copy of this information shall be received in the office of the State Contractor Utilization Engineer or at DBE@ncdot.gov no later than 12:00 noon of the sixth calendar day following opening of bids unless the sixth day falls on an official state holiday. In that situation, it is due in the office of the State Contractor Utilization Engineer the next official state business day. If the contractor cannot send the information electronically, then one complete set and 9 copies of this information shall be received under the same time constraints above.

Note: Where the information submitted includes repetitious solicitation letters, it will be acceptable to submit a representative letter along with a distribution list of the firms that were solicited. Documentation of DBE quotations shall be a part of the good faith effort submittal. This documentation may include written subcontractor quotations, telephone log notations of verbal quotations, or other types of quotation documentation.

### **Consideration of Good Faith Effort for Projects with DBE Goals More Than Zero**

Adequate good faith efforts mean that the bidder took all necessary and reasonable steps to achieve the goal which, by their scope, intensity, and appropriateness, could reasonably be expected to obtain sufficient DBE participation. Adequate good faith efforts also mean that the bidder actively and aggressively sought DBE participation. Mere *pro forma* efforts are not considered good faith efforts.

The Department will consider the quality, quantity, and intensity of the different kinds of efforts a bidder has made. Listed below are examples of the types of actions a bidder will take in making a good faith effort to meet the goal and are not intended to be exclusive or exhaustive, nor is it intended to be a mandatory checklist.

- (A) Soliciting through all reasonable and available means (e.g. attendance at pre-bid meetings, advertising, written notices, use of verifiable electronic means through the use of the NCDOT Directory of Transportation Firms) the interest of all certified DBEs who have the capability to perform the work of the contract. The bidder must solicit this interest within at least 10 days prior to bid opening to allow the DBEs to respond to the solicitation. Solicitation shall provide the opportunity to DBEs within the Division and surrounding Divisions where the project is located. The bidder must determine with certainty if the DBEs are interested by taking appropriate steps to follow up initial solicitations.
- (B) Selecting portions of the work to be performed by DBEs in order to increase the likelihood that the DBE goals will be achieved.
  - (1) Where appropriate, break out contract work items into economically feasible units to facilitate DBE participation, even when the prime contractor might otherwise prefer to perform these work items with its own forces.
  - (2) Negotiate with subcontractors to assume part of the responsibility to meet the contract DBE goal when the work to be sublet includes potential for DBE participation (2<sup>nd</sup> and 3<sup>rd</sup> tier subcontractors).
- (C) Providing interested DBEs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.
- (D) (1) Negotiating in good faith with interested DBEs. It is the bidder's responsibility to

make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBEs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBEs to perform the work.

- (2) A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBEs is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also, the ability or desire of a prime contractor to perform the work of a contract with its own organization does not relieve the bidder of the responsibility to make good faith efforts. Bidding contractors are not, however, required to accept higher quotes from DBEs if the price difference is excessive or unreasonable.
- (E) Not rejecting DBEs as being unqualified without sound reasons based on a thorough investigation of their capabilities. The bidder's standing within its industry, membership in specific groups, organizations, or associates and political or social affiliations (for example, union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of bids in the bidder's efforts to meet the project goal.
- (F) Making efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance as required by the recipient or bidder.
- (G) Making efforts to assist interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services.
- (H) Effectively using the services of available minority/women community organizations; minority/women contractors' groups; Federal, State, and local minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBEs. Contact within 7 days from the bid opening the Business Development Manager in the Business Opportunity and Work Force Development Unit to give notification of the bidder's inability to get DBE quotes.
- (I) Any other evidence that the bidder submits which shows that the bidder has made reasonable good faith efforts to meet the DBE goal.

In addition, the Department may take into account the following:

- (1) Whether the bidder's documentation reflects a clear and realistic plan for achieving the DBE goal.



- (2) The bidders' past performance in meeting the DBE goals.
- (3) The performance of other bidders in meeting the DBE goal. For example, when the apparent successful bidder fails to meet the DBE goal, but others meet it, you may reasonably raise the question of whether, with additional reasonable efforts the apparent successful bidder could have met the goal. If the apparent successful bidder fails to meet the DBE goal, but meets or exceeds the average DBE participation obtained by other bidders, the Department may view this, in conjunction with other factors, as evidence of the apparent successful bidder having made a good faith effort.

If the Department does not award the contract to the apparent lowest responsive bidder, the Department reserves the right to award the contract to the next lowest responsive bidder that can satisfy to the Department that the DBE goal can be met or that an adequate good faith effort has been made to meet the DBE goal.

### **Non-Good Faith Appeal**

The State Contractor Utilization Engineer will notify the contractor verbally and in writing of non-good faith. A contractor may appeal a determination of non-good faith made by the Goal Compliance Committee. If a contractor wishes to appeal the determination made by the Committee, they shall provide written notification to the State Contractual Services Engineer or at DBE@ncdot.gov. The appeal shall be made within 2 business days of notification of the determination of non-good faith.

### **Counting DBE Participation Toward Meeting DBE Goal**

#### **(A) Participation**

The total dollar value of the participation by a committed DBE will be counted toward the contract goal requirement. The total dollar value of participation by a committed DBE will be based upon the value of work actually performed by the DBE and the actual payments to DBE firms by the Contractor.

#### **(B) Joint Checks**

Prior notification of joint check use shall be required when counting DBE participation for services or purchases that involves the use of a joint check. Notification shall be through submission of Form JC-1 (*Joint Check Notification Form*) and the use of joint checks shall be in accordance with the Department's Joint Check Procedures.

#### **(C) Subcontracts (Non-Trucking)**

A DBE may enter into subcontracts. Work that a DBE subcontracts to another DBE firm may be counted toward the contract goal requirement. Work that a DBE subcontracts to

a non-DBE firm does not count toward the contract goal requirement. If a DBE contractor or subcontractor subcontracts a significantly greater portion of the work of the contract than would be expected on the basis of standard industry practices, it shall be presumed that the DBE is not performing a commercially useful function. The DBE may present evidence to rebut this presumption to the Department. The Department's decision on the rebuttal of this presumption is subject to review by the Federal Highway Administration but is not administratively appealable to USDOT.

(D) Joint Venture

When a DBE performs as a participant in a joint venture, the Contractor may count toward its contract goal requirement a portion of the total value of participation with the DBE in the joint venture, that portion of the total dollar value being a distinct clearly defined portion of work that the DBE performs with its forces.

(E) Suppliers

A contractor may count toward its DBE requirement 60 percent of its expenditures for materials and supplies required to complete the contract and obtained from a DBE regular dealer and 100 percent of such expenditures from a DBE manufacturer.

(F) Manufacturers and Regular Dealers

A contractor may count toward its DBE requirement the following expenditures to DBE firms that are not manufacturers or regular dealers:

- (1) The fees or commissions charged by a DBE firm for providing a *bona fide* service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a DOT-assisted contract, provided the fees or commissions are determined to be reasonable and not excessive as compared with fees and commissions customarily allowed for similar services.
- (2) With respect to materials or supplies purchased from a DBE, which is neither a manufacturer nor a regular dealer, count the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials or supplies required on a job site (but not the cost of the materials and supplies themselves), provided the fees are determined to be reasonable and not excessive as compared with fees customarily allowed for similar services.

**Commercially Useful Function****(A) DBE Utilization**

The Contractor may count toward its contract goal requirement only expenditures to DBEs that perform a commercially useful function in the work of a contract. A DBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a commercially useful function, the DBE shall also be responsible with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material and installing (where applicable) and paying for the material itself. To determine whether a DBE is performing a commercially useful function, the Department will evaluate the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing and the DBE credit claimed for its performance of the work, and any other relevant factors.

**(B) DBE Utilization in Trucking**

The following factors will be used to determine if a DBE trucking firm is performing a commercially useful function:

- (1) The DBE shall be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there shall not be a contrived arrangement for the purpose of meeting DBE goals.
- (2) The DBE shall itself own and operate at least one fully licensed, insured, and operational truck used on the contract.
- (3) The DBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.
- (4) The DBE may subcontract the work to another DBE firm, including an owner-operator who is certified as a DBE. The DBE who subcontracts work to another DBE receives credit for the total value of the transportation services the subcontracted DBE provides on the contract.
- (5) The DBE may also subcontract the work to a non-DBE firm, including from an owner-operator. The DBE who subcontracts the work to a non-DBE is entitled to credit for the total value of transportation services provided by the non-DBE subcontractor not to exceed the value of transportation services provided by DBE-owned trucks on the contract. Additional participation by non-DBE subcontractors receives credit only for the fee or commission it receives as a result of the subcontract arrangement. The value of services performed under

subcontract agreements between the DBE and the Contractor will not count towards the DBE contract requirement.

- (6) A DBE may lease truck(s) from an established equipment leasing business open to the general public. The lease must indicate that the DBE has exclusive use of and control over the truck. This requirement does not preclude the leased truck from working for others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. This type of lease may count toward the DBE's credit as long as the driver is under the DBE's payroll.
- (7) Subcontracted/leased trucks shall display clearly on the dashboard the name of the DBE that they are subcontracted/leased to and their own company name if it is not identified on the truck itself. Magnetic door signs are not permitted.

### **DBE Replacement**

When a Contractor has relied on a commitment to a DBE firm (or an approved substitute DBE firm) to meet all or part of a contract goal requirement, the contractor shall not terminate the DBE for convenience. This includes, but is not limited to, instances in which the Contractor seeks to perform the work of the terminated subcontractor with another DBE subcontractor, a non-DBE subcontractor, or with the Contractor's own forces or those of an affiliate. A DBE may only be terminated after receiving the Engineer's written approval based upon a finding of good cause for the termination.

All requests for replacement of a committed DBE firm shall be submitted to the Engineer for approval on Form RF-1 (*DBE Replacement Request*). If the Contractor fails to follow this procedure, the Contractor may be disqualified from further bidding for a period of up to 6 months.

The Contractor shall comply with the following for replacement of a committed DBE:

#### **(A) Performance Related Replacement**

When a committed DBE is terminated for good cause as stated above, an additional DBE that was submitted at the time of bid may be used to fulfill the DBE commitment. A good faith effort will only be required for removing a committed DBE if there were no additional DBEs submitted at the time of bid to cover the same amount of work as the DBE that was terminated.

If a replacement DBE is not found that can perform at least the same amount of work as the terminated DBE, the Contractor shall submit a good faith effort documenting the steps taken. Such documentation shall include, but not be limited to, the following:

- (1) Copies of written notification to DBEs that their interest is solicited in contracting the work defaulted by the previous DBE or in subcontracting other items of work in the contract.
  - (2) Efforts to negotiate with DBEs for specific subbids including, at a minimum:
    - (a) The names, addresses, and telephone numbers of DBEs who were contacted.
    - (b) A description of the information provided to DBEs regarding the plans and specifications for portions of the work to be performed.
  - (3) A list of reasons why DBE quotes were not accepted.
  - (4) Efforts made to assist the DBEs contacted, if needed, in obtaining bonding or insurance required by the Contractor.
- (B) Decertification Replacement
- (1) When a committed DBE is decertified by the Department after the SAF (*Subcontract Approval Form*) has been received by the Department, the Department will not require the Contractor to solicit replacement DBE participation equal to the remaining work to be performed by the decertified firm. The participation equal to the remaining work performed by the decertified firm will count toward the contract goal requirement.
  - (2) When a committed DBE is decertified prior to the Department receiving the SAF (*Subcontract Approval Form*) for the named DBE firm, the Contractor shall take all necessary and reasonable steps to replace the DBE subcontractor with another DBE subcontractor to perform at least the same amount of work to meet the DBE goal requirement. If a DBE firm is not found to do the same amount of work, a good faith effort must be submitted to NCDOT (see A herein for required documentation).

### **Changes in the Work**

When the Engineer makes changes that result in the reduction or elimination of work to be performed by a committed DBE, the Contractor will not be required to seek additional participation. When the Engineer makes changes that result in additional work to be performed by a DBE based upon the Contractor's commitment, the DBE shall participate in additional work to the same extent as the DBE participated in the original contract work.

When the Engineer makes changes that result in extra work, which has more than a minimal impact on the contract amount, the Contractor shall seek additional participation by DBEs unless otherwise approved by the Engineer.

When the Engineer makes changes that result in an alteration of plans or details of construction, and a portion or all of the work had been expected to be performed by a committed DBE, the Contractor shall seek participation by DBEs unless otherwise approved by the Engineer.

When the Contractor requests changes in the work that result in the reduction or elimination of work that the Contractor committed to be performed by a DBE, the Contractor shall seek additional participation by DBEs equal to the reduced DBE participation caused by the changes.

### **Reports and Documentation**

A SAF (*Subcontract Approval Form*) shall be submitted for all work which is to be performed by a DBE subcontractor. The Department reserves the right to require copies of actual subcontract agreements involving DBE subcontractors.

When using transportation services to meet the contract commitment, the Contractor shall submit a proposed trucking plan in addition to the SAF. The plan shall be submitted prior to beginning construction on the project. The plan shall include the names of all trucking firms proposed for use, their certification type(s), the number of trucks owned by the firm, as well as the individual truck identification numbers, and the line item(s) being performed.

Within 30 calendar days of entering into an agreement with a DBE for materials, supplies or services, not otherwise documented by the SAF as specified above, the Contractor shall furnish the Engineer a copy of the agreement. The documentation shall also indicate the percentage (60% or 100%) of expenditures claimed for DBE credit.

### **Reporting Disadvantaged Business Enterprise Participation**

The Contractor shall provide the Engineer with an accounting of payments made to all DBE firms, including material suppliers and contractors at all levels (prime, subcontractor, or second tier subcontractor). This accounting shall be furnished to the Engineer for any given month by the end of the following month. Failure to submit this information accordingly may result in the following action:

- (A) Withholding of money due in the next partial pay estimate; or
- (B) Removal of an approved contractor from the prequalified bidders' list or the removal of other entities from the approved subcontractors list.

While each contractor (prime, subcontractor, 2nd tier subcontractor) is responsible for accurate accounting of payments to DBEs, it shall be the prime contractor's responsibility to report all monthly and final payment information in the correct reporting manner.

Failure on the part of the Contractor to submit the required information in the time frame specified may result in the disqualification of that contractor and any affiliate companies from further bidding until the required information is submitted.

Failure on the part of any subcontractor to submit the required information in the time frame specified may result in the disqualification of that contractor and any affiliate companies from being approved for work on future DOT projects until the required information is submitted.

Contractors reporting transportation services provided by non-DBE lessees shall evaluate the value of services provided during the month of the reporting period only.

At any time, the Engineer can request written verification of subcontractor payments.

(A) Electronic Bids Reporting

The Contractor shall report the accounting of payments through the Department's DBE Payment Tracking System.

(B) Paper Bids Reporting

The Contractor shall report the accounting of payments on the Department's DBE-IS (*Subcontractor Payment Information*) with each invoice. Invoices will not be processed for payment until the DBE-IS is received.

**Failure to Meet Contract Requirements**

Failure to meet contract requirements in accordance with Subarticle 102-15(J) of the *2012 Standard Specifications* may be cause to disqualify the Contractor.

**CERTIFICATION FOR FEDERAL-AID CONTRACTS:**

(3-21-90)

SP1 G85

The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

- (A) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (B) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of

a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, *Disclosure Form to Report Lobbying*, in accordance with its instructions.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by *Section 1352, Title 31, U.S. Code*. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

The prospective participant also agrees by submitting his or her bid or proposal that he or she shall require that the language of this certification be included in all lower tier subcontracts, which exceed \$100,000 and that all such subrecipients shall certify and disclose accordingly.

**CONTRACTOR'S LICENSE REQUIREMENTS:**

(7-1-95)

102-14

SP1 G88

If the successful bidder does not hold the proper license to perform any plumbing, heating, air conditioning, or electrical work in this contract, he will be required to sublet such work to a contractor properly licensed in accordance with *Article 2 of Chapter 87 of the General Statutes* (licensing of heating, plumbing, and air conditioning contractors) and *Article 4 of Chapter 87 of the General Statutes* (licensing of electrical contractors).

**U.S. DEPARTMENT OF TRANSPORTATION HOTLINE:**

(11-22-94)

108-5

SP1 G100

To report bid rigging activities call: **1-800-424-9071**

The U.S. Department of Transportation (DOT) operates the above toll-free hotline Monday through Friday, 8:00 a.m. to 5:00 p.m. eastern time. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should use the hotline to report such activities.

The hotline is part of the DOT's continuing effort to identify and investigate highway construction contract fraud and abuse is operated under the direction of the DOT Inspector General. All information will be treated confidentially and caller anonymity will be respected.

**SUBSURFACE INFORMATION:**

(7-1-95)

450

SP1 G112 A

There is **no** subsurface information available on this project. The Contractor shall make his own investigation of subsurface conditions.



**LOCATING EXISTING UNDERGROUND UTILITIES:**

(3-20-12)

105

SP1 G115

Revise the *2012 Standard Specifications* as follows:

**Page 1-43, Article 105-8, line 28, after the first sentence,** add the following:

Identify excavation locations by means of pre-marking with white paint, flags, or stakes or provide a specific written description of the location in the locate request.

**VALUE ENGINEERING PROPOSAL:**

(05-19-15)

104

SP01 G116

Revise the *2012 Standard Specifications* as follows:

**Page 1-36, Subarticle 104-12(B) Evaluation of Proposals, lines 42-44,** replace the fourth sentence of the second paragraph with the following:

Pending execution of a formal supplemental agreement implementing an approved VEP and transferal of final plans (hard copy and electronic) sealed by an engineer licensed in the State of North Carolina incorporating an approved VEP to the Resident Engineer and the State Value Management Engineer, the Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract.

**Page 1-37, Subarticle 104-12(D) Preliminary Review, lines 9-12,** replace the first sentence of the first paragraph with the following:

Should the Contractor desire a preliminary review of a possible VEP, before expending considerable time and expense in full development, a copy of the Preliminary VEP shall be submitted to the Resident Engineer and the State Value Management Engineer at ValueManagementUnit@ncdot.gov.

**Page 1-37, Subarticle 104-12(E) Final Proposal, lines 22-23,** replace the first sentence of the first paragraph with the following:

A copy of the Final VEP shall be submitted by the Contractor to the Resident Engineer and the State Value Management Engineer at ValueManagementUnit@ncdot.gov.

**Page 1-38, Subarticle 104-12(F) Modifications, lines 2-8,** replace the first paragraph with the following:

To facilitate the preparation of revisions to contract drawings, the Contractor may purchase reproducible copies of drawings for his use through the Department's Value Management Unit. The preparation of new design drawings by or for the Contractor shall be coordinated with the appropriate Design Branch through the State Value Management Engineer. The Contractor shall provide, at no charge to the Department, one set of reproducible drawings of the approved design needed to implement the VEP. Drawings (hard copy and electronic) which are sealed by an

engineer licensed in the State of North Carolina shall be submitted to the State Value Management Engineer no later than ten (10) business days after acceptance of a VEP unless otherwise permitted.

**Page 1-38, Subarticle 104-12(F) Modifications, line 17,** add the following at the end of the third paragraph:

Supplemental agreements executed for design-bid-build contracts shall reflect any realized savings in the corresponding line items. Supplemental agreements executed for design-build contracts shall add one line item deducting the full savings from the total contract price and one line item crediting the Contractor with 50% of the total VEP savings.

**Page 1-38, Subarticle 104-12(F) Modifications, lines 45-47,** replace the eighth paragraph with the following:

Unless and until a supplemental agreement is executed and issued by the Department and final plans (hard copy and electronic) sealed by an engineer licensed in the State of North Carolina incorporating an approved VEP have been provided to the Resident Engineer and the State Value Management Engineer, the Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract.

**RESOURCE CONSERVATION AND ENV. SUSTAINABLE PRACTICES:**

(5-21-13) (Rev. 5-19-15)

104-13

SP1 G118

In accordance with North Carolina Executive Order 156, NCGS 130A-309.14(3), and NCGS 136-28.8, it is the objective of the Department to aid in the reduction of materials that become a part of our solid waste stream, to divert materials from landfills, to find ways to recycle and reuse materials, to consider and minimize, where economically feasible, the environmental impacts associated with agency land use and acquisition, construction, maintenance and facility management for the benefit of the Citizens of North Carolina.

To achieve the mission of reducing environmental impacts across the state, the Department is committed to supporting the efforts to initiate, develop and use products and construction methods that incorporate the use of recycled, solid waste products and environmentally sustainable practices in accordance with Article 104-13 of the *Standard Specifications*.

Report the quantities of reused or recycled materials either incorporated in the project or diverted from landfills and any practice that minimizes the environmental impact on the project annually on the Project Construction Reuse and Recycling Reporting Form. The Project Construction Reuse and Recycling Reporting Form and a location tool for local recycling facilities are available at:

<http://connect.ncdot.gov/resources/Environmental/Pages/North-Carolina-Recycling-Locations.aspx>.

Submit the Project Construction Reuse and Recycling Reporting Form by August 1 annually to [valuemanagementunit@ncdot.gov](mailto:valuemanagementunit@ncdot.gov). For questions regarding the form or reporting, please contact the State Value Management Engineer at 919-707-4810.

**DOMESTIC STEEL:**

(4-16-13)

106

SP1 G120

Revise the *2012 Standard Specifications* as follows:

**Page 1-49, Subarticle 106-1(B) Domestic Steel, lines 2-7,** replace the first paragraph with the following:

All steel and iron products that are permanently incorporated into this project shall be produced in the United States except minimal amounts of foreign steel and iron products may be used provided the combined material cost of the items involved does not exceed 0.1% of the total amount bid for the entire project or \$2,500, whichever is greater. If invoices showing the cost of the material are not provided, the amount of the bid item involving the foreign material will be used for calculations. This minimal amount of foreign produced steel and iron products permitted for use is not applicable to high strength fasteners. Domestically produced high strength fasteners are required.

**GIFTS FROM VENDORS AND CONTRACTORS:**

(12-15-09)

107-1

SP1 G152

By Executive Order 24, issued by Governor Perdue, and *N.C.G.S. § 133-32*, it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, landlord, offeror, seller, subcontractor, supplier, or vendor), to make gifts or to give favors to any State employee of the Governor's Cabinet Agencies (i.e. Administration, Commerce, Correction, Crime Control and Public Safety, Cultural Resources, Environment and Natural Resources, Health and Human Services, Juvenile Justice and Delinquency Prevention, Revenue, Transportation, and the Office of the Governor). This prohibition covers those vendors and contractors who:

- (A) Have a contract with a governmental agency; or
- (B) Have performed under such a contract within the past year; or
- (C) Anticipate bidding on such a contract in the future.

For additional information regarding the specific requirements and exemptions, vendors and contractors are encouraged to review Executive Order 24 and *N.C.G.S. § 133-32*.

Executive Order 24 also encouraged and invited other State Agencies to implement the requirements and prohibitions of the Executive Order to their agencies. Vendors and contractors should contact other State Agencies to determine if those agencies have adopted Executive Order 24.

**LIABILITY INSURANCE:**

(5-20-14)

SP1 G160

Revise the *2012 Standard Specifications* as follows:

**Page 1-60, Article 107-15 LIABILITY INSURANCE, line 16**, add the following as the second sentence of the third paragraph:

Prior to beginning services, all contractors shall provide proof of coverage issued by a workers' compensation insurance carrier, or a certificate of compliance issued by the Department of Insurance for self-insured subcontractors, irrespective of whether having regularly in service fewer than three employees.

**EMPLOYMENT:**

(11-15-11) (Rev. 1-17-12)

108, 102

SP1 G184

Revise the *2012 Standard Specifications* as follows:

**Page 1-20, Subarticle 102-15(O)**, delete and replace with the following:

(O) Failure to restrict a former Department employee as prohibited by Article 108-5.

**Page 1-65, Article 108-5 Character of Workmen, Methods, and Equipment, line 32**, delete all of line 32, the first sentence of the second paragraph and the first word of the second sentence of the second paragraph.

**STATE HIGHWAY ADMINISTRATOR TITLE CHANGE:**

(9-18-12)

SP1 G185

Revise the *2012 Standard Specifications* as follows:

Replace all references to "State Highway Administrator" with "Chief Engineer".

**SUBLETTING OF CONTRACT:**

(11-18-2014)

108-6

SP1 G186

Revise the *2012 Standard Specifications* as follows:

**Page 1-66, Article 108-6 Subletting of Contract, line 37**, add the following as the second sentence of the first paragraph:

All requests to sublet work shall be submitted within 30 days of the date of availability or prior to expiration of 20% of the contract time, whichever date is later, unless otherwise approved by the Engineer.

**Page 1-67, Article 108-6 Subletting of Contract, line 7,** add the following as the second sentence of the fourth paragraph:

Purchasing materials for subcontractors is not included in the percentage of work required to be performed by the Contractor. If the Contractor sublets items of work but elects to purchase material for the subcontractor, the value of the material purchased will be included in the total dollar amount considered to have been sublet.

**PROJECT SPECIAL PROVISIONS****ROADWAY****MATERIALS:**

(2-21-12) (Rev. 10-20-15)

1000, 1002, 1005, 1018, 1024, 1050, 1056, 1074, 1078, 1080, 1081, 1086, 1084, 1087, 1092

SP10 R01

Revise the *2012 Standard Specifications* as follows:

**Page 10-1, Article 1000-1, DESCRIPTION, lines 9-10**, replace the last sentence of the first paragraph with the following:

Type IL, IP, IS or IT blended cement may be used instead of Portland cement.

**Page 10-1, Article 1000-1, DESCRIPTION, line 14**, add the following:

If any change is made to the mix design, submit a new mix design (with the exception of an approved pozzolan source change).

If any major change is made to the mix design, also submit new test results showing the mix design conforms to the criteria. Define a major change to the mix design as:

- (1) A source change in coarse aggregate, fine aggregate or cement.
- (2) A pozzolan class or type change (e.g. Class F fly ash to Class C fly ash).
- (3) A quantitative change in coarse aggregate (applies to an increase or decrease greater than 5%), fine aggregate (applies to an increase or decrease greater than 5%), water (applies to an increase only), cement (applies to a decrease only), or pozzolan (applies to an increase or decrease greater than 5%).

Use materials which do not produce a mottled appearance through rusting or other staining of the finished concrete surface.

**Page 10-1, Article 1000-2, MATERIALS, line 16; Page 10-8, Subarticle 1000-7(A), Materials, line 8; and Page 10-18, Article 1002-2, MATERIALS, line 9**, add the following to the table of item references:

<b>Item</b>	<b>Section</b>
Type IL Blended Cement	1024-1

**Page 10-1, Subarticle 1000-3(A), Composition and Design, lines 25-27**, replace the second paragraph with the following:

Fly ash may be substituted for cement in the mix design up to 30% at a rate of 1.0 lb of fly ash to each pound of cement replaced.

**Page 10-2, Subarticle 1000-3(A), Composition and Design, lines 12-21,** delete the third paragraph through the sixth paragraph beginning with “If any change is made to the mix design, submit...” through “...(applies to a decrease only).”

**Page 10-5, Table 1000-1, REQUIREMENTS FOR CONCRETE,** replace with the following:

TABLE 1000-1 REQUIREMENTS FOR CONCRETE											
Class of Concrete	Min. Comp. Strength at 28 days	Maximum Water-Cement Ratio				Consistency Max. Slump		Cement Content			
		Air-Entrained Concrete		Non Air-Entrained Concrete		Vibrated	Non-Vibrated	Vibrated		Non-Vibrated	
		Rounded Aggregate	Angular Aggregate	Rounded Aggregate	Angular Aggregate			Min.	Max.	Min.	Max.
Units	psi					inch	inch	lb/cy	lb/cy	lb/cy	lb/cy
AA	4,500	0.381	0.426	-	-	3.5	-	639	715	-	-
AA Slip Form	4,500	0.381	0.426	-	-	1.5	-	639	715	-	-
Drilled Pier	4,500	-	-	0.450	0.450	-	5-7 dry 7-9 wet	-	-	640	800
A	3,000	0.488	0.532	0.550	0.594	3.5	4	564	-	602	-
B	2,500	0.488	0.567	0.559	0.630	1.5 machine-placed 2.5 hand-placed	4	508	-	545	-
Sand Lightweight	4,500	-	0.420	-	-	4	-	715	-	-	-
Latex Modified	3,000 7 day	0.400	0.400	-	-	6	-	658	-	-	-
Flowable Fill excavatable	150 max. at 56 days	as needed	as needed	as needed	as needed	-	Flow-able	-	-	40	100
Flowable Fill non-excavatable	125	as needed	as needed	as needed	as needed	-	Flow-able	-	-	100	as needed
Pavement	4,500 design, field 650 flexural, design only	0.559	0.559	-	-	1.5 slip form 3.0 hand place	-	526	-	-	-
Precast	See Table 1077-1	as needed	as needed	-	-	6	as needed	as needed	as needed	as needed	as needed
Prestress	per contract	See Table 1078-1	See Table 1078-1	-	-	8	-	564	as needed	-	-

**Page 10-6, Subarticle 1000-4(I), Use of Fly Ash, lines 36-2,** replace the first paragraph with the following:

Fly ash may be substituted for cement in the mix design up to 30% at a rate of 1.0 lb of fly ash to each pound of cement replaced. Use Table 1000-1 to determine the maximum allowable water-cementitious material (cement + fly ash) ratio for the classes of concrete listed.

**Page 10-7, Table 1000-3, MAXIMUM WATER-CEMENTITIOUS MATERIAL RATIO,** delete the table.

**Page 10-7, Article 1000-5, HIGH EARLY STRENGTH PORTLAND CEMENT CONCRETE, lines 30-31,** delete the second sentence of the third paragraph.

**Page 10-19, Article 1002-3, SHOTCRETE FOR TEMPORARY SUPPORT OF EXCAVATIONS, line 30,** add the following at the end of Section 1002:

**(H) Handling and Storing Test Panels**

Notify the Area Materials Engineer when preconstruction or production test panels are made within 24 hours of shooting the panels. Field cure and protect test panels from damage in accordance with ASTM C1140 until the Department transports panels to the Materials and Tests Regional Laboratory for coring.



Page 10-23, Table 1005-1, AGGREGATE GRADATION-COARSE AGGREGATE, replace with the following:

<b>TABLE 1005-1 AGGREGATE GRADATION - COARSE AGGREGATE</b>													
<b>Percentage of Total by Weight Passing</b>													
<b>Std. Size #</b>	<b>2"</b>	<b>1 1/2"</b>	<b>1"</b>	<b>3/4"</b>	<b>1/2"</b>	<b>3/8"</b>	<b>#4</b>	<b>#8</b>	<b>#10</b>	<b>#16</b>	<b>#40</b>	<b>#200</b>	<b>Remarks</b>
4	100	90-100	20-55	0-15	-	0-5	-	-	-	-	-	A	Asphalt Plant Mix
467M	100	95-100	-	35-70	-	0-30	0-5	-	-	-	-	A	Asphalt Plant Mix
5	-	100	90-100	20-55	0-10	0-5	-	-	-	-	-	A	AST, Sediment Control Stone
57	-	100	95-100	-	25-60	-	0-10	0-5	-	-	-	A	AST, Str. Concrete, Shoulder Drain, Sediment Control Stone
57M	-	100	95-100	-	25-45	-	0-10	0-5	-	-	-	A	AST, Concrete Pavement
6M	-	-	100	90-100	20-55	0-20	0-8	-	-	-	-	A	AST
67	-	-	100	90-100	-	20-55	0-10	0-5	-	-	-	A	AST, Str. Concrete, Asphalt Plant Mix
78M	-	-	-	100	98-100	75-100	20-45	0-15	-	-	-	A	Asphalt Plant Mix, AST, Str. Conc. Weep Hole Drains
14M	-	-	-	-	-	100	35-70	5-20	-	0-8	-	A	Asphalt Plant Mix, AST, Weep Hole Drains, Str. Concrete
9	-	-	-	-	-	100	85-100	10-40	-	0-10	-	A	AST
ABC	-	100	75-97	-	55-80	-	35-55	-	25-45	-	14-30	4-12 <sup>B</sup>	Aggregate Base Course, Aggregate Stabilization
ABC (M)	-	100	75-100	-	45-79	-	20-40	-	0-25	-	-	0-12 <sup>B</sup>	Maintenance Stabilization
Light-C weight	-	-	-	-	100	80-100	5-40	0-20	-	0-10	-	0-2.5	AST

A. See Subarticle 1005-4(A).  
 B. See Subarticle 1005-4(B).  
 C. For Lightweight Aggregate used in Structural Concrete, see Subarticle 1014-2(E)(6).

**Page 10-40, Tables 1018-1 and 1018-2, PIEDMONT, WESTERN AND COASTAL AREA CRITERIA FOR ACCEPTANCE OF BORROW MATERIAL**, under second column in both tables, replace second row with the following:

Acceptable, but not to be used in the top 3 ft of embankment or backfill

**Page 10-46, Article 1024-1, PORTLAND CEMENT, line 33**, add the following as the ninth paragraph:

Use Type IL blended cement that meets AASHTO M 240, except that the limestone content is limited to between 5 and 12% by weight and the constituents shall be interground. Class F fly ash can replace a portion of Type IL blended cement and shall be replaced as outlined in Subarticle 1000-4(I) for Portland cement. For mixes that contain cement with alkali content between 0.6% and 1.0% and for mixes that contain a reactive aggregate documented by the Department, use a pozzolan in the amount shown in Table 1024-1.

**Page 10-46, Table 1024-1, POZZOLANS FOR USE IN PORTLAND CEMENT CONCRETE**, replace with the following:

<b>TABLE 1024-1 POZZOLANS FOR USE IN PORTLAND CEMENT CONCRETE</b>	
<b>Pozzolan</b>	<b>Rate</b>
Class F Fly Ash	20% - 30% by weight of required cement content with 1.0 lb Class F fly ash per lb of cement replaced
Ground Granulated Blast Furnace Slag	35%-50% by weight of required cement content with 1.0 lb slag per lb of cement replaced
Microsilica	4%-8% by weight of required cement content with 1.0 lb microsilica per lb of cement replaced

**Page 10-47, Subarticle 1024-3(B), Approved Sources, lines 16-18**, replace the second sentence of the second paragraph with the following:

Tests shall be performed by AASHTO's designated National Transportation Product Evaluation Program (NTPEP) laboratory for concrete admixture testing.

**Page 10-65, Article 1050-1, GENERAL, line 41**, replace the first sentence with the following:

All fencing material and accessories shall meet Section 106.

**Page 10-73, Article 1056-1, DESCRIPTION, lines 7-8**, delete the first sentence of the second paragraph and replace with the following:

Use geotextile fabrics that are on the NCDOT Approved Products List.

**Page 10-73, Article 1056-2, HANDLING AND STORING, line 17**, replace "mechanically stabilized earth (MSE) wall faces" with "temporary wall faces".

**Page 10-73, Article 1056-4, GEOTEXTILES, line 33,** add the following after the first sentence in the second paragraph:

Geotextiles will be identified by the product name printed directly on the geotextile. When geotextiles are not marked with a product name or marked with only a manufacturing plant identification code, geotextiles will be identified by product labels attached to the geotextile wrapping. When identification is based on labels instead of markings, unwrap geotextiles just before use in the presence of the Engineer to confirm that the product labels on both ends of the outside of the geotextile outer wrapping match the labels affixed to both ends of the inside of the geotextile roll core. Partial geotextile roles without the product name printed on the geotextile or product labels affixed to the geotextile roll core may not be used.

Page 10-74, Table 1056-1, GEOTEXTILE REQUIREMENTS, replace with the following:

TABLE 1056-1 GEOTEXTILE REQUIREMENTS						
Property	Requirement					Test Method
	Type 1	Type 2	Type 3 <sup>A</sup>	Type 4	Type 5 <sup>B</sup>	
<i>Typical Application</i>	<i>Shoulder Drains</i>	<i>Under Rip Rap</i>	<i>Temporary Silt Fence</i>	<i>Soil Stabilization</i>	<i>Temporary Walls</i>	
Elongation (MD & CD)	≥ 50%	≥ 50%	≤ 25%	< 50%	< 50%	ASTM D4632
Grab Strength (MD & CD)	Table 1 <sup>D</sup> , Class 3	Table 1 <sup>D</sup> , Class 1	100 lb <sup>C</sup>	Table 1 <sup>D</sup> , Class 3	-	ASTM D4632
Tear Strength (MD & CD)			-			ASTM D4533
Puncture Strength			-			ASTM D6241
Ultimate Tensile Strength (MD & CD)	-	-	-	-	2,400 lb/ft <sup>C</sup> (unless required otherwise in the contract)	ASTM D4595
Permittivity	Table 2 <sup>D</sup> , 15% to 50% <i>in Situ</i> Soil Passing No. 200 <sup>E</sup>		Table 7 <sup>D</sup>	Table 5 <sup>D</sup>	0.20 sec <sup>-1,C</sup>	ASTM D4491
Apparent Opening Size					0.60 mm <sup>F</sup>	ASTM D4751
UV Stability (Retained Strength)					70% <sup>C, G</sup>	ASTM D4355

- A. Minimum roll width of 36" required.
- B. Minimum roll width of 13 ft required.
- C. MARV per Article 1056-3.
- D. AASHTO M 288.
- E. US Sieve No. per AASHTO M 92.
- F. Maximum average roll value.
- G. After 500 hours of exposure.

Page 10-74, Article 1056-5, GEOCOMPOSITES, lines 7-8, replace the first sentence with the following:

Provide geocomposite drain strips with a width of at least 12" and Type 1 geotextiles attached to drainage cores that meet Table 1056-2.

**Page 10-115, Subarticle 1074-7(B), Gray Iron Castings, lines 10-11,** replace the first two sentences with the following:

Supply gray iron castings meeting all facets of AASHTO M 306 excluding proof load. Proof load testing will only be required for new casting designs during the design process, and conformance to M306 loading (40,000 lbs.) will be required only when noted on the design documents.

**Page 10-126, Table 1078-1, REQUIREMENTS FOR CONCRETE,** replace with the following:

<b>TABLE 1078-1 REQUIREMENTS FOR CONCRETE</b>		
<b>Property</b>	<b>28 Day Design Compressive Strength 6,000 psi or less</b>	<b>28 Day Design Compressive Strength greater than 6,000 psi</b>
Maximum Water/Cementitious Material Ratio	0.45	0.40
Maximum Slump without HRWR	3.5"	3.5"
Maximum Slump with HRWR	8"	8"
Air Content (upon discharge into forms)	5 + 2%	5 + 2%

**Page 10-151, Article 1080-4, INSPECTION AND SAMPLING, lines 18-22,** replace (B), (C) and (D) with the following:

- (B) At least 3 panels prepared as specified in 5.5.10 of AASHTO M 300, Bullet Hole Immersion Test.
- (C) At least 3 panels of 4"x6"x1/4" for the Elcometer Adhesion Pull Off Test, ASTM D4541.
- (D) A certified test report from an approved independent testing laboratory for the Salt Fog Resistance Test, Cyclic Weathering Resistance Test, and Bullet Hole Immersion Test as specified in AASHTO M 300.
- (E) A certified test report from an approved independent testing laboratory that the product has been tested for slip coefficient and meets AASHTO M253, Class B.

**Page 10-161, Subarticle 1081-1(A), Classifications, lines 29-33,** delete first 3 sentences of the description for Type 2 and replace with the following:

**Type 2** - A low-modulus, general-purpose adhesive used in epoxy mortar repairs. It may be used to patch spalled, cracked or broken concrete where vibration, shock or expansion and contraction are expected.

**Page 10-162, Subarticle 1081-1(A), Classifications, lines 4-7**, delete the second and third sentences of the description for Type 3A. **Lines 16-22**, delete Types 6A, 6B and 6C.

**Page 10-162, Subarticle 1081-1(B), Requirements, lines 26-30**, replace the second paragraph with the following:

For epoxy resin systems used for embedding dowel bars, threaded rods, rebar, anchor bolts and other fixtures in hardened concrete, the manufacturer shall submit test results showing that the bonding system will obtain 125% of the specified required yield strength of the fixture. Furnish certification that, for the particular bolt grade, diameter and embedment depth required, the anchor system will not fail by adhesive failure and that there is no movement of the anchor bolt. For certification and anchorage, use 3,000 psi as the minimum Portland cement concrete compressive strength used in this test. Use adhesives that meet Section 1081.

List the properties of the adhesive on the container and include density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength.

Page 10-163, Table 1081-1, PROPERTIES OF MIXED EPOXY RESIN SYSTEMS, replace with the following:

Property	Type 1	Type 2	Type 3	Type 3A	Type 4A	Type 4B	Type 5
Viscosity-Poises at 77°F ± 2°F	Gel	10-30	25-75	Gel	40-150	40-150	1-6
Spindle No.	-	3	4	--	4	4	2
Speed (RPM)	-	20	20	--	10	10	50
Pot Life (Minutes)	20-50	30-60	20-50	5-50	40-80	40-80	20-60
Minimum Tensile Strength at 7 days (psi)	1,500	2,000	4,000	4,000	1,500	1,500	4,000
Tensile Elongation at 7 days (%)	30 min.	30 min.	2-5	2-5	5-15	5-15	2-5
Min. Compressive Strength of 2" mortar cubes at 24 hours	3,000 (Neat)	4,000-	6,000-	6,000 (Neat)	3,000	3,000	6,000
Min. Compressive Strength of 2" mortar cubes at 7 days	5,000 (Neat)	-	-	-	-	5,000	-
Maximum Water Absorption (%)	1.5	1.0	1.0	1.5	1.0	1.0	1.0
Min. Bond Strength Slant Shear Test at 14 days (psi)	1,500	1,500	2,000	2,000	1,500	1,500	1,500

Page 10-164, Subarticle 1081-1(E), Prequalification, lines 31-33, replace the second sentence of the first paragraph with the following:

Manufacturers choosing to supply material for Department jobs must submit an application through the Value Management Unit with the following information for each type and brand name:

**Page 10-164, Subarticle 1081-1(E)(3), line 37**, replace with the following:

(3) Type of the material in accordance with Articles 1081-1 and 1081-4,

**Page 10-165, Subarticle 1081-1(E)(6), line 1**, in the first sentence of the first paragraph replace “AASHTO M 237” with “the specifications”.

**Page 10-165, Subarticle 1081-1(E), Prequalification, line 9-10**, delete the second sentence of the last paragraph.

**Page 10-165, Subarticle 1081-1(F), Acceptance, line 14**, in the first sentence of the first paragraph replace “Type 1” with “Type 3”.

**Page 10-169, Subarticle 1081-3(G), Anchor Bolt Adhesives**, delete this subarticle.

**Page 10-170, Article 1081-3, HOT BITUMEN, line 9**, add the following at the end of Section 1081:

#### **1081-4 EPOXY RESIN ADHESIVE FOR BONDING TRAFFIC MARKINGS**

##### **(A) General**

This section covers epoxy resin adhesive for bonding traffic markers to pavement surfaces.

##### **(B) Classification**

The types of epoxies and their uses are as shown below:

**Type I** – Rapid Setting, High Viscosity, Epoxy Adhesive. This type of adhesive provides rapid adherence to traffic markers to the surface of pavement.

**Type II** – Standard Setting, High Viscosity, Epoxy Adhesive. This type of adhesive is recommended for adherence of traffic markers to pavement surfaces when rapid set is not required.

**Type III** – Rapid Setting, Low Viscosity, Water Resistant, Epoxy Adhesive. This type of rapid setting adhesive, due to its low viscosity, is appropriate only for use with embedded traffic markers.

**Type IV** – Standard Set Epoxy for Blade Deflecting-Type Plowable Markers.

##### **(C) Requirements**

Epoxies shall conform to the requirements set forth in AASHTO M 237.



**(D) Prequalification**

Refer to Subarticle 1081-1(E).

**(E) Acceptance**

Refer to Subarticle 1081-1(F).

**Page 10-173, Article 1084-2, STEEL SHEET PILES, lines 37-38**, replace first paragraph with the following:

Steel sheet piles detailed for permanent applications shall be hot rolled and meet ASTM A572 or ASTM A690 unless otherwise required by the plans. Steel sheet piles shall be coated as required by the plans. Galvanized sheet piles shall be coated in accordance with Section 1076. Metallized sheet piles shall be metallized in accordance to the Project Special Provision “Thermal Sprayed Coatings (Metallization)” with an 8 mil, 99.9% aluminum alloy coating and a 0.5 mil seal coating. Any portion of the metallized sheet piling encased in concrete shall receive a barrier coat. The barrier coat shall be an approved waterborne coating with a low-viscosity which readily absorbs into the pores of the aluminum thermal sprayed coating. The waterborne coating shall be applied at a spreading rate that results in a theoretical 1.5 mil dry film thickness. The manufacturer shall issue a letter of certification that the resin chemistry of the waterborne coating is compatible with the 99.9% aluminum thermal sprayed alloy and suitable for tidal water applications.

**Page 10-174, Subarticle 1086-1(B)(1), Epoxy, lines 18-24**, replace with the following:

The epoxy shall meet Article 1081-4.

The 2 types of epoxy adhesive which may be used are Type I, Rapid Setting, and Type II, Standard Setting. Use Type II when the pavement temperature is above 60°F or per the manufacturer’s recommendations whichever is more stringent. Use Type I when the pavement temperature is between 50°F and 60°F or per the manufacturer’s recommendations whichever is more stringent. Epoxy adhesive Type I, Cold Set, may be used to attach temporary pavement markers to the pavement surface when the pavement temperature is between 32°F and 50°F or per the manufacturer’s recommendations whichever is more stringent.

**Page 10-175, Subarticle 1086-2(E), Epoxy Adhesives, line 27**, replace “Section 1081” with “Article 1081-4”.

**Page 10-177, Subarticle 1086-3(E), Epoxy Adhesives, line 22**, replace “Section 1081” with “Article 1081-4”.

**Page 10-179, Subarticle 1087-4(A), Composition, lines 39-41,** replace the third paragraph with the following:

All intermixed and drop-on glass beads shall not contain more than 75 ppm arsenic or 200 ppm lead.

**Page 10-180, Subarticle 1087-4(B), Physical Characteristics, line 8,** replace the second paragraph with the following:

All intermixed and drop-on glass beads shall comply with NCGS § 136-30.2 and 23 USC § 109(r).

**Page 10-181, Subarticle 1087-7(A), Intermixed and Drop-on Glass Beads, line 24,** add the following after the first paragraph:

Use X-ray Fluorescence for the normal sampling procedure for intermixed and drop-on beads, without crushing, to check for any levels of arsenic and lead. If any arsenic or lead is detected, the sample shall be crushed and repeat the test using X-ray Fluorescence. If the X-ray Fluorescence test shows more than a LOD of 5 ppm, test the beads using United States Environmental Protection Agency Method 6010B, 6010C or 3052 for no more than 75 ppm arsenic or 200 ppm lead.

### **GROUT PRODUCTION AND DELIVERY:**

(3-17-15)

1003

SP10 R20

Revise the *2012 Standard Specifications* as follows:

Replace Section 1003 with the following:

### **SECTION 1003 GROUT PRODUCTION AND DELIVERY**

#### **1003-1 DESCRIPTION**

This section addresses cement grout to be used for structures, foundations, retaining walls, concrete barriers, embankments, pavements and other applications in accordance with the contract. Produce non-metallic grout composed of Portland cement and water and at the Contractor's option or as required, aggregate and pozzolans. Include chemical admixtures as required or needed. Provide sand cement or neat cement grout as required. Define "sand cement grout" as grout with only fine aggregate and "neat cement grout" as grout without aggregate.

The types of grout with their typical uses are as shown below:

**Type 1** – A cement grout with only a 3-day strength requirement and a fluid consistency that is typically used for filling subsurface voids.

**Type 2** – A nonshrink grout with strength, height change and flow conforming to ASTM C1107 that is typically used for foundations, ground anchors and soil nails.

**Type 3** – A nonshrink grout with high early strength and freeze-thaw durability requirements that is typically used in pile blockouts, grout pockets, shear keys, dowel holes and recesses for concrete barriers and structures.

**Type 4** – A neat cement grout with low strength, a fluid consistency and high fly ash content that is typically used for slab jacking.

**Type 5** – A low slump, low mobility sand cement grout with minimal strength that is typically used for compaction grouting.

### **1003-2 MATERIALS**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Chemical Admixtures	1024-3
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Water	1024-4

Do not use grout that contains soluble chlorides or more than 1% soluble sulfate. At the Contractor's option, use an approved packaged grout instead of the materials above except for water. Use packaged grouts that are on the NCDOT Approved Products List.

Use admixtures for grout that are on the NCDOT Approved Products List or other admixtures in accordance with Subarticle 1024-3(E) except do not use concrete additives or unclassified or other admixtures in Type 4 or 5 grout. Use Class F fly ash for Type 4 grout and Type II Portland cement for Type 5 grout.

Use well graded rounded aggregate with a gradation, liquid limit (LL) and plasticity index (PI) that meet Table 1003-1 for Type 5 grout. Fly ash may be substituted for a portion of the fines in the aggregate. Do not use any other pozzolans in Type 5 grout.

**TABLE 1003-1  
AGGREGATE REQUIREMENTS FOR TYPE 5 GROUT**

Gradation		Maximum Liquid Limit	Maximum Plasticity Index
Sieve Designation per AASHTO M 92	Percentage Passing (% by weight)		
3/8"	100	N/A	N/A
No. 4	70 – 95		
No. 8	50 – 90		
No. 16	30 – 80		
No. 30	25 – 70		
No. 50	20 – 50		
No. 100	15 – 40	25	10
No. 200	10 – 30		

### 1003-3 COMPOSITION AND DESIGN

When using an approved packaged grout, a grout mix design submittal is not required. Otherwise, submit proposed grout mix designs for each grout mix to be used in the work. Mixes for all grout shall be designed by a Certified Concrete Mix Design Technician or an Engineer licensed by the State of North Carolina. Mix proportions shall be determined by a testing laboratory approved by the Department. Base grout mix designs on laboratory trial batches that meet Table 1003-2 and this section. With permission, the Contractor may use a quantity of chemical admixture within the range shown on the current list of approved admixtures maintained by the Materials and Tests Unit.

Submit grout mix designs in terms of saturated surface dry weights on Materials and Tests Form 312U at least 35 days before proposed use. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated surface dry mix proportions will not be permitted unless revised grout mix designs have been submitted to the Engineer and approved.

Accompany Materials and Tests Form 312U with a listing of laboratory test results of compressive strength, density and flow or slump and if applicable, aggregate gradation, durability and height change. List the compressive strength of at least three 2" cubes at the age of 3 and 28 days.

The Engineer will review the grout mix design for compliance with the contract and notify the Contractor as to its acceptability. Do not use a grout mix until written notice has been received. Acceptance of the grout mix design or use of approved packaged grouts does not relieve the Contractor of his responsibility to furnish a product that meets the contract. Upon written request from the Contractor, a grout mix design accepted and used satisfactorily on any Department project may be accepted for use on other projects.

Perform laboratory tests in accordance with the following test procedures:

<b>Property</b>	<b>Test Method</b>
Aggregate Gradation <sup>A</sup>	AASHTO T 27
Compressive Strength	AASHTO T 106
Density (Unit Weight)	AASHTO T 121, AASHTO T 133 <sup>B</sup> , ANSI/API RP <sup>C</sup> 13B-1 <sup>B</sup> (Section 4, Mud Balance)
Durability	AASHTO T 161 <sup>D</sup>
Flow	ASTM C939 (Flow Cone)
Height Change	ASTM C1090 <sup>E</sup>
Slump	AASHTO T 119

**A.** Applicable to grout with aggregate.

**B.** Applicable to Neat Cement Grout.

**C.** American National Standards Institute/American Petroleum Institute Recommended Practice.

**D.** Procedure A (Rapid Freezing and Thawing in Water) required.

**E.** Moist room storage required.

#### **1003-4 GROUT REQUIREMENTS**

Provide grout types in accordance with the contract. Use grouts with properties that meet Table 1003-2. The compressive strength of the grout will be considered the average compressive strength test results of three 2" cubes at each age. Make cubes that meet AASHTO T 106 from the grout delivered for the work or mixed on-site. Make cubes at such frequencies as the Engineer may determine and cure them in accordance with AASHTO T 106.

Type of Grout	Minimum Compressive Strength at		Height Change at 28 days	Flow <sup>A</sup> /Slump <sup>B</sup>	Minimum Durability Factor
	3 days	28 days			
1	3,000 psi	–	–	10 – 30 sec	–
2	Table 1 <sup>C</sup>			Fluid Consistency <sup>C</sup>	–
3	5,000 psi	–	0 – 0.2%	Per Accepted Grout Mix Design/ Approved Packaged Grout	80
4 <sup>D</sup>	600 psi	1,500 psi	–	10 – 26 sec	–
5	–	500 psi	–	1 – 3"	–

A. Applicable to Type 1 through 4 grouts.

B. Applicable to Type 5 grout.

C. ASTM C1107.

D. Use Type 4 grout with proportions by volume of 1 part cement and 3 parts fly ash.

### 1003-5 TEMPERATURE REQUIREMENTS

When using an approved packaged grout, follow the manufacturer's instructions for grout and air temperature at the time of placement. Otherwise, the grout temperature at the time of placement shall be not less than 50°F nor more than 90°F. Do not place grout when the air temperature measured at the location of the grouting operation in the shade away from artificial heat is below 40°F.

### 1003-6 ELAPSED TIME FOR PLACING GROUT

Agitate grout continuously before placement. Regulate the delivery so the maximum interval between the placing of batches at the work site does not exceed 20 minutes. Place grout before exceeding the times in Table 1003-3. Measure the elapsed time as the time between adding the mixing water to the grout mix and placing the grout.

Air or Grout Temperature, Whichever is Higher	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below	60 minutes	1 hr. 45 minutes

**1003-7 MIXING AND DELIVERY**

Use grout free of any lumps and undispersed cement. When using an approved packaged grout, mix grout in accordance with the manufacturer's instructions. Otherwise, comply with Articles 1000-8 through 1000-12 to the extent applicable for grout instead of concrete.

**TRUCK MOUNTED CHANGEABLE MESSAGE SIGNS:**

(8-21-12)

1101.02

SP11 R10

Revise the *2012 Roadway Standard Drawings* as follows:

**Drawing No. 1101.02, Sheet 12, TEMPORARY LANE CLOSURES**, replace General Note #11 with the following:

11- TRUCK MOUNTED CHANGEABLE MESSAGE SIGNS (TMCMS) USED ON SHADOW VEHICLES FOR "IN LANE" ACTIVITIES SHALL BE A MINIMUM OF 43" X 73". THE DISPLAY PANEL SHALL HAVE FULL MATRIX CAPABILITY WITH THE CAPABILITY TO PROVIDE 2 MESSAGE LINES WITH 7 CHARACTERS PER LINE WITH A MINIMUM CHARACTER HEIGHT OF 18". FOR ADDITIONAL MESSAGING, CONTACT THE WORK ZONE TRAFFIC CONTROL SECTION.

12- TMCMS USED FOR ADVANCED WARNING ON VEHICLES LOCATED ON THE SHOULDER MAY BE SMALLER THAN 43" X 73". THE DISPLAY PANEL SHALL HAVE THE CAPABILITY TO PROVIDE 2 MESSAGE LINES WITH 7 CHARACTERS PER LINE WITH A MINIMUM CHARACTER HEIGHT OF 18". FOR ADDITIONAL MESSAGING, CONTACT THE WORK ZONE TRAFFIC CONTROL SECTION.

**Drawing No. 1101.02, Sheet 13, TEMPORARY LANE CLOSURES**, replace General Note #12 with the following:

12- TRUCK MOUNTED CHANGEABLE MESSAGE SIGNS (TMCMS) USED ON SHADOW VEHICLES FOR "IN LANE" ACTIVITIES SHALL BE A MINIMUM OF 43" X 73". THE DISPLAY PANEL SHALL HAVE FULL MATRIX CAPABILITY WITH THE CAPABILITY TO PROVIDE 2 MESSAGE LINES WITH 7 CHARACTERS PER LINE WITH A MINIMUM CHARACTER HEIGHT OF 18". FOR ADDITIONAL MESSAGING, CONTACT THE WORK ZONE TRAFFIC CONTROL SECTION.

13- TMCMS USED FOR ADVANCED WARNING ON VEHICLES LOCATED ON THE SHOULDER MAY BE SMALLER THAN 43" X 73". THE DISPLAY PANEL SHALL HAVE THE CAPABILITY TO PROVIDE 2 MESSAGE LINES WITH 7 CHARACTERS PER LINE WITH A MINIMUM CHARACTER HEIGHT OF 18". FOR ADDITIONAL MESSAGING, CONTACT THE WORK ZONE TRAFFIC CONTROL SECTION.

**STANDARD SPECIAL PROVISION**  
**AVAILABILITY OF FUNDS – TERMINATION OF CONTRACTS**

(5-20-08)

Z-2

*General Statute 143C-6-11. (h) Highway Appropriation* is hereby incorporated verbatim in this contract as follows:

(h) Amounts Encumbered. – Transportation project appropriations may be encumbered in the amount of allotments made to the Department of Transportation by the Director for the estimated payments for transportation project contract work to be performed in the appropriation fiscal year. The allotments shall be multiyear allotments and shall be based on estimated revenues and shall be subject to the maximum contract authority contained in *General Statute 143C-6-11(c)*. Payment for transportation project work performed pursuant to contract in any fiscal year other than the current fiscal year is subject to appropriations by the General Assembly. Transportation project contracts shall contain a schedule of estimated completion progress, and any acceleration of this progress shall be subject to the approval of the Department of Transportation provided funds are available. The State reserves the right to terminate or suspend any transportation project contract, and any transportation project contract shall be so terminated or suspended if funds will not be available for payment of the work to be performed during that fiscal year pursuant to the contract. In the event of termination of any contract, the contractor shall be given a written notice of termination at least 60 days before completion of scheduled work for which funds are available. In the event of termination, the contractor shall be paid for the work already performed in accordance with the contract specifications.

Payment will be made on any contract terminated pursuant to the special provision in accordance with Subarticle 108-13(E) of the *2012 Standard Specifications*.



**STANDARD SPECIAL PROVISION****ERRATA**

(1-17-12) (Rev. 04-21-15)

Z-4

Revise the 2012 *Standard Specifications* as follows:

**Division 2**

**Page 2-7, line 31, Article 215-2 Construction Methods**, replace “Article 107-26” with “Article 107-25”.

**Page 2-17, Article 226-3, Measurement and Payment, line 2**, delete “pipe culverts.”

**Page 2-20, Subarticle 230-4(B), Contractor Furnished Sources, change references as follows:** **Line 1**, replace “(4) Buffer Zone” with “(c) Buffer Zone”; **Line 12**, replace “(5) Evaluation for Potential Wetlands and Endangered Species” with “(d) Evaluation for Potential Wetlands and Endangered Species”; and **Line 33**, replace “(6) Approval” with “(4) Approval”.

**Division 3**

**Page 3-1, after line 15, Article 300-2 Materials**, replace “1032-9(F)” with “1032-6(F)”.

**Division 4**

**Page 4-77, line 27, Subarticle 452-3(C) Concrete Coping**, replace “sheet pile” with “reinforcement”.

**Division 6**

**Page 6-7, line 31, Article 609-3 Field Verification of Mixture and Job Mix Formula Adjustments**, replace “30” with “45”.

**Page 6-10, line 42, Subarticle 609-6(C)(2)**, replace “Subarticle 609-6(E)” with “Subarticle 609-6(D)”.

**Page 6-11, Table 609-1 Control Limits**, replace “Max. Spec. Limit” for the Target Source of  $P_{0.075}/P_{be}$  Ratio with “1.0”.

**Page 6-40, Article 650-2 Materials**, replace “Subarticle 1012-1(F)” with “Subarticle 1012-1(E)”

**Division 7**

**Page 7-1, Article 700-3, CONCRETE HAULING EQUIPMENT**, line 33, replace “competition” with “completion”.

**Division 8**

**Page 8-23, line 10, Article 838-2 Materials**, replace “Portland Cement Concrete, Class B” with “Portland Cement Concrete, Class A”.

**Division 10**

**Page 10-166, Article 1081-3 Hot Bitumen**, replace “Table 1081-16” with “Table 1081-2”, replace “Table 1081-17” with “Table 1081-3”, and replace “Table 1081-18” with “Table 1081-4”.

**Division 12**

**Page 12-7, Table 1205-3**, add “FOR THERMOPLASTIC” to the end of the title.

**Page 12-8, Subarticle 1205-5(B), line 13**, replace “Table 1205-2” with “Table 1205-4”.

**Page 12-8, Table 1205-4 and 1205-5**, replace “THERMOPLASTIC” in the title of these tables with “POLYUREA”.

**Page 12-9, Subarticle 1205-6(B), line 21**, replace “Table 1205-4” with “Table 1205-6”.

**Page 12-11, Subarticle 1205-8(C), line 25**, replace “Table 1205-5” with “Table 1205-7”.

**Division 15**

**Page 15-4, Subarticle 1505-3(F) Backfilling, line 26**, replace “Subarticle 235-4(C)” with “Subarticle 235-3(C)”.

**Page 15-6, Subarticle 1510-3(B), after line 21**, replace the allowable leakage formula with the following:  $W=LD\sqrt{P} \div 148,000$

**Page 15-6, Subarticle 1510-3(B), line 32**, delete “may be performed concurrently or” and replace with “shall be performed”.

**Page 15-17, Subarticle 1540-3(E), line 27**, delete “Type 1”.

**Division 17**

**Page 17-26, line 42, Subarticle 1731-3(D) Termination and Splicing within Interconnect Center**, delete this subarticle.

Revise the *2012 Roadway Standard Drawings* as follows:

**1633.01 Sheet 1 of 1, English Standard Drawing for Matting Installation**, replace “1633.01” with “1631.01”.

**STANDARD SPECIAL PROVISION****PLANT AND PEST QUARANTINES****(Imported Fire Ant, Gypsy Moth, Witchweed, And Other Noxious Weeds)**

(3-18-03) (Rev. 10-15-13)

Z-04a

**Within Quarantined Area**

This project may be within a county regulated for plant and/or pests. If the project or any part of the Contractor's operations is located within a quarantined area, thoroughly clean all equipment prior to moving out of the quarantined area. Comply with federal/state regulations by obtaining a certificate or limited permit for any regulated article moving from the quarantined area.

**Originating in a Quarantined County**

Obtain a certificate or limited permit issued by the N.C. Department of Agriculture/United States Department of Agriculture. Have the certificate or limited permit accompany the article when it arrives at the project site.

**Contact**

Contact the N.C. Department of Agriculture/United States Department of Agriculture at 1-800-206-9333, 919-733-6932, or <http://www.ncagr.gov/plantind/> to determine those specific project sites located in the quarantined area or for any regulated article used on this project originating in a quarantined county.

**Regulated Articles Include**

1. Soil, sand, gravel, compost, peat, humus, muck, and decomposed manure, separately or with other articles. This includes movement of articles listed above that may be associated with cut/waste, ditch pulling, and shoulder cutting.
2. Plants with roots including grass sod.
3. Plant crowns and roots.
4. Bulbs, corms, rhizomes, and tubers of ornamental plants.
5. Hay, straw, fodder, and plant litter of any kind.
6. Clearing and grubbing debris.
7. Used agricultural cultivating and harvesting equipment.
8. Used earth-moving equipment.
9. Any other products, articles, or means of conveyance, of any character, if determined by an inspector to present a hazard of spreading imported fire ant, gypsy moth, witchweed or other noxious weeds.

**STANDARD SPECIAL PROVISION****AWARD OF CONTRACT**

(6-28-77)

Z-6

“The North Carolina Department of Transportation, in accordance with the provisions of *Title VI of the Civil Rights Act of 1964* (78 Stat. 252) and the Regulations of the Department of Transportation (*49 C.F.R., Part 21*), issued pursuant to such act, hereby notifies all bidders that it will affirmatively insure that the contract entered into pursuant to this advertisement will be awarded to the lowest responsible bidder without discrimination on the ground of race, color, or national origin”.

**STANDARD SPECIAL PROVISION****MINORITY AND FEMALE EMPLOYMENT REQUIREMENTS**

Z-7

**NOTICE OF REQUIREMENTS FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY (*EXECUTIVE NUMBER 11246*)**

1. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, see as shown on the attached sheet entitled "Employment Goals for Minority and Female participation".

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and nonfederally involved construction.

The Contractor's compliance with the Executive Order and the regulations in *41 CFR Part 60-4* shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in *41 CFR 60-4.3(a)*, and its effort to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project or the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the executive Order and the regulations in *41 CFR Part 60-4*. Compliance with the goals will be measured against the total work hours performed.

2. As used in this Notice and in the contract resulting from this solicitation, the "covered area" is the county or counties shown on the cover sheet of the proposal form and contract.

**EMPLOYMENT GOALS FOR MINORITY  
AND FEMALE PARTICIPATION**

Economic Areas

**Area 023 29.7%**

Bertie County  
Camden County  
Chowan County  
Gates County  
Hertford County  
Pasquotank County  
Perquimans County

**Area 024 31.7%**

Beaufort County  
Carteret County  
Craven County  
Dare County  
Edgecombe County  
Green County  
Halifax County  
Hyde County  
Jones County  
Lenoir County  
Martin County  
Nash County  
Northampton County  
Pamlico County  
Pitt County  
Tyrrell County  
Washington County  
Wayne County  
Wilson County

**Area 025 23.5%**

Columbus County  
Duplin County  
Onslow County  
Pender County

**Area 026 33.5%**

Bladen County  
Hoke County  
Richmond County  
Robeson County  
Sampson County  
Scotland County

**Area 027 24.7%**

Chatham County  
Franklin County  
Granville County  
Harnett County  
Johnston County  
Lee County  
Person County  
Vance County  
Warren County

**Area 028 15.5%**

Alleghany County  
Ashe County  
Caswell County  
Davie County  
Montgomery County  
Moore County  
Rockingham County  
Surry County  
Watauga County  
Wilkes County

**Area 029 15.7%**

Alexander County  
Anson County  
Burke County  
Cabarrus County  
Caldwell County  
Catawba County  
Cleveland County  
Iredell County  
Lincoln County  
Polk County  
Rowan County  
Rutherford County  
Stanly County

**Area 0480 8.5%**

Buncombe County  
Madison County

**Area 030 6.3%**

Avery County  
Cherokee County  
Clay County  
Graham County  
Haywood County  
Henderson County  
Jackson County  
McDowell County  
Macon County  
Mitchell County  
Swain County  
Transylvania County  
Yancey County

SMSA Areas

Area 5720 26.6%

Currituck County

Area 9200 20.7%

Brunswick County  
New Hanover County

Area 2560 24.2%

Cumberland County

Area 6640 22.8%

Durham County  
Orange County  
Wake County

Area 1300 16.2%

Alamance County

Area 3120 16.4%

Davidson County  
Forsyth County  
Guilford County  
Randolph County  
Stokes County  
Yadkin County

Area 1520 18.3%

Gaston County  
Mecklenburg County  
Union County

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Goals for Female

Participation in Each Trade

(Statewide) 6.9%

**STANDARD SPECIAL PROVISION****REQUIRED CONTRACT PROVISIONS FEDERAL - AID CONSTRUCTION CONTRACTS**

FHWA - 1273 Electronic Version - May 1, 2012

Z-8

- I. General
- II. Nondiscrimination
- III. Nonsegregated Facilities
- IV. Davis-Bacon and Related Act Provisions
- V. Contract Work Hours and Safety Standards Act Provisions
- VI. Subletting or Assigning the Contract
- VII. Safety: Accident Prevention
- VIII. False Statements Concerning Highway Projects
- IX. Implementation of Clean Air Act and Federal Water Pollution Control Act
- X. Compliance with Governmentwide Suspension and Debarment Requirements
- XI. Certification Regarding Use of Contract Funds for Lobbying

**ATTACHMENTS**

- A. Employment and Materials Preference for Appalachian Development Highway System or Appalachian Local Access Road Contracts (included in Appalachian contracts only)

**I. GENERAL**

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).  
The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.  
Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.  
Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).
2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.
3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.
4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

**II. NONDISCRIMINATION**

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of \$10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding \$10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. **Equal Employment Opportunity:** Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are



incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

- a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.
  - b. The contractor will accept as its operating policy the following statement:  
"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."
2. **EEO Officer:** The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.
  3. **Dissemination of Policy:** All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:
    - a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.
    - b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.
    - c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.
    - d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.
    - e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.
  4. **Recruitment:** When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.
    - a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.
    - b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.
    - c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.
  5. **Personnel Actions:** Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:
    - a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.
    - b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.
    - c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.
    - d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.
  6. **Training and Promotion:**
    - a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.
    - b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).
    - c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.
    - d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. **Unions:** If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:
  - a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.
  - b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.
  - c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.
  - d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.
8. **Reasonable Accommodation for Applicants / Employees with Disabilities:** The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.
9. **Selection of Subcontractors, Procurement of Materials and Leasing of Equipment:** The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.
  - a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.
  - b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.
10. **Assurance Required by 49 CFR 26.13(b):**
  - a. The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.
  - b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.
11. **Records and Reports:** The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.
  - a. The records kept by the contractor shall document the following:
    - (1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;
    - (2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and
    - (3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;
  - b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

### III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of \$10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

### IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding \$2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 "Contract provisions and related matters" with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

#### 1. Minimum wages

- a. All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the

Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.d. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph 1.b. of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

- b. (1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:
    - (i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and
    - (ii) The classification is utilized in the area by the construction industry; and
    - (iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.
  - (2) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
  - (3) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. The Wage and Hour Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
  - (4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.
  - c. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.
  - d. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.
2. **Withholding.** The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.
3. **Payrolls and basic records**
- a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.
  - b. (1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the

payrolls shall only need to include an individually identifying number for each employee ( e.g. , the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/esa/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency.

- (2) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:
- (i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;
  - (ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;
  - (iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.
- (3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.
- (4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.
- c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.
- 4. Apprentices and trainees**
- a. Apprentices (programs of the USDOL). Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice.
- The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.
- Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.
- In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.
- b. Trainees (programs of the USDOL). Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.
- The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.
- Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

- In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.
- c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.
  - d. Apprentices and Trainees (programs of the U.S. DOT). Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.
5. **Compliance with Copeland Act requirements.** The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.
  6. **Subcontracts.** The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.
  7. **Contract termination:** debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.
  8. **Compliance with Davis-Bacon and Related Act requirements.** All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.
  9. **Disputes concerning labor standards.** Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.
  10. **Certification of eligibility.**
    - a. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
    - b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
    - c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

#### V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. **Overtime requirements.** No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.
2. **Violation; liability for unpaid wages; liquidated damages.** In the event of any violation of the clause set forth in paragraph (1.) of this section, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1.) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1.) of this section.
3. **Withholding for unpaid wages and liquidated damages.** The FHWA or the contacting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2.) of this section.
4. **Subcontracts.** The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1.) through (4.) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1.) through (4.) of this section.

#### VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).
  - a. The term "perform work with its own organization" refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions:
    - (1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;

- (2) the prime contractor remains responsible for the quality of the work of the leased employees;
  - (3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and
  - (4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.
- b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.
2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.
  3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.
  4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.
  5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

#### **VII. SAFETY: ACCIDENT PREVENTION**

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.
2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).
3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

#### **VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS**

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

#### **IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT**

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

**X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION**

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost \$25,000 or more – as defined in 2 CFR Parts 180 and 1200.

**1. Instructions for Certification – First Tier Participants:**

- a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.
- b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.
- c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.
- d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
- e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).
- f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.
- g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the \$25,000 threshold.
- h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (<https://www.epls.gov/>), which is compiled by the General Services Administration.
- i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
- j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

\* \* \* \* \*

**2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:**

- a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:
  - (1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;
  - (2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
  - (3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and
  - (4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.
- b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

**2. Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost \$25,000 or more - 2 CFR Parts 180 and 1200)

- a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.
- b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

- c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.
- d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contractor). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).
- e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.
- f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the \$25,000 threshold.
- g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (<https://www.epls.gov/>), which is compiled by the General Services Administration.
- h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
- i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

\* \* \* \* \*

**Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:**

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.
2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

\* \* \* \* \*

**XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING**

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed \$100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:
  - a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
  - b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.
3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed \$100,000 and that all such recipients shall certify and disclose accordingly.



**STANDARD SPECIAL PROVISION****ON-THE-JOB TRAINING**

(10-16-07) (Rev. 4-21-15)

Z-10

**Description**

The North Carolina Department of Transportation will administer a custom version of the Federal On-the-Job Training (OJT) Program, commonly referred to as the Alternate OJT Program. All contractors (existing and newcomers) will be automatically placed in the Alternate Program. Standard OJT requirements typically associated with individual projects will no longer be applied at the project level. Instead, these requirements will be applicable on an annual basis for each contractor administered by the OJT Program Manager.

On the Job Training shall meet the requirements of 23 CFR 230.107 (b), 23 USC – Section 140, this provision and the On-the-Job Training Program Manual.

The Alternate OJT Program will allow a contractor to train employees on Federal, State and privately funded projects located in North Carolina. However, priority shall be given to training employees on NCDOT Federal-Aid funded projects.

**Minorities and Women**

Developing, training and upgrading of minorities and women toward journeyman level status is a primary objective of this special training provision. Accordingly, the Contractor shall make every effort to enroll minority and women as trainees to the extent that such persons are available within a reasonable area of recruitment. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

**Assigning Training Goals**

The Department, through the OJT Program Manager, will assign training goals for a calendar year based on the contractors' past three years' activity and the contractors' anticipated upcoming year's activity with the Department. At the beginning of each year, all contractors eligible will be contacted by the Department to determine the number of trainees that will be assigned for the upcoming calendar year. At that time the Contractor shall enter into an agreement with the Department to provide a self-imposed on-the-job training program for the calendar year. This agreement will include a specific number of annual training goals agreed to by both parties. The number of training assignments may range from 1 to 15 per contractor per calendar year. The Contractor shall sign an agreement to fulfill their annual goal for the year.\

**Training Classifications**

The Contractor shall provide on-the-job training aimed at developing full journeyman level workers in the construction craft/operator positions. Preference shall be given to providing training in the following skilled work classifications:

Equipment Operators	Office Engineers
Truck Drivers	Estimators
Carpenters	Iron / Reinforcing Steel Workers
Concrete Finishers	Mechanics
Pipe Layers	Welders

The Department has established common training classifications and their respective training requirements that may be used by the contractors. However, the classifications established are not all-inclusive. Where the training is oriented toward construction applications, training will be allowed in lower-level management positions such as office engineers and estimators. Contractors shall submit new classifications for specific job functions that their employees are performing. The Department will review and recommend for acceptance to FHWA the new classifications proposed by contractors, if applicable. New classifications shall meet the following requirements:

Proposed training classifications are reasonable and realistic based on the job skill classification needs, and

The number of training hours specified in the training classification is consistent with common practices and provides enough time for the trainee to obtain journeyman level status.

The Contractor may allow trainees to be trained by a subcontractor provided that the Contractor retains primary responsibility for meeting the training and this provision is made applicable to the subcontract. However, only the Contractor will receive credit towards the annual goal for the trainee.

Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. The number of trainees shall be distributed among the work classifications on the basis of the contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment.

No employee shall be employed as a trainee in any classification in which they have successfully completed a training course leading to journeyman level status or in which they have been employed as a journeyman.

**Records and Reports**

The Contractor shall maintain enrollment, monthly and completion reports documenting company compliance under these contract documents. These documents and any other information as requested shall be submitted to the OJT Program Manager.

Upon completion and graduation of the program, the Contractor shall provide each trainee with a certification Certificate showing the type and length of training satisfactorily completed.

**Trainee Interviews**

All trainees enrolled in the program will receive an initial and Trainee/Post graduate interview conducted by the OJT program staff.

**Trainee Wages**

Contractors shall compensate trainees on a graduating pay scale based upon a percentage of the prevailing minimum journeyman wages (Davis-Bacon Act). Minimum pay shall be as follows:

60 percent	of the journeyman wage for the first half of the training period
75 percent	of the journeyman wage for the third quarter of the training period
90 percent	of the journeyman wage for the last quarter of the training period

In no instance shall a trainee be paid less than the local minimum wage. The Contractor shall adhere to the minimum hourly wage rate that will satisfy both the NC Department of Labor (NCDOL) and the Department.

**Achieving or Failing to Meet Training Goals**

The Contractor will be credited for each trainee employed by him on the contract work who is currently enrolled or becomes enrolled in an approved program and who receives training for at least 50 percent of the specific program requirement. Trainees will be allowed to be transferred between projects if required by the Contractor's scheduled workload to meet training goals.

If a contractor fails to attain their training assignments for the calendar year, they may be taken off the NCDOT's Bidders List.

**Measurement and Payment**

No compensation will be made for providing required training in accordance with these contract documents.

**STANDARD SPECIAL PROVISION**  
**MINIMUM WAGES**  
**GENERAL DECISION NC150101 01/23/2015 NC101**

Z-101

Date: January 23, 2015

General Decision Number: NC150101 01/23/2015 NC101

Superseded General Decision Numbers: NC20140101

State: North Carolina

Construction Type: HIGHWAY

**COUNTIES:**

Alamance	Forsyth	Randolph
Anson	Gaston	Rockingham
Cabarrus	Guilford	Stokes
Chatham	Mecklenburg	Union
Davie	Orange	Yadkin
Durham	Person	

HIGHWAY CONSTRUCTION PROJECTS (excluding tunnels, building structures in rest area projects & railroad construction; bascule, suspension & spandrel arch bridges designed for commercial navigation, bridges involving marine construction; and other major bridges).

Note: Executive Order (EO) 13658 establishes an hourly minimum wage of \$10.10 for 2015 that applies to all contracts subject to the Davis-Bacon Act for which the solicitation is issued on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.10 (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract. The EO minimum wage rate will be adjusted annually. Additional information on contractor requirements and worker protections under the EO is available at [www.dol.gov/whd/govcontracts](http://www.dol.gov/whd/govcontracts).

Modification Number

Publication Date

0

01/02/2015

1

01/23/2015

SUNC2014-003 11/14/2014

	Rates	Fringes
BLASTER	18.64	
CARPENTER	13.68	.05
CEMENT MASON/CONCRETE FINISHER	13.93	
ELECTRICIAN		
Electrician	18.79	2.72

	Rates	Fringes
Telecommunications Technician	15.19	1.25
<b>IRONWORKER</b>	13.30	
<b>LABORER</b>		
Asphalt Raker and Spreader	12.78	
Asphalt Screed/Jackman	14.50	
Carpenter Tender	12.51	.27
Cement Mason/Concrete Finisher Tender	11.04	
Common or General	10.40	.01
Guardrail/Fence Installer	13.22	
Pipelayer	12.43	
Traffic Signal/Lighting Installer	15.65	.24
<b>PAINTER</b>		
Bridge	23.77	
<b>POWER EQUIPMENT OPERATORS</b>		
Asphalt Broom Tractor	10.00	
Bulldozer Fine	16.13	
Bulldozer Rough	14.36	
Concrete Grinder/Groover	17.92	
Crane Boom Trucks	18.19	
Crane Other	19.83	
Crane Rough/All-Terrain	19.10	
Drill Operator Rock	14.28	
Drill Operator Structure	20.89	
Excavator Fine	16.95	
Excavator Rough	13.63	
Grader/Blade Fine	19.84	
Grader/Blade Rough	15.47	
Loader 2 Cubic Yards or Less	13.31	
Loader Greater Than 2 Cubic Yards	16.19	
Material Transfer Vehicle (Shuttle Buggy)	15.44	
Mechanic	17.51	
Milling Machine	15.22	
Off-Road Hauler/Water Tanker	11.83	
Oiler/Greaser	14.16	
Pavement Marking Equipment	12.05	
Paver Asphalt	15.97	
Paver Concrete	18.20	
Roller Asphalt Breakdown	12.79	
Roller Asphalt Finish	13.76	
Roller Other	12.08	
Scraper Finish	12.65	
Scraper Rough	11.50	
Slip Form Machine	19.60	
Tack Truck/Distributor Operator	14.82	

	Rates	Fringes
TRUCK DRIVER		
GVWR of 26,000 Lbs or Greater	11.45	
GVWR of 26,000 Lbs or Less	13.57	.03

Welders – Receive rate prescribed for craft performing operation to which welding is incidental.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29 CFR 5.5(a)(1)(ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

#### Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or "UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

#### Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

### Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

### WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- \* an existing published wage determination
- \* a survey underlying a wage determination
- \* a Wage and Hour Division letter setting forth a position on a wage determination matter
- \* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations  
Wage and Hour Division  
U. S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, D.C. 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, D.C. 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board  
U.S. Department of Labor  
200 Constitution Avenue, N.W.  
Washington, D.C. 20210

4.) All decisions by the Administrative Review Board are final.

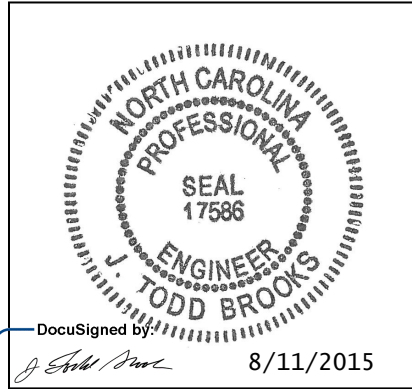
END OF GENERAL DECISION



C-5558

ITS-1

Guilford County



**PROJECT SPECIAL PROVISIONS**  
**City Of High Point Traffic Signal System**  
**Upgrade/Expansion Project**

**N.C. Project No. C-5558 (WBS # 55063.3.FI)**  
**F.A. Project No. CMS-0710(29)**

*Based On*  
**NCDOT ITS and Signals Project Special Provisions**  
*Version 12.4*

8E5B7B60A2A2466...  
 Prepared by:

**ATKINS**

1616 East Millbrook Road, Suite 310  
 Raleigh, NC 27609 • NCBEES # F-0326

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## 1. GENERAL REQUIREMENTS

### 1.1. DESCRIPTION

#### (A) Summary of Work

The purpose of this project is to rehabilitate and expand the existing City of High Point, North Carolina's computerized traffic signal system. Work will be primarily comprised of communications system replacement and expansion, field equipment upgrades, replacement of the existing CLMATSTM closed-loop traffic signal system with a new distributed processing traffic control system, enhancement of the Traffic Operations Center (TOC), and the expansion of the video monitoring system. This project includes:

- Signal display upgrades at selected locations and replacement of existing controllers and cabinets with new Model 2070E controllers housed in Model 332 or 336S cabinets for 218 signalized intersections;
- Incorporating into the system 7 existing signalized intersections that will already have Model 2070E controllers and Type 332 cabinets;
- Replacement of an existing single-mode fiber-optic serial communications system with a new Ethernet-based, fault-tolerant, fiber-optic communications system comprised of approximately 87 roadway miles of fiber-optic cable (84 miles installed under this project, C-5558 + 3 miles installed by others under NCDOT U-3615B);
- Upgrading and expanding the existing video monitoring system by replacing 37 existing analog CCTV cameras and analog video switch with new digital equipment, adding 17 new digital camera locations (54 total locations), and replacing the central video equipment and software; and
- Replacing the existing closed-loop signal system software and central computers with new distributed processing software and new computer workstations and servers.

All of the existing NEMA controllers and cabinets are to be replaced with Model 2070E controllers in Type 332 or 336S cabinets under this project. Existing 2070L controllers and their Type 332/336S cabinets will be replaced with new 2070E controllers and new Type 332/336S cabinets (2012 NCDOT *Standard Specification* models). Existing 2070E controllers and their cabinets will be retained. There are two existing, independent closed-loop systems that will be incorporated into the expanded and upgraded High Point Signal system as follows:

- NC 62 (Liberty Road) between the I-85 Northbound and Southbound Ramps - The existing closed-loop system consisting of two signals with existing Model 2070L controllers in Type 332/336S cabinets linked by existing fiber-optic communications cable and fiber-optic transceivers will be replaced with new Model 2070E controllers, Ethernet edge switches, controller cabinets and fiber-optic communications cable.
- Skeet Club between Johnson Street and Oak Hollow Shopping Center Entrance - This closed-loop system being installed by others under State Project U-3615B will consist of seven signals with existing Model 2070E controllers in Type 332/336S cabinets linked by existing fiber-optic communications cable and fiber-optic transceivers. The fiber-optic transceivers will be replaced with Ethernet edge switches but the existing

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2070E controllers and their cabinets along with the fiber-optic communications cable will be retained.

Currently, there are another five existing standalone (i.e., isolated) signals with 2070L controllers and cabinets that will be brought into the expanded signal system by extending new fiber-optic communications cable to these intersections and replacing the existing equipment with new 2070E controllers, Ethernet edge switches and controller cabinets.

New fiber-optic communications cable will be installed primarily by overlashing to the existing fiber-optic communications cable but also by lashing to new messenger cable, installing in existing underground conduit/duct systems, and installing in new underground conduit/duct systems. To migrate from the existing to the new communications system while minimizing disruptions to signal system operations, the existing fiber-optic communications system will be progressively decommissioned as the new Ethernet-based fiber-optic communications system is built-out and brought online.

Provide a complete, fully functional, and fully integrated traffic signal system, video surveillance system, and Ethernet communications system. Perform the following major tasks under this contract, as shown in the Plans (the list that follows is not meant to be all-inclusive):

- Furnish and install a new Ethernet-based fiber-optic communications system for the traffic signal system comprised of fiber-optic cable, fiber-optic drop cables, and fiber-optic splice centers (i.e., splice enclosures, interconnect centers, etc.), Ethernet switches and related electronics;
- Furnish and install underground conduit/duct, junction boxes, risers with heat shrink tubing, risers with weatherheads, messenger cable, fiber-optic cable storage guides, wood poles, and pole guy assemblies with guy guards;
- Furnish and install managed Ethernet core switch, Ethernet distribution switch and Ethernet edge switches;
- Furnish and install new traffic signal controllers and cabinets with ancillary equipment, extending existing field wiring as necessary;
- Modify existing cabinet foundations and install new cabinet foundations;
- Upgrade existing traffic signal displays;
- Remove existing control equipment and cabinets;
- Remove existing fiber-optic communications cable, including associated risers, splice cabinets and junction boxes, where designated in the Plans;
- Furnish and install detector loops, junction boxes, and lead-in cables;
- Furnish and install signal cable;
- Furnish and install CCTV camera assemblies and CCTV cabinets;
- Furnish and install digital video encoders;
- Modify existing electrical services and install new electrical services and associated grounding;
- Fully integrate all components into a fully-functioning Ethernet-based, fiber-optic communications network;
- Fully integrate all traffic signal controllers, system detectors, software, computers and servers into a fully functioning distributed processing traffic control system; and
- Fully integrate all CCTV cameras, video components and software into a fully functioning video monitoring system.



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Traffic signals and fiber-optic communications cable being installed by others under separate but concurrent NCDOT TIP and City road/intersection improvement contracts will ultimately be integrated (by others) into the upgraded and expanded High Point Signal System. These concurrent projects include but may not be limited to the following:

NCDOT TIP Projects:

- Skeet Club Road – from Johnson Street to NC 68 - Eastchester Drive (U-3615B)

City of High Point Projects:

- N. Main Street at Lexington Avenue signal upgrade
- N. Centennial Street at Montlieu Avenue signal upgrade

In addition to these NCDOT and City projects, there may be private developer projects constructed by others that modify existing or add new traffic signals and that include associated communications cable work. Possible concurrent private developer projects include but are not limited to the following intersections:

- 07-0752 – N. Main Street at Old Winston Road/Oxford Place
- 07-1323 – Greensboro Road/W. Main Street at Penny Road

While some of the traffic signal work on the above projects may be complete by the time construction begins on this signal system project, some work may still be ongoing when signal system construction begins. Contractors for different traffic signal projects who are working within the same area shall coordinate and cooperate with each other. Each contractor shall conduct his work so as not to interfere with or hinder the progress of the work being performed by the other contractors.

**(B) Specifications and Special Provisions**

Conform to these Project Special Provisions and the North Carolina Department of Transportation (NCDOT) *Standard Specifications for Roads and Structures*, dated January 2012, hereinafter referred to as the “*Standard Specifications*.” Conform to the Codes and Regulations described in Section 1700 of the *Standard Specifications*.

Within these Project Special Provisions, the “Department” refers to the North Carolina Department of Transportation, and the “City” refers to the City of High Point’s Transportation Department.

**(C) Coordination of Plans, Specifications, and Special Provisions**

The *Standard Specifications*, the Plans and these Project Special Provisions are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are complementary and provide and describe the complete contract. In case of a discrepancy or conflict, the following will apply in ascending order:

- Calculated dimensions shall govern over scaled dimensions;
- Supplemental Specifications shall govern over *Standard Specifications*;
- Plans shall govern over Supplemental Specifications, *Standard Specifications* and *Roadway Standard Drawings*;

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- Project Special Provisions shall govern over Standard Special Provisions, Plans, *Standard Specifications*, Supplemental Specifications and *Roadway Standard Drawings*.

In the event of a contradiction within the Project Special Provisions as to the measurement and payment of any pay item, the text of the respective Measurement and Payment subsection for the pay item in question shall govern.

The Contractor shall not take advantage of any apparent error or omission in the contract. In the event such errors or omissions are discovered, the Engineer will make such corrections and interpretations as may be determined necessary for the fulfillment of the intent of the contract.

**(D) Proposed Street Name Changes**

Changes to the names of some streets in the project area have been proposed and may be implemented before or during signal system construction. The Plans and these Project Special Provisions use only the existing street names. Coordinate with the City of High Point regarding any changes to names of streets labeled in the Plans and mentioned in these Project Special Provisions. Proposed street name changes include but may not be limited to the following:

Current Name	Proposed Name
Kivett Drive	Martin L. King, Jr. Drive
College Drive (from Main Street to Surrett Drive only)	University Parkway

**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.

2012 ITS and Signals Qualified Products List (QPL) is available on the North Carolina Department of Transportation's website at the following address:

<https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals-Qualified-Products.aspx>

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) Submittal Requirements**

Furnish a Type 3 material certification in accordance with Article 106-3 of the *Standard Specifications*. 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.

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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 or electrical 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 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.

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

Refer to the "Submittal Data and Documentation" section of these Project Special Provisions for additional submittal requirements.

**(C) Observation Period**

Prior to final acceptance, all Contractor-furnished equipment and software shall successfully complete a 60-day Observation Period.

The 60-day Observation Period is considered to be part of the work included in the total contract time and must be completed prior to final acceptance of the project.

Final acceptance will occur following the successful completion of the 60-day Observation Period and after all documentation requirements have been fully satisfied.

Refer to the "Testing and Acceptance" section of these Project Special Provisions for additional requirements.

**(D) Warranties**

Unless otherwise required herein, provide manufacturer's warranties on Contractor-furnished equipment for material and workmanship that are customarily issued by the equipment manufacturer or that are at least one year in length, whichever is greater, from the date of final acceptance of the project by the Department. Include unconditional coverage for all parts and labor necessary or incidental to repair of defective equipment or workmanship and malfunctions that arise during warranty period.

For light emitting diode (LED) traffic signal modules, provide a written warranty against defects in materials and workmanship 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 Department.

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 and will support user-definable parameters for setting the start and end dates for daylight savings time.

Upon receipt of the Department's written final acceptance of project, transfer manufacturer's warranties with proper validation by the manufacturer to the Department and the City. Provide

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warranties in the names of both the North Carolina Department of Transportation and the City of High Point.

**(E) Firmware Licensing and Upgrades**

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

Ensure software/firmware performance upgrades that occur during the contract period up through final acceptance of the project are furnished to the Department at no additional cost.

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

Provide licensed copies of all software/firmware to the Department for any programmable devices furnished by the Contractor and installed under this project for which licensed software has not already been provided by the City and the Department. The Department shall have the right to install any and all software/firmware for maintenance and support on all hardware provided under this contract. This shall include but not be limited to all servers for the Signal System, CCTV System, LAN System, traffic signal controllers and network. Provide software/firmware for maintenance and support of workstations, laptop computers, system support software, utility software, traffic signal controllers, and CCTV systems and controllers, and all other programmable devices.

**(F) 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.

**(G) Painting**

Where painting of signal heads, signal poles, and pedestals 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 and to the weatherhead and camera mounting plate. For the aforementioned unfinished components that require field painting, prepare the surface to receive the paint in accordance with the coating manufacturer's instructions, including application of primer.

**(H) Performance of Warranty Repair and Maintenance**

Provide authorization to the Traffic Electronics Center of the North Carolina Department of Transportation (NCDOT) to perform all warranty repairs after project acceptance. The decision to perform warranty work at the Traffic Electronics Center by NCDOT electronics technicians or to have warranty work performed by the vendor shall be at the discretion of the Department. Provide any training required by the manufacturer to authorize the Traffic Electronics Center to perform warranty work and ensure manufacturer will furnish parts to the Traffic Electronics Center for all warranty repairs at no cost to the Department. In addition, ensure the manufacturer

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agrees to provide prompt technical support to the NCDOT electronics technicians for a period of one year after the end of the warranty period at no cost to the Department. Defective parts replaced under warranty by the Traffic Electronics Center will be returned to the vendor at the vendor's request. Provide schematics, part lists, and other documentation to perform bench repair to the Traffic Electronics Center within 2 weeks upon request. The Department 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 Department, the manufacturer shall perform warranty repairs to equipment which fails during the warranty period at no cost to the Department including freight costs to ship repaired equipment back to the Traffic Electronics Center. Ensure all equipment is repaired and returned to the Traffic Electronics Center within 21 calendar days of receipt by the manufacturer.

### **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.

Identify and label all field wiring (e.g., signal conductors, pushbutton wires, loop detector lead-ins, etc.) in existing controller cabinets prior to disconnecting any field wiring.

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 on the Plans are approximate.

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

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

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

Avoid trimming (i.e., pruning) trees wherever possible. Removal and topping of trees is strictly prohibited. Contact the City's Planning and Development Department at (336) 883-3328 to obtain approval from the City's Urban Forestry Committee for any proposed tree trimming and pruning prior to performing tree trimming. Comply with Article F, "City Tree Conservation," of the High Point Development Ordinance, which may be found online at: <http://www.highpointnc.gov/cityofhighpoint/plan/docs/C7f.pdf> . All tree trimming must be performed by an ISA Certified Arborist Trimming and must conform to ANSI A300 standards.

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In addition, the Contractor must obtain a Minor Work Certificate of Appropriateness from the Historic Resources Commission for any tree trimming or pruning in and around the Johnson Street, Sherrod Park and West High Street Historic Districts. The Contractor will be assessed civil penalties (i.e., fines) for any tree trimming performed in violation of the requirements of the Project Special Provisions and the City's Development Ordinance, including but not limited to work performed by someone other than an ISA Certified Arborist, unauthorized tree trimming, failure to obtain required permit and approvals, excessive tree trimming and tree removal.

**(B) Contractor's Office**

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

**(C) Work within Historic Districts**

Several signalized intersections, some proposed CCTV camera sites and several fiber-optic communications cable routes lie within or adjacent to historic districts. The Department has coordinated with the agencies that have jurisdiction over these historic districts and has received the permits and certificates for the work called for in the Plans in these historic districts. Do not deviate from the work called for in the Plans within a historic district without the prior approval of the Engineer and the agency/agencies that have jurisdiction over the historic district. Where construction work must deviate from the Plans, notify the Engineer in advance so that the Department can request/apply for the appropriate approvals for such changes prior to the Contractor performing work at that location.

Avoid damaging or removing sidewalks and curbs within designated historic districts whenever possible. Do not damage, disturb or remove any existing granite curbs. Where granite curbs conflict with the installation of underground conduit and cable, bore (drill) conduit underneath granite curb. Do not bore through granite curbs. Replace any granite curb damaged due to construction of this project at no cost to the Department or the City. Immediately notify the Engineer and coordinate with the City of High Point's Street Maintenance Division at 336-883-3455 when any existing granite curb is disturbed or damaged by construction of this project. As directed by the Engineer, reset disturbed granite curb and replace damaged granite curb in accordance with the "Existing Granite Curb" subsection below.

Where removal and replacement of concrete sidewalk and concrete curb is unavoidable, replace them with concrete materials that match the finish, appearance and color of the adjacent existing sidewalk as close as technically feasible as determined by the Engineer. Finishes may include but are not limited to water-washed, broom and trowel. The dimensions and the profile (i.e., shape) of the new curbing shall match that of the adjacent existing curbing.

Where removal and replacement of sidewalk constructed of materials other than concrete is unavoidable, notify the Engineer and coordinate with the City of High Point's Director of the Streets Division at 336-734-1550 at least two weeks prior to disturbing the existing sidewalk. Replace the sidewalk with in-kind materials that match the finish, appearance and color of the adjacent existing sidewalk as close as technically feasible as determined by the Engineer and the City's Streets Division Director. If the sidewalk is constructed of materials such as brick, stone or pavers, carefully remove and subsequently reinstall the bricks, stones or pavers using methods approved by the Engineer. Take photographs and make sketches to record the pattern of the existing materials prior to removal. Replace any bricks, stones or pavers damaged due to construction on this project with approved in-kind, matching materials.

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Repair and replacement of existing sidewalk will be measured and paid for in accordance with the "Equipment Cabinet Foundations" section of these Project Special Provisions.

**Complete all repairs with in-kind materials to all sidewalks removed for construction and reopen the repaired and restored sidewalk to pedestrian traffic within five consecutive calendar days following initial removal.** If the Contractor fails to repair and reopen a sidewalk in accordance with these Project Special Provisions within the time frame specified, the Department reserves the right to make the necessary repairs, and all expenses incurred by the Department in making the repairs and restoring the sidewalk will be deducted from payment due the Contractor, plus **\$500 liquidated damage per occasion, per day, or any portion thereof,** until corrected.

For new signal cabinet foundations constructed within historic districts, use concrete tinted to light earth-toned palette to soften the visual impact of the new concrete.

Do not trim, remove or damage tree limbs within historic districts. Hand-lashing of aerial cables to messenger cable may be required in some areas due to overhanging and protruding tree limbs along the cable route.

**(D) Existing Granite Curb**

Replace any granite curb damaged due to construction of this project at no cost to the Department or the City. Immediately notify the Engineer and coordinate with the City of High Point's Street Maintenance Division at 336-883-3455 when any existing granite curb is disturbed or damaged by construction of this project. As directed by the Engineer, reset disturbed granite curb and replace damaged granite curb in accordance with the following City of High Point requirements:

1. Exercise care to remove, store, and resetting granite curb without breaking.
2. During removing and resetting granite curb, use belt slings or slab tongs. Exercise due care to ensure no chipping, breakage or other damage occurs during this process.
3. Prior to removing the granite curb, saw-cut the pavement to full depth for a minimum distance of 6" from the face of the curb for the full length of the curb section being removed.
4. If a concrete or granite gutter exists, remove and reinstall the gutter after the granite curb is reinstalled.
5. Where the granite curb returns into an adjacent street, project the saw cuts on the designated lines to a point where both cuts intersect, unless the Engineer directs otherwise.
6. Excavate the area to required grade.
7. Reset the granite curb so that the top of reset curb aligns with the top of the abutting curb at each end of the reset block and is approximately 6" above the existing asphalt.
8. Reset granite curb on a bed of dry mix 3000 psi concrete (compressive strength of 3000 psi in 28 days), conforming to ASTM M 157-97.
9. Provide a continuous concrete bed that is 12" wide and 4" deep.
10. Before resetting granite curb, install a string line true to the vertical and horizontal alignment.
11. Reset granite curb to new grade.

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12. The maximum gap between blocks should be 1/8".
13. After resetting the granite curb to line and grade, fill the widened area with 3000 psi concrete.
14. Place concrete to a depth of 1.5" below final pavement grade (asphalt pavement), or to finished gutter grade. Place 3000 psi concrete at each joint.
15. Place concrete to a depth of approximately 10", to a width of 6" (3" either side of the joint) and to a thickness of 6".
16. Do not place concrete within 4" of the top of the granite curb.

**(E) Work within the Central Business District (CBD)**

The central business district (CBD) in downtown High Point features a high concentration of businesses (including furniture showrooms, retail stores, restaurants, offices), governmental offices and community services providers, on-street parking lining most curbs, and an extensive sidewalk network. This area is prone to concentrated volumes of vehicular and pedestrian traffic and on-street parking during business hours on weekdays as well as on some weekends due to special events. For the purpose of this project, the CBD is defined as the area in downtown High Point bounded by Lindsay Street, W. Green Drive, S. Elm Street, Grimes Avenue, Park Street, Commerce Avenue, Centennial Street, Kivett Drive, Steele Street, Oakland Street, Montlieu Avenue, Hamilton Street and Parkway Avenue inclusive.

Do not perform any work within this CBD boundary, including along the boundary streets, without prior approval of the Department. Submit to the Department for review and approval two weeks in advance a schedule for proposed work that will require narrowing or closing a lane, road, sidewalk or pedestrian crossing within this area.

**(F) High Point Market**

The twice-yearly High Point Market is the largest furnishings industry trade show in the world and attracts more than 75,000 visitors to High Point during April (Spring Market) and October (Fall Market) each year. Consult the High Point Market website, [www.highpointmarket.org](http://www.highpointmarket.org), for additional information and consult [www.highpointmarket.org/about-market/dates](http://www.highpointmarket.org/about-market/dates) for market dates. The entire High Point metropolitan area experiences tremendous increases in traffic due to the large influx of visitors during Market. A core area in downtown High Point generally defined by College Drive, Hartley Drive, Eastchester Drive, Westchester Drive and Market Center Drive contains the highest concentration of Market showrooms and experiences intense vehicular traffic and extremely large numbers of pedestrians. **From 6:00 AM the Monday before the start of the High Point Market through 8:00 PM the Friday after the end of High Point Market, do not perform ANY construction work or ANY other work that disrupts normal operation of traffic signals, CCTV cameras and the associated communications system inside and including this core area as well as along the following roadways outside this core area:**

- NC 68 (Eastchester Drive)
- Montlieu Avenue
- Triangle Lake Road/Green Drive
- Greensboro Road/Main Street in Jamestown
- US 311/I-74



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- Business 85/US 29-70
- Johnson Street
- Main Street
- Kivett Drive
- Lexington Avenue
- NC 68 (English Road)
- Wendover Avenue
- Hartley Drive

**(G) Special Pedestrian Considerations around College Campuses**

The streets and sidewalks around High Point University and GTCC (Guilford Technical Community Colleges) High Point Campus experience high volumes of pedestrian and bicycle activity when school is in session. Preserving pedestrian and bicycle mobility, including maintaining access to Hi tran bus stops, in these areas may require special, additional measures.

Submit to the Department and City for review and approval two weeks in advance a schedule for proposed work that will require narrowing or closing a lane, road, sidewalk or pedestrian crossing within the following areas:

- High Point University area bounded by and including Montlieu Avenue, Centennial Street, Lexington Avenue and College Drive.
- GTCC High Point Campus area bounded by and including S. Main Street, Ward Avenue, S. Hamilton Street and GTCC Place.

**(H) Regulations and Codes**

Furnish material and workmanship conforming to the *National Electric Code* (NEC), *National Electric Safety Code* (NESC), Underwriters Laboratories (UL), or other listing agencies approved by the North Carolina Department of Insurance, 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 the Plans, all previously referenced specifications, and all applicable local ordinances and regulations before and during all stages of the electrical work.

When required by the local ordinances and governmental agencies, upon completion of the work, have all systems inspected and approved in writing by the authorized governmental electrical inspector for the area. Furnish written certification of the authorized inspector's approval to the Engineer. Inspection by the authorized governmental electrical inspector must neither eliminate nor take the place of the inspections by the Engineer. Upon the Engineer's receipt of written certification and the Contractor's written request for a final inspection of the installations, the Engineer will perform a final inspection.

Where required, conform to ITE, AASHTO, and ASTM standards 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, unless otherwise instructed herein.

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Install meter bases and service disconnects as required by the NESC, NEC, local utility companies, and local ordinances. Install standoffs only when required and approved by the local utility companies. Where a standoff must be used, obtain the local utility company's approval prior to installing the standoff.

**(I) Utility Services**

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

When electrical, telephone, and telecommunication service is not furnished by the Department or the City 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 for Department-owned locations and in the City's name for City-owned locations. Make application for service in the Department's name for Department-owned locations and in the City's name for City-owned locations.

The Department and the City will be responsible for direct payment of monthly utility company usage charges. The Contractor will be responsible for all expenses associated with utility installation costs, hookups, etc.

Coordinate all work involving electrical service with the appropriate electric utility company. Coordinate with the utility company to ascertain the feasibility of installing electrical service at each location before performing any work. Obtain all required local permits before beginning work.

**(J) Maintenance and Repair of Material**

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

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.

Maintain and repair all Contractor-furnished and installed 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. This requirement for maintaining and repairing said equipment shall remain in effect in the event of severe weather (see NOAA National Severe Storms Laboratory website <http://www.nssl.noaa.gov/primer/>) or a natural disaster, including but not limited to floods, winter weather, lightning, damaging winds, hail, tornado, tropical storm or hurricane. Items reused (that are unmodified), such as signal heads, signal cable, local detector loops and lead-in cable, will be maintained by others.

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

**For all failures, malfunctions, damages to equipment, or errors in workmanship affecting signal operation, begin necessary repairs within 4 hours of notification. Complete**

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**repairs within 8 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 equipment furnished by other contractors within the construction limits of separate NCDOT TIP projects and City of High Point projects that have not yet been formally accepted by the Department. Maintenance and repair of equipment within the construction limits of NCDOT TIP projects will be the responsibility of the respective TIP project contractors until the Department's final acceptance of those TIP projects.

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.

Perform maintenance (testing) on all traffic signal conflict monitors every 12 months for the life of the project beginning with the initial test and every 12 months thereafter. Provide initial test date via the manufacturer's certification or via testing prior to installation of the conflict monitor at an intersection. Use ATSI Incorporated Model PCMT-2000 Conflict Monitor Tester or an Engineer approved equivalent. Use a signal conflict monitor tester that is capable of interfacing with an Intel<sup>®</sup>-based notebook computer for input/output. The tester shall test signal conflict monitor displays, timing and voltage functions, and input/output combinations of either true or false conflicts. All outputs shall be in plain English. It shall be possible to generate a hard copy printout or to store the results to a file on computer disc. A "No Faults Detected" indication shall be displayed as appropriate.

Ensure that the signal 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 signal conflict monitor tester is in proper working order before testing any traffic signal conflict monitors. Perform test on each traffic signal conflict monitor per the manufacturer's recommendation. For each traffic signal conflict monitor tested, provide two (2) dated copies of the traffic signal conflict monitor test results: one copy for the Engineer and one copy placed in the traffic signal controller cabinet.

In the event the Contractor fails to perform in accordance with the Plans and Project Special Provisions 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 damages per occasion, per day, or any portion thereof**, until corrected.

**(K) Inspections**

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

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Remove all Department-owned and City-owned signal, CCTV and communications related equipment and material that will not be used. Signal, CCTV and communications equipment and materials to be removed under this project include, but are not limited to: signal controllers and cabinets and the equipment housed therein; signal and lead-in cables; CCTV cameras and mounting brackets; CCTV cabinets and equipment housed therein; CCTV central equipment housed in the City's TOC and City DOT office; poles; splice cabinets; cabinet foundations; junction boxes; messenger cable; communications cable; and guy assemblies.

Assume ownership of removed poles (including stub poles), messenger cable, junction boxes, interconnect cable, communications cable, and supporting hardware. Assume ownership of Department-owned traffic signal controller cabinets removed from locations in Randolph County only, along with all equipment housed inside the removed cabinets (including existing controller and conflict monitor). Return all other Department-owned and City-owned equipment and material as follows:

- Return Department-owned equipment removed from locations in Guilford County between 7:30 a.m. and 2:30 p.m., Monday through Thursday, to the Division 7 Traffic Services Office, located at 4256 Camp Burton Road in McLeansville, North Carolina, 27301, or at a time mutually agreed to by the Contractor, the Engineer and the Division 7 Traffic Signal Supervisor. Contact the Division 7 Traffic Signal Supervisor at (336) 375-5477 in advance of each delivery to schedule a mutually agreed up day and time for delivery of removed materials and equipment.
- Return all other City-owned equipment and material between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the City Signal Shop located in R.V. Moss Traffic Services Center at 3534 Triangle Lake Road (27260). Contact the City to determine which CCTV equipment and material the City wants to retain and deliver the requested equipment to the City. Return all other CCTV equipment and material that the City does not wish to retain to the Department at the Division 7 Traffic Services office at location and times described above.

Label all returned equipment and material to indicate the location from which it was removed. Replace or repair all material lost or damaged during its removal and transit. The Department will deduct the cost of Department-owned and City-owned equipment damaged by the Contractor from money due to the Contractor.

**(M) Water Conservation**

Be advised that the City of High Point may be under water restrictions at the time of construction and that the use of potable water from the City of High Point system for construction activities on this project may be prohibited. As part of ongoing efforts to improve water supply management and promote conservation, permanent water conservation rules that restrict or prohibit the use of potable water from the City's system for work on this project and that apply even when water restrictions are not in effect could be adopted. When preparing a bid for this project, the Contractor shall take into consideration the possibility of water restrictions, including those more restrictive than the ones in force at the time that the bid is prepared. It shall be the Contractor's responsibility to become familiar and comply with the City's water conservation rules and practices at the time of bid and at all times during construction.

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For information and answers to questions concerning the City's conservation efforts and current restrictions, contact the City's Public Services Department at (336) 883-3215. The City of High Point's Water Shortage Management Policy may be at:

[http://www.highpointnc.gov/pubsrv/Water\\_Shortage\\_MGMT\\_Policy.pdf](http://www.highpointnc.gov/pubsrv/Water_Shortage_MGMT_Policy.pdf).

**(N) Railroad Preemption**

Where railroad preemption is required, coordinate all work with the railroad. Do not place signals into operation until signal and railroad company equipment has been interconnected with required railroad-highway crossing devices and railroad preemption is working properly. Ensure preemption sequences begin immediately after activation of train detection. Contact and coordinate with the railroad company to schedule interconnection of the signal to the railroad controller cabinet. Install lead-in cable from the signal controller cabinet to a railroad company furnished and installed lockable junction box. Interconnection will be made by the railroad company. Provide fail-safe operation such that removal of voltage from the railroad side of the isolation relay will initiate the railroad preemption sequence.

Conduct a railroad-highway interconnection preemption inspection for each intersection prior to placing new signal equipment into steady operation. The inspection shall be performed with all appropriate Division, City and Railroad personnel in attendance. The signal shall pass all requirements of the preemption inspection before it can be accepted under the project by the Engineer. The railroad preemption inspection form is available on the NCDOT ITS & Signals Unit website:

<https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx>

The Contractor along with other appropriate personnel shall conduct additional preemption inspections annually as long as the signal is in operation under the Contractor's jurisdiction until the signal is accepted by the Engineer.

**(O) Timing of Signals**

The Contractor shall utilize experienced signal timing personnel to revise existing timings and to implement new timing values.

Modify proposed phasing and timing of existing controllers to accommodate all changes which result from installation of new equipment under this project. Convert and reinstall all existing time-of-day plans, including revisions to offset references from NEMA-type equipment, to function and operate in newly installed 2070E equipment. Coordinate timing work with City staff for converting the existing offset references to new offset references. The Contractor will be responsible for installing the revised offset references once developed through coordination with and with approval of City staff.

Submit requests for intersection timing parameters and data to the Engineer at least three weeks (15 business days) prior to needing them. The City will provide existing intersection and system timing parameters (cycle, split and offset) and available custom graphics. City-supplied intersection and system timing parameters, databases and timing plans will be provided in MS Excel format electronically as portable document format (PDF) files only.

The Contractor shall be responsible for converting City-furnished timing data to OASIS™ - formatted data and for loading all timing data into the controllers and conflict monitors. Submit the converted dat files for review and approval by the City at least two weeks (10 business days)

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prior to scheduled implementation. The City will supply the signal timing parameters (cycle, split and offset) and available custom graphics for any signal requiring phasing changes.

The Department reserves the right to make, or have the Contractor make, field timing adjustments and modifications to coordination and offsets to account for changes in signal phasing and equipment operations necessary for pattern optimization and to eliminate identifiable, potential hazards to the motoring public. The Engineer will notify the Contractor of timing changes made or supply the Contractor with revised timing plans if the Department requires the Contractor to implement the timing changes.

**(P) 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.

Only splice lead-in cables in junction boxes using UL<sup>®</sup>-approved, underground splice connectors or in condulets using gel-filled splice connectors. Splice all other electrical wire and cable (i.e., signal cable, etc.) inside equipment cabinets, cabinet base extenders/adapters, and terminal splice boxes at nickel-plated brass, recessed-screw, barrier-type terminal blocks or using gel-filled splice connectors. Unless specifically allowed, connect no more than two conductors to the same terminal screw. Do not splice any electrical wire or cable other than lead-in cables in junction boxes or condulets.

Maintain color coding of wires through splices.

Protect ends of wire and cable from water and moisture.

Place permanent labels on all wires and cables to clearly identify each one. Use an indelible black ink marker or approved labeling devices to write on the permanent labels when required.

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.

**(Q) Electrical Services and Grounding**

Where electrical services do not include an external electrical service disconnect, modify or replace the electrical service to add an electrical service disconnect and a new grounding electrode system. Comply with the "Electrical Service" section of these Project Special Provisions.

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

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

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Provisions and test requirements. Refer to the “Electrical Service” section of these Project Special Provisions for additional requirements pertaining to grounding of electrical services.

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

Submit a completed Inductive Loop & Grounding Test Form available on the Department’s website. The form is located on the Department’s website at:

<https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx>

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

**(R) Electrical Bonding**

Using an approved termination means, connect a number 14 AWG minimum 19-strand copper conductor (Type THWN) with green insulation to serve as an equipment grounding conductor to metal poles, vehicular and pedestrian signal pedestals, and other metallic components which are not otherwise bonded, through means approved by the Engineer.

**(S) Traffic Signal Activation**

Do not place signal in steady (stop-and-go) mode until inspected and authorized by the Engineer.

**(T) Requirements for Cables Crossing Railroads**

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

**(1) Railroad Crossings**

Application has been made with Norfolk Southern Corporation (NS), North Carolina Railroad Company (NCR), and High Point, Thomasville and Denton Railroad (HPTD) through CSX Transportation, Inc. (CSX) herein called the Railroad Company(ies), for the encroachment agreements necessary under this Contract. Do not commence cable routings over or under railroad-owned facilities until notification and coordination with Engineer and the appropriate Railroad Company has occurred. Install fiber-optic communications cable as shown on the Plans. All work associated with the crossing is to conform to the Railroad Company’s specifications.

For work within NS rights of way, comply with latest approved edition of NCSE-4 (Specifications for Wire, Conduit and Cable Occupations of Norfolk Southern Corporation Property) and NSCE-8 (Specifications for Pipeline Occupancy of Norfolk Southern Corporation Property).

For work within CSX (HPTD) rights of way, comply with the latest approved edition of DESIGN & CONSTRUCTION STANDARD SPECIFICATIONS – Wireline Occupancies.

For work within NCR rights of way, comply with the latest approved edition of NCR Form NCR 101 “Specifications for Wire, Conduit, and Cable Occupations of North Carolina Railroad Company Property.”

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Cable crossings include the following locations:

Plan Sheet	Location	Railroad Company
CRP-6.013	RR Overpass at Market Center Drive east of W. English Road / Crossing # 904 599J & 942 919J	NS/NCRR
CRP-6.022	At-Grade Crossing across Amhurst Avenue near Prospect Street / Crossing # 836 546X	HPTD (thru CSX)
CRP-6.040	At-Grade Crossing across College Drive near Jarrell Street / Crossing # 722 377V	NS
CRP-6.044	At-Grade Crossing across Surrett Drive near Corporation Drive/Eden Terrace / Crossing # 734 253L	NS
CRP-6.118	At-Grade Crossing across Hoskins Street near E. Washington Drive/Gordon Street / Crossing # 722 351T	NS/NCRR
CRP-6.161	RR Underpass at Lindsay Street between High Avenue and Kivett Drive/ Crossing # 722 338E*	NS/NCRR
CRP-6.162 CRP-6.165	RR Underpass at Elm Street between High Avenue and Broad Avenue/ Crossing at Milepost 299 + 1522 ft.**	NS/NCRR
CRP-6.164	RR Underpass at Hamilton Street between High Avenue and Broad Avenue/ Crossing # 722 344H*	NS/NCRR

\* Replacement of existing communication cables in existing bridge-mounted conduits on Lindsay Street and Hamilton Street will be handled under existing agreements as maintenance.

\*\* Existing communication cables in existing bridge-mounted conduits on Elm Street will be abandoned in place (not removed from conduits). The cables will be cut and cable ID markers applied to each end under the existing agreement as maintenance.

## (2) Insurance Requirements

The Department has provided Railroad Protective Liability Insurance to the railroad companies as part of the Department's encroachment agreements with the railroad companies for each of location listed in the table above.

If required by the railroad, pay for railroad personnel to be present when work is performed.

In addition to any other forms of insurance or bonds required under the terms of the Contract and the *Standard Specifications*, take out and keep in force from the commencement of all construction on railroad right-of-way until the final inspection and acceptance of the project by the Engineer, insurance of the following kinds and amount. It is understood that the amounts specified are minimum amounts and that larger amounts may be carried if so desired. Any insurance taken out due to these requirements shall be subject to the approval of the Engineer, and the Railroad Companies as to form and amount. Furnish satisfactory policies prior to beginning of the work on railroad right-of-way.

Refer to the following web links for more specific insurance requirements and requirements for working on the rights-of-way of each railroad company. In the event of a conflict between the requirements of one or more railroad companies and the requirements contained in the Plans or these Project Special Provisions, the requirements of the railroad company shall govern.



**C-5558****ITS-33****Guilford County**Norfolk Southern Corporation:<http://www.nscorp.com/content/nscorp/en/real-estate/customer-resources.html>North Carolina Railroad Company:<http://www.ncrr.com/wp/wp-content/uploads/2011/11/NCR1031.pdf>CSX Transportation, Inc.:[http://www.csx.com/index.cfm/customers/non-freight-services/propertyreal-estate/permitting-utility-installations-and-rights-of-entry/COS\\_Facility\\_Application\\_Information\\_Packet\[1\].pdf](http://www.csx.com/index.cfm/customers/non-freight-services/propertyreal-estate/permitting-utility-installations-and-rights-of-entry/COS_Facility_Application_Information_Packet[1].pdf)**Commercial General Liability Insurance**

Furnish evidence to the Engineer of Contractor's commercial General Liability Insurance coverage with a combined single limit of not less than \$5,000,000 for each occurrence for operations performed on the railroad right-of-way. The Contractor's policy shall name the railroad company(ies) as an additional insured. If any part of the work is sublet, similar insurance in the same amounts and evidence thereof as required of the Prime Contractor shall be provided by or on behalf of the Subcontractor to cover Subcontractor's operations on the railroad right-of-way.

Keep such insurance in force until final inspection of the project, or that portion or portions within the railroad right-of-way, by the Engineer or, in the case of Subcontractors, until the Contractor furnishes a letter to the Engineer stating that the Subcontractor has completed his/her subcontracted work within the railroad right-of-way to Contractor's satisfaction, and that the Contractor will accomplish any additional work necessary on the railroad right-of-way with the Contractor's own forces.

**Termination of Insurance and Policies to be Submitted**

Any insurance policies given hereunder shall cover all Contractor-performed work the Contractor in connection with the work in the introductory paragraph within railroad right-of-way, but shall not be liable for accidents occurring after acceptance of the completed project by the Department. Such policies shall contain a clause requiring 30 days written notice be given to the Engineer and to the appropriate Railroad Company, prior to cancellation or change.

Submit to the Engineer the original and one copy of the Commercial General Liability Policy, one certified duplicate copy of all other policies, and certificates of insurance in an original and two copies as required by these Project Special Provisions.

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

The named insured under the commercial General Liability Insurance Policy is the respective Railroad Company, and the designation of the job site description of work is as follows: All construction on the <<RAILROAD COMPANY>> right-of-way on NCDOT Project No. C-5558 in High Point and Guilford County, North Carolina.

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Provide 72 hours advance notice to Norfolk Southern (NS) in order that flagging service can be arranged and provided. Do not undertake any work within the NS right-of-way until the flagman is at the job site.

Provide a minimum of 7 days advance notice to High Point, Thomasville and Denton Railroad (HPTD) in order that flagging service can be arranged and provided. Provide this advance notice to Mr. Jeff Butler of CSX at 888-631-9085 (alternate contact: Mr. Jody Freeman of CSX at 336-529-9600, if Mr. Butler is not available) to provide this advance notice. Do not undertake any work within the HPTD right-of-way until the flagman is at the job site.

**(4) Delays Caused by Operations of Others**

Neither the Department 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 or the Railroad Company for any inconvenience, delay, or additional cost incurred by the Contractor on account of such operations by others.

**(5) Time Extensions**

No time extensions related to railroad encroachments will be allowed until the related work becomes the controlling factor relative to overall project completion.

**(6) 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.

**(7) Authority of Railroad Engineer**

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

**(8) 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, first submit the method of doing such work to the Railroad Engineer for approval. However, such approval will not relieve the Contractor from liability.

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

**(9) Storage of Materials**

Do not store materials and equipment where they will interfere with railroad operations, nor on the rights-of-way of the Railroad Company without first having obtained permission from the

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Railroad Engineer. Such permission will be with the understanding that the Railroad Company will not be liable or damage to such material and equipment from any cause, and that the Railroad Engineer may move or require the Contractor to move, at the Contractor's expense, such material and equipment.

**(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. Acceptance of the work will be contingent upon final inspection by the Department and by the Railroad Company (if required by the Railroad Company) to determine if the work was completed satisfactorily in a manner acceptable to the Department and the Railroad Company.

**1.4. CONSTRUCTION STAGING/MIGRATION**

**(A) Introduction**

This section addresses the general flow of construction in regards to communications throughout the life of the project. It is essential that the Contractor make every effort to minimize communications downtime to the traffic signals.

Follow the outline of construction described below. Update the construction schedule monthly. Submit a detailed field migration plan (including details of controller cabinet change-outs) and schedule to the Department for review and approval at least two weeks prior to the onset of work, and no later than 60 days after Notice to Proceed. Update the migration plan monthly and submit it at least five business days prior to each monthly construction meeting. Include a detail of controller cabinet change-outs, listing every intersection, existing and future control zone, and existing and future communication zone, and a schedule of the migration. Obtain approval from the Engineer in advance for any deviations from this sequence. Include information explaining how the following situations will be handled:

1. Existing pole-mount cabinet converted to base-mount,
2. Existing cabinet foundation retained,
3. Base-mount cabinet on new foundation,
4. Installation and splicing of fiber-optic drop cable assemblies,
5. Installation of drop cable assemblies into risers with existing fiber-optic cable,
6. Reel-to-reel splice locations,
7. Transitioning the City's existing Peek CLMATS<sup>®</sup> closed-loop system over to the new signal system software, changing out the controllers and switching from the existing serial fiber-optic communications system to a new Ethernet-based fiber-optic communications network,
8. Removal of existing fiber-optic communications cable once a controller cabinet has been changed out;
9. Removal of existing fiber-optic communications cable followed by installation of new fiber-optic communications cable in the existing underground conduit system in downtown High Point; and
10. How to coordinate with others at the time new cabinets are set to make the necessary signal changes at the TOC to get the controller online.

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Submit a System Design Report to the Engineer for Department review and approval prior to beginning any migration from the existing signal system and communications system to the new signal system and new Ethernet communications system. Submit the System Design Report in both hard copy and electronic form. Refer to “Submittal Data and Documentation” section of these Project Special Provisions for additional requirements.

**(B) General Requirements**

Configure the edge switches for the permanent IP addresses, VLANs, and other configuration data before their field installation.

Notify the City of High Point Signal System Supervisor, James Baker at (336) 883-8540 at least two weeks prior to the commencement of work on a particular communications channel to ensure that time-base coordination will be operating and effective during the time of communications interruption. Before the existing communication is interrupted within a control zone, verify the time-based coordination plans installed in all of the intersection controllers within the control zone. Place in time-base coordination only those signals within the existing communications circuits that are actively being migrated to the Ethernet communications system. Ensure that the time-based coordination plans from existing controllers are transferred to the replacement controllers at those same locations.

It is the intent of these Project Special Provisions to minimize the length of time signals are offline from either the existing or new communication system, thereby limiting the duration of use of time-based coordination. **Do not take any existing controller off-line from signal system communications and implement time-base coordination without prior approval of the Engineer.** Reconnect the controller to the communications system within a timeframe mutually agreed to and approved by the Engineer in advance of the initial disconnection from system communications.

Verify time-base coordination in 2070E controllers that upon installation will not be immediately connected to communicate with the new signal system over the new Ethernet fiber-optic cable network. Verify time-base coordination in existing 2070L controllers that upon disconnection from existing coordinated communication will not be immediately replaced with 2070E controllers and cabinets and re-connected to the signal system over the new Ethernet fiber-optic cable network.

Verify the time reference on each controller at least once per week (by synchronizing with a National Standard Time source) while time-based coordination is in use and make any corrections necessary to maintain proper coordination. Reset the controller’s clock to the common time source if it has drifted. **Ensure that controllers’ internal clocks are all synchronized at least once per week to the same date and time of day.** Maintain the time synchronization in all controllers during any time that communication with the TOC is interrupted (i.e., while signals are offline).

Record the time and date of each visit, the activity performed and name of person who visited the cabinet and performed the clock maintenance activity. Maintain a record of clock maintenance activity in a single document and furnish to the Engineer for review upon request. Failure to visit each intersection that is not online to check and update clocks will result in **liquidated damages of \$1,500 per visit not performed.**

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Where possible, start at the outer edges of the existing local communications circuit and work inward toward the TOC. The existing fiber-optic communications cable will be progressively decommissioned as the new Ethernet-based fiber-optic communications system is built-out and brought online, starting at the outer reaches of the system boundaries and working inward toward the TOC.

Group the work by the existing communications circuits, allowing intersection migration to take place in discrete packages. The boundaries of the existing communications circuits may be obtained from the City of High Point through the Engineer upon request. Interrupt communications, replace cabinets and controllers, and migrate signals from the existing fiber-optic communications network to the new fiber-optic communications network.

In addition to grouping work by existing communications circuits, further organize work by proposed communications ring. Once migration begins on a given communications ring, continue migrating signals along that ring until all of the communications ring is complete before beginning migration of signals residing along another communications ring. Complete the intersection migrations in a communications ring within the number of workdays equal to no more than the number of signalized intersections in the communications ring. **Liquidated damages** for failure to complete intersection migrations and restore system communications to all intersections in the communications ring within the specified time are **\$1,500 per 24-hour period or any portion thereof.**

Exceptions to the requirements in this section must be approved by the Engineer.

Upon successful testing, integrate into the central system software under Ethernet communications.

Install system timing and graphics as per the requirements of in the previous subsection “Timing of Signals.”

As each Ethernet circuit is completed and lit, test communications to each Ethernet edge switch in that circuit as per the requirements of “Testing and Acceptance” section of these Project Special Provisions.

Prior to the end of any work day, ensure that communication between the TOC and existing signal controllers still connected to the existing communications cable is reestablished and working correctly.

Construct and splice drop cables to existing and proposed CCTV cameras while maintaining the existing communications. Migrate the existing and proposed cameras as the adjacent traffic signals are migrated to new system whenever possible.

### **(C) Staging Concept**

Construction of the signal system upgrade and expansion and migration from the existing to the new system is envisioned to occur in the following general stages:

**Stage 1:** Begin construction of field infrastructure (i.e., messenger cable, risers, underground conduits, junction boxes, foundation modifications, CCTV poles/cameras/cabinets, SMFO communications cable). Begin “make-ready” work at the TOC and Signal Shop.

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- Stage 2:** Complete field infrastructure construction for the “south side” of the signal system then migrate south side of system to new communications system and integrate south side into new central software using new servers at TOC and Signal Shop. Continue construction of “north side” field infrastructure. (See “Communications Migration” subsection below for more detailed description of “north side” and “south side.”)
- Stage 3:** Complete field infrastructure construction for the “north” of the signal system then migrate north side of system to new communications system and integrate north side into new central software using new servers at TOC and Signal Shop.

The “Field Infrastructure”, “Communications Migration” and “TOC Migration” subsections that follow describe the envisioned construction sequence and migration in greater detail. Be advised that some work in each of these three subsections is concurrent with and interrelated to work described in the other subsections.

**(D) Field Infrastructure**

The approach to maintaining and maximizing communications to all signals and CCTV cameras throughout the construction process requires that the new fiber-optic communications infrastructure be constructed while the existing communications infrastructure remains in place and operational. This will allow the intersections, even those in close proximity to one another, to function on the existing communications system until such time as they are migrated to the new Ethernet fiber-optic communications system. The new Ethernet fiber-optic communications network is comprised of:

- New aerial cable overlashed to existing communications cable while the existing communications cable remains in use. Install messenger cable and down guys before beginning any overhead fiber-optic cable installation. The overlashed existing communications cable will be abandoned in place after construction. Certain aerial routes are on new pole lines or deviate from the course of the existing communications cable. Existing communications cable that is not overlashed (e.g., in risers, where route changes, etc.) may be removed along with existing splice cabinets, unused risers and abandoned junction boxes where specified in the Plans or directed by the Engineer, after communications have completely migrated to the new fiber-optic cable and the existing communications cable is no longer in use.
- New underground cable in existing underground conduit. New fiber-optic cable will be pulled through an existing spare conduit that runs alongside the conduit containing the existing cable(s) where a spare conduit is available. Where there is no spare conduit in the existing underground run, the fiber-optic cable will have to be installed inside the same conduit that contains the existing cable(s); in some cases, this may require removal of one or more existing communications cables to enable pulling of the new cable.
- New underground cable in a new trenched, drilled or bored underground conduit.
- New NCDOT fiber-optic cable being installed under STIP project U-3615B (Skeet Club Road), and possibly segments of other existing City and NCDOT fiber-optic cable, will be spliced into the new fiber-optic network and incorporated into the expanded signal system.

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The City has joint-use permits for the proposed new attachments of aerial fiber-optic communications cable. Joint-use permits issued by the utility pole owners expire 120 days from the date of issuance. The Contractor shall commence installation of messenger cables and guy assemblies at the outset of construction and work continuously and expeditiously to complete this work prior to the joint-use permit expiration date. In the event that this work cannot be completed within 120 days, notify the Engineer 20 calendar days in advance to allow the City to request an extension of the permit.

**(2) Step 2**

Begin construction of the trunk cables along the major routes. For those routes with overhead cable, overlash the new fiber-optic cable to the existing fiber-optic cable or new messenger cable. For the underground routes, install the new cable:

- In spare ducts, where available
- In the same conduit as the existing fiber-optic cable where there is no available, accessible spare conduit, or
- In new conduits installed as part of this project.

In a few locations, the use of the existing occupied conduit may require removal of one or more existing communications cable. Provide cable storage for subsequent and future splices where called for in the Plans.

These trunk cables will provide homerun routes for Ethernet communications to the City's Traffic Operations Center (TOC). Establish Ethernet communications and test as per requirements of the "Testing and Acceptance" section of these Project Special Provisions.

**(3) Step 3**

Construct the branch cables to the minor arterials and non-redundant links and splice them to the trunk cables constructed in Step 2.

**(4) Step 4**

Construct and splice drop cables to local intersections while maintaining the existing communications. The original traffic signal system was largely constructed with drop and repeat transceivers and fiber-optic cable that daisy-chained through the each traffic signal controller cabinets. At many locations, the new drop cable can be installed into the cabinet while maintaining the existing communications cable either by using a new riser or conduit entrance installed per the Plans or by installing the drop cable in the existing conduit or riser alongside the existing cables. Where the drop cable cannot be installed while the existing cables remain inside the existing conduit or riser, initially coil and store the new drop cable on the pole or span above the occupied riser or in a junction box adjacent to the cabinet. Subsequently remove the existing cable(s) and pull the new drop cable into the cabinet during controller and cabinet changeout.

**(5) Step 5**

Configure the edge switches for the permanent IP addresses, VLANs, and other configuration data before their field installation.

Once the communications cable plant in Step 4 is completed and successfully tested, and continuous communications paths are established with outlying signals, begin the process of

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transferring communications from the old fiber-optic network to the new fiber-optic network. See “Time-Based Coordination” section below for further details. Exceptions to the requirements in this section must be approved by the Engineer. Notify the City of High Point Signal System Supervisor at least two weeks prior to the commencement of work on a particular communications channel to ensure that time-base coordination will be operating and effective during the time of communications interruption. As each Ethernet circuit is completed and lit, test the intersection communications as per the requirements of “Testing and Acceptance” section of these Project Special Provisions.

Generally, start at the outer edge of the existing communications circuit and work towards the TOC. Group the work by the existing communications circuits as identified in the Plans, allowing intersection migration to take place in discrete packages.

Interrupt communications, replace cabinets and controllers, and migrate signals from the existing fiber-optic communications network to the new fiber-optic communications network. Replace and migrate CCTV cameras at the same time. If communications conversion in the subject communications circuit interrupts the communication in another communications circuit, the Contractor must re-establish communication continuity in the adjacent communications circuit before any work can continue.

After the controllers are replaced, additional database work must be performed. Reconfigure the controllers’ communications addresses on the existing serial communications network to the Ethernet network. Revise the offset references when the NEMA controllers are replaced with 2070s. The NEMA controllers use offsets referenced to the end of the coordinated phase green. The 2070s with Oasis IP-based firmware use as an offset reference to the beginning of the green interval of the coordinated phase. If there are two coordinated phases such as two and six, then the new reference is to be the beginning of the coordinated phase green of the second phase.

#### **(6) Step 6a – South Side Downtown Signals**

Perform as much of the necessary “make ready” work as possible within Rings 15, 16 and 17 in the downtown area before proceeding to the steps that follow. Make ready work includes: new underground conduits, new junction boxes, intercepted and rerouted conduits at new and existing junction boxes, fiber-optic cable overhead and in new conduit, cabinet foundation modifications, electrical service, etc.

Once all signal migration outside the downtown area is complete, establish or otherwise verify that time-based coordination is properly programmed on all existing controllers in Rings 15, 16 and 17 in the downtown area. (Refer to the “Time-Based Coordination (TBC)” section below.) Then contact the City Traffic Signal System Supervisor to arrange for communication on the fiber-optic communications cables in the downtown area to be discontinued. At this point, disconnect and remove the existing communications cable in the downtown area as designated in the Plans. As cable is removed, leave a pull tape in place for subsequent installation of new fiber-optic cable or use existing cable to pull in new fiber-optic cable.

**NOTE:** Starting from the date that communication within Rings 15, 16 and 17 is discontinued as described above, complete the migration of all signals within the respective area to the fiber-optic network within **75 calendar days**. Failure to complete the work within the specified time will result in damages due to public inconvenience, obstruction and delay to traffic, safety and other considerations. For each consecutive calendar day in excess of the



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contract time specified, the Contractor shall pay, or have withheld monies due, a sum of **\$1,000.00 per calendar day**. This will be adjusted and assessed on a monthly basis at the time of each partial payment request based on the Contractor's progress in comparison with the approved project schedule.

Be advised that some or all of the work to construct integrated cabinet base adapters along with their new electrical services and grounding systems is likely to be part of the work that must be accomplished during the 75-day period due to its potential disruption of the existing signal operation.

Also, be advised that work described in the following Step "a" and Step "b" may be performed simultaneously.

- a) Install all remaining trunk, branch and drop cables with Rings 15, 16 and 17 in the downtown area. Establish Ethernet communications and test as per the requirements of the "Testing and Acceptance" section of these Project Special Provisions.
- b) Begin the process of replacing cabinets and controllers. Prior to installing each new cabinet and controller, program or otherwise verify that time-based coordination is properly programmed. See "Time-Based Coordination (TBC)" section below for further details.
- c) Configure the Ethernet edge switches either in advance of or at the time the cabinets with Ethernet edge switches are installed in the field. Group the work by the existing Control Zones as identified in the Plans, allowing intersection migration to take place in discrete packages. For one-way streets within Control Zones, start at the most upstream intersection and work downstream without skipping intersections.
- d) As fiber-optic cable installation, splicing and testing is completed for an entire Ring, connect the Ethernet edge switches to establish communication to the Ethernet core switch.
- e) Upon successful testing, integrate into the new central system software under Ethernet communications.
- f) Complete the work of migrating all the signals in one Ring before moving to the next Ring. Exceptions to the requirements in this section must be approved by the Engineer. As each ring is completed and lit, test intersection communications as per the requirements of "Testing and Acceptance" section of these Project Special Provisions.

**(7) Step 6b – North Side Downtown Signals**

Perform as much of the necessary "make ready" work as possible within Rings 18, 19 and 20 in the downtown area before proceeding to the steps that follow. Make ready work includes: new underground conduits, new junction boxes, intercepted and rerouted conduits at new and existing junction boxes, fiber-optic cable overhead and in new conduit, cabinet foundation modifications, electrical service, etc.

Once all signal migration outside the downtown area is complete, establish or otherwise verify that time-based coordination is properly programmed on all existing controllers in Rings 18, 19 and 20 in the downtown area. (Refer to the "Time-Based Coordination (TBC)" section below.) Then contact the City Traffic Signal System Supervisor to arrange for communication

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on the fiber-optic communications cables in the downtown area to be discontinued. At this point, disconnect and remove the existing communications cable in the downtown area as designated in the Plans. As cable is removed, leave a pull tape in place for subsequent installation of new fiber-optic cable or use existing cable to pull in new fiber-optic cable.

**NOTE:** Starting from the date that communication within Rings 18, 19 and 20 is discontinued as described above, complete the migration of all signals within the respective area to the fiber-optic network within **75 calendar days**. Failure to complete the work within the specified time will result in damages due to public inconvenience, obstruction and delay to traffic, safety and other considerations. For each consecutive calendar day in excess of the contract time specified, the Contractor shall pay, or have withheld monies due, a sum of **\$1,000.00 per calendar day**. This will be adjusted and assessed on a monthly basis at the time of each partial payment request based on the Contractor's progress in comparison with the approved project schedule.

Be advised that some or all of the work to construct integrated cabinet base adapters along with their new electrical services and grounding systems is likely to be part of the work that must be accomplished during the 75-day period due to its potential disruption of the existing signal operation.

Also, be advised that work described in the following Step "a" and Step "b" may be performed simultaneously.

- a) Install all remaining trunk, branch and drop cables with Rings 18, 19 and 20 in the downtown area. Establish Ethernet communications and test as per the requirements of the "Testing and Acceptance" section of these Project Special Provisions.
- b) Begin the process of replacing cabinets and controllers. Prior to installing each new cabinet and controller, program or otherwise verify that time-based coordination is properly programmed. See "Time-Based Coordination (TBC)" section below for further details.
- c) Configure the Ethernet edge switches either in advance of or at the time the cabinets with switches are installed in the field. Group the work by the existing Control Zones as identified in the Plans, allowing intersection migration to take place in discrete packages. For one-way streets within Control Zones, start at the most upstream intersection and work downstream without skipping intersections.
- d) As fiber-optic cable installation, splicing and testing is completed for an entire Ring, connect the Ethernet edge switches to establish communication to the Ethernet core switch.
- e) Upon successful testing, integrate into the new central system software under Ethernet communications.
- f) Complete the work of migrating all the signals in one Ring before moving to the next Ring. Exceptions to the requirements in this section must be approved by the Engineer. As each ring is completed and lit, test intersection communications as per the requirements of "Testing and Acceptance" section of these Project Special Provisions.

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Upon successful testing, integrate the traffic signals into the central system software under Ethernet communications.

As each Ethernet circuit is completed and lit, test intersection communications as per the requirements of “Testing and Acceptance” section of the Project Special Provisions.

Ensure controller cabinet change-outs adhere to all requirements listed in Subsections 1.3(A) and 1.3(I) as well as in the “Temporary Traffic Control” section of these Project Special Provisions.

Prior to the end of any work day, ensure that communications between the Ethernet edge switches and the Ethernet core switch in TOC, are reestablished, if they were interrupted, and are working correctly.

**(9) Step 8**

Conduct system testing, acceptance and burn in period.

**(E) Communications Migration**

The existing communications infrastructure divides the communications system into physically separate networks, roughly north and south of the Municipal Building/TOC. The Signal Shop and the area between the Municipal Building and the Signal Shop are part of the south network.

The **south side cable network** includes three trunk cables into the TOC through the south end of the Municipal Building. The proposed trunk cables include: (1) Chestnut Drive west towards Westchester Drive; (2) South Main Street; and (3) East Green Drive. The trunk cable along South Main Street provides redundancy to the Chestnut Drive and East Green Drive cables and all of the rings south of the TOC including out to the Signal Shop.

The cable network of the north side of the City does not provide complete redundancy. The **north side cable network** includes four trunk cables into the TOC through the north end of the Municipal Building. One single non-redundant trunk cable along North Main Street north of Montlieu Avenue will serve North Main Street. A second trunk cable will serve Greensboro Road, Guilford Road, Guilford College Road, and East Wendover Avenue. The third trunk cable will serve Eastchester Drive and will provide redundancy to the cable serving Greensboro Rd. These three trunk cables will run together to the intersection of Hamilton Street and Montlieu Avenue in the same underground conduit and on the same overhead spans. The fourth cable will only serve the visitor information kiosk at the IHFC Transit Terminal on Commerce Avenue between Hamilton Street and Wrenn Street.

Because the south network includes the Signal Shop and has redundancy into the TOC, it is highly desirable and preferred this south side cable network be constructed first. The south network provides more flexibility to stage and sequence the migration with less downtime.

The sequence described below is designed to minimize the downtime between the old and new systems and maintain the connection to the TRTMC. The Contractor may elect to perform the major steps identified for each network in a sequence different than proposed below for each network; however, each major step must be completed before moving to the next major step regardless of sequence and the sequence must be approved by the Department.

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Prior to the initiation of the first step of migration in each network, follow the steps described below in the subsection entitled "Field Infrastructure." Perform as much of the necessary "make-ready" work as possible within the downtown area before proceeding to the steps that follow. Make-ready work includes: new underground conduits, new junction boxes, intercepted and rerouted conduits at new and existing junction boxes, fiber-optic cable overhead and in new conduit, cabinet foundation modifications, electrical service, etc.

**(F) South Side Migration**

The migration to the cable plant into the TOC on the south side will occur in three major steps. This assumes the proposed trunk cable needed for each step has already been constructed up to the underground vault on the south side of the Municipal Building. Maintain communications for the existing signal and CCTV systems to the Signal Shop.

Three major steps on the south side are (listed in order):

**Step 1:** West Green Drive, Chestnut Drive and Westchester Drive and counterclockwise to South Main Street and the local streets connecting to them.

**Step 2:** East Green Avenue/College Drive, East Kivett Drive, Triangle Lake Road, Brentwood Street and the local streets connecting to them.

**Step 3:** East South Main Street and the local streets connecting to it

**(1) Step A**

Utilize existing spare building entrance conduits and pull in the proposed fiber cables from Chestnut Drive, East Green Drive, and South Main Street that connects to all rings on the south side of town.

**(2) Step B**

Establish non-redundant communications to those rings served by the proposed Chestnut Drive cable including Rings 14 and 17.

**(3) Step C**

Establish non-redundant communications to the Signal Shop and those rings served by the proposed East Green Drive cable including Rings 9, 10, 15, and 17.

Migrate communications between the TOC and the Signal Shop over to the new Ethernet communications system as early as possible using a redundant communications path until the primary path can be established.

Resplice the drop cables to the NCDOT cameras for Ring DOT 2 on US 311 Bypass starting at Kivett Drive and southward as the communications is migrated to the new Ethernet network. Connect the NCDOT cameras to the new City CCTV system.

**(4) Step D**

Establish communications to those rings served by the proposed South Main Street cable including Rings 11, 12, and 13. When connected the signals will have redundant communications due to the work in preceding steps.

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**(5) Step E**

Complete the redundant communications to all signalized intersections and cameras in each ring on the south side.

**(6) Step F**

**Perform the work shown in the Plans within 48 consecutive hours** on a non-holiday, non-High-Point-Market weekend to splice the existing NCDOT ITS fiber-optic cable at the intersection of Brentwood Street at Green Drive to the new signal system fiber-optic cable.

**Notify the Engineer, the City of High Point Signal System Supervisor at (336) 883-8450 and coordinate with the Triad Regional ITS Engineer at (336) 315-7079 at least two weeks prior to the commencement of splicing or other work on the existing NCDOT 24-fiber cable along Brentwood Street.** Provide the City of High Point Signal System Supervisor and the Triad Regional ITS Engineer updated splice details, updated field splicing location, and Contractor emergency contact information prior to beginning work. The interruption of connectivity of this 24-fiber cable shall be limited to 48 hours or less, and shall occur only on a non-holiday weekend. **Liquidated damages** for failure to restore communications in this existing 24-fiber NCDOT ITS communications cable within 48 hours are **\$1,500 per 24-hour period or any portion thereof.**

Repair at own expense, any damage to NCDOT fiber within 48 hours of notification of the incidence of damage. **Liquidated damages** for failure to repair a damaged NCDOT ITS fiber-optic communications cable and restore communications within 48 hours are **\$1,500 per 24-hour period or any portion thereof.**

**(7) Step G**

Remove the existing communications cables for south side communications only from the TOC and Municipal Building entrance conduits. Maintain existing communications cables for existing north side communications.

**(G) North Side Migration**

The migration to the new communications network on the north side will occur in four major steps. This assumes the proposed trunk cable needed for each step has already been constructed up to the underground vault on the north side of the Municipal Building.

**Four major steps** on the north side are, in an order determined by the Contractor's schedule:

**Step 1:** Downtown signals in the north network.

**Step 2:** North Main Street and the local streets connecting to it.

**Step 3:** Hartley Drive/Eastchester Drive and the local streets connecting to them.

**Step 4:** Lexington Avenue/Greensboro Road, Guilford Road, Guilford College Road and Wendover Avenue and the local streets connecting to them. This includes the connection to Eastchester Drive at Wendover Road and at Piedmont Parkway.

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Resplice the drop cables to the NCDOT cameras on US 311 Bypass starting at Greensboro Road and northward as the communications is migrated to the new Ethernet network. Connect the NCDOT cameras to the new City CCTV system.

**(1) Step A**

Utilize existing spare building entrance conduits and pull in the new fiber-optic cables serving North Main Street, East Lexington Avenue/Greensboro Road, and Eastchester Drive that connect to all rings on the north side of the City.

**(2) Step B**

Terminate the three trunk cables along North Main Street in the TOC for the rings to be connected later. Establish non-redundant communications to all signalized intersections and cameras connected to the North Main Street trunk cable, including Rings 18, 19, and 20.

**(3) Step C**

Establish non-redundant communications to all remaining signalized intersections and cameras connected to the North Main Street cable, including Rings 5, 6, and 7 and DOT 1 (Johnson Street).

**(4) Step D**

**Perform work shown in Plans within 48 consecutive hours** on a non-holiday weekend to splice into existing NCDOT ITS fiber-optic cable to the new signal system fiber-optic cable at the intersection of Eastchester Drive at Centennial Street to maintain video sharing with NCDOT.

**Notify the Engineer, the City of High Point Signal System Supervisor at (336) 883-8450 and coordinate with the Triad Regional ITS Engineer at (336) 315-7079 at least two weeks prior to the commencement of splicing or other work on the existing NCDOT 24-fiber cable along Eastchester Drive.** Provide the City of High Point Signal System Supervisor and the Triad Regional ITS Engineer updated splice details, updated field splicing location, and Contractor emergency contact information prior to beginning work. The interruption of connectivity of this 24-fiber cable shall be limited to 48 hours or less, and shall occur only on a non-holiday, non-High-Point-Market weekend. **Liquidated damages** for failure to restore communications in this existing 24-fiber NCDOT ITS communications cable within 48 hours are **\$1,500 per 24-hour period or any portion thereof.**

Repair at own expense, any damage to NCDOT fiber within 48 hours of notification of the incidence of damage. **Liquidated damages** for failure to repair a damaged NCDOT ITS fiber-optic communications cable and restore communications within 48 hours are **\$1,500 per 24-hour period or any portion thereof.**

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Establish non-redundant communications to those rings served by the proposed Eastchester Drive cable including Rings 2, 3, and 4 including the major splice at Eastchester Drive and Wendover Avenue/Skeet Club Road.

**(6) Step F**

Establish communications to those rings served by the proposed Lexington Avenue/Greensboro Road cable including Rings 1, 8 and DOT 1 (Greensboro Road). This will also establish redundant communications to Rings 1, 2, 3, 4 and 8. This completes the work on the north side of the City.

**(7) Step G**

Conduct system testing, acceptance and burn in period.

**(H) TOC Migration**

The block diagrams for the new signal system shown on the Plans depict the existing system equipment to be retained and the new equipment to be installed. The proposed sequence is described below.

**(1) Step 1**

The City will remove or relocate their non-essential equipment and furniture to facilitate the temporary operations. Relocate and maintain the operation of the existing CCTV and signal systems to facilitate the new system communications and equipment.

**(2) Step 2**

The City will construct new intermediate metal conduit (IMC) from the telecommunications room over the hallway into the TOC. During non-critical time, remove the existing fiber-optic cables serving the Off-Street Parking Division and Hi tran and reinstall them in the new conduits and terminate them on their existing patch panels in the TOC. Work must be completed on a weekend and shall not be performed starting one week before until one week after the semi-annual High Point Market. Refer to the "Building Modifications" section of these Project Special Provisions for additional, more detailed requirements.

**(3) Step 3**

Maintain the operation of the existing CCTV monitoring system and CLMATS<sup>®</sup> signal system. Install the head end communications racks, Ethernet core switch, server(s), monitors, workstations, and all necessary equipment at the TOC, the Signal Shop, and the Transportation Department conference room on the second floor of the Municipal Building. Install the network management software. Configure the central software applications. Initially locate the primary server(s) at the Signal Shop to facilitate renovations in the TOC and the initial migration. This step must be completed with the establishment of communications to the Signal Shop.

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Setup a test facility to configure local equipment. The test facility shall utilize the same models of equipment to test the network configuration as is being installed on the project. Configure the Ethernet core switch for the permanent IP addresses, VLANs, and other configuration data before its installation.

Begin building the device database. Convert the signal timing data and build the system and intersection graphics.

**(5) Step 5**

Coordinate the installation of trunk cables into the TOC with the field infrastructure. Utilize existing spare conduits from the manholes/vaults on the north and south sides of the Municipal Building into the telecommunications room to bring the fiber-optic cable into that room and then into the TOC across the hall. See the subsection below entitled "Field Migration" for additional requirements and details.

**(6) Step 6**

Move the traffic signals from the existing communications cables to the new Ethernet over single-mode fiber-optic cables by connecting to the Ethernet switches. Move the CCTV cameras from the existing communications cables to the new Ethernet over single-mode fiber-optic cables.

**1.5. MEASUREMENT AND PAYMENT**

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section. Include the incidental costs for furnishing and/or installing materials and equipment expressly required under the contract for successful completion of the contract, but whose measurement and payment is not specifically stated under any of the contract pay items, into the unit cost(s) for the various items in the contract.



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**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 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% of the total amount bid for the contract. Where the amount bid for *Mobilization* exceeds 5% of the total amount bid for the contract, 2.5% percent of the total amount bid will be paid on each of the first two partial pay estimates. That portion exceeding 5% 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 before beginning work on the various items on the project site.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Mobilization	Lump Sum

### 3. TEMPORARY TRAFFIC CONTROL

#### 3.1. DESCRIPTION

Furnish, install, maintain, relocate, and remove temporary traffic control devices in accordance with these Project Special Provisions, the Transportation Management Plan, the MUTCD, and Roadway Standard Drawings to maintain and control vehicular and pedestrian traffic in a safe and efficient manner during signal system construction. All temporary traffic control devices furnished by the Contractor shall remain the property of the Contractor, unless otherwise specified in the contract.

#### 3.2. GENERAL REQUIREMENTS

##### (A) Maintenance of Traffic

The Contractor will be required to maintain traffic, both vehicular and pedestrian, within the limits of the project, including roadways that cross or intersect the project, unless otherwise provided for in the contract or approved by the Engineer. The Contractor shall conduct his work in a safe manner that will create a minimum amount of inconvenience to traffic, both vehicular and pedestrian.

Maintain vehicular and pedestrian traffic through work zones in accordance with these Project Special Provisions, the MUTCD, and *Roadway Standard Drawings*, 23 CFR 630 Subparts J and K and the Transportation Management Plan (TMP).

Mark all hazards with signs, barricades, drums or other warning devices until the hazard is eliminated.

##### (B) Temporary Lane Closures

###### (1) General

Operate all equipment and personnel within the designated work area during lane closures. Do not impede or stop traffic for the purpose of performing construction related work on the traffic side of the lane closure, except when called for in the Transportation Management Plan.

Install lane closures with the traffic flow, beginning with devices on the upstream side of traffic. Remove lane closures against the traffic flow, beginning with devices on the downstream side of traffic.

Vehicles used to install or remove lane closures shall have flashing or rotating beacons.

###### (2) Intersections

When construction proceeds through an intersection, provide flagger(s) and all other necessary Traffic Control as required by the Plans to direct the traffic through the intersection. When an intersection is signalized, have authorized personnel place the signal in flash mode prior to beginning work in the intersection.

When it is necessary to close a lane of traffic for construction on the departure (downstream) side of an intersection, implement the lane closure on the approach (upstream) side of the intersection. Close the appropriate lane of dual turn lanes that would otherwise turn into the lane that is closed on the departure side of the intersection.

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Limit the stoppage of traffic to times specified in the Plans. Provide enough time between consecutive stoppages to allow the traffic queue to dissipate.

**(D) Traffic Control Supervision**

Provide the service of at least one qualified work zone supervisor. The work zone supervisor shall have the overall responsibility for the proper implementation of the traffic management plans and ensure all employees working inside the NCDOT and City rights-of-way have received the proper training appropriate to the job decisions each individual is required to make.

The work zone supervisor is not required to be on site at all times but shall be available to address concerns of the Engineer. The name and contract information of the work zone supervisor shall be provided to the Engineer prior to or at the preconstruction conference.

Qualification of work zone supervisors shall be done by an NCDOT approved training agency or other approved training provider. For a complete listing of these, see the Work Zone Traffic Control's webpage: <https://connect.ncdot.gov/projects/WZTC/Pages/Training.aspx>

Coordinate with and cooperate with traffic control supervisors of adjacent or overlapping construction projects to insure safe and adequate traffic control is maintained throughout the projects at all times including periods of construction inactivity in accordance with Article 105-7 of the *Standard Specifications*.

**(E) Vehicular Access**

Maintain continuous and safe vehicular access, including but not limited to, all residences, businesses, schools, police and fire stations, hydrants, other emergency services, hospitals and mailboxes. Conduct operations in such a manner as to limit the inconvenience to property owners.

**(F) Pedestrian Access**

Maintain continuous and safe pedestrian access, including but not limited to, all residences, businesses, schools and mailboxes. Conduct operations in such a manner as to limit the inconvenience to pedestrians. Pay special attention to pedestrian areas used by visually-impaired pedestrians. Coordinate with local Orientation and Mobility Specialists to make appropriate provisions for visually impaired pedestrians when construction activities will disrupt pedestrian paths that they normally use.

Protect open excavations within or adjacent to areas subject to pedestrian traffic from pedestrian intrusion by surrounding the excavation/hazard with orange plastic mesh construction fencing (also referred to as safety fence, tree protection barricade, warning fence, etc.) or other method approved by the Engineer. Do not use tape, flagging, rope or plastic chain strung between barricades, cones or stakes.

Determine the extent of pedestrian needs through engineering judgment or by the traffic control supervisor responsible for the work zone. Inspect the work zone regularly so effective pedestrian traffic is maintained. When pedestrian movement through or around a work site is necessary, provide a separate usable footpath. If the previous pedestrian facility was accessible to pedestrians with disabilities, provide a footpath during temporary traffic control that is accessible. Do not have any abrupt changes in grade or terrain that could cause a tripping hazard

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or could be a barrier to wheelchair use. Provide barriers and channelizing devices that are detectable to pedestrians who have visual disabilities. Provide temporary pedestrian facilities that are made of concrete, asphalt or other suitable material as approved by the Engineer at all locations where the existing sidewalks have been removed for construction operations.

Do not sever or move pedestrian facilities for non-construction activities such as parking for vehicles and equipment. Separate pedestrian movements from both work site activity and vehicular traffic.

**(G) Greenways**

Comply with all requirements of the "Pedestrians" for all work that is adjacent to, encroaches upon or is within City of High Point Greenways. Maintain and make provisions for bicycle ingress and egress and provide for safe passage of bicycles along greenways in manner similar to the requirement for pedestrians. At least two weeks prior to beginning any work that may affect or disrupt pedestrian and bicycle traffic along a City Greenway, coordinate with the City of High Point Department of Transportation concerning any special requirements, any special events like bike races, and work day/hour limitations for the affected Greenway. A map showing the location and routes of the City's Greenways may be found at the following Web address: <http://www.highpointnc.gov/pr/GreenwayBasemap.pdf>

**(H) Alternate to Transportation Management Plan**

If desired, submit an alternate TMP a minimum of 30 calendar days in advance of the anticipated implementation to allow for adequate review time. Do not implement alternate plans for traffic control until approved in writing and properly sealed. No adjustment in compensation or extension of the completion date(s) will be allowed due to the review time of the alternate. If an alternate TMP is implemented, the Contractor shall be responsible for any unanticipated changes to subsequent Steps.

**(I) Temporary Traffic Control Plan Not fully Covered in the Contract**

When the Transportation Management Plan does not cover a particular work function, notify the Engineer to allow for the development or modification of a sealed set of the Transportation Management Plans.

**3.3. MATERIALS****(A) Work Zone Traffic Control Devices**

Refer to Division 10 of the *Standard Specifications*.

Use temporary traffic control devices that comply with 23 CFR 630 Subpart K. Provide a Type 7 material certifications in accordance with Article 106-3 of the *Standard Specifications* at least 72 hours before use for all used temporary traffic control devices.

Provide temporary traffic control devices that are listed on the NCDOT Approved Product List.

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**(B) Work Zone Signs**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Barricade Mounted Signs	1089-3
Work Zone Signs	1089-1
Work Zone Sign Supports	1089-2

Portable work zone signs shall be roll up or approved composite substrates. Use portable work zone signs only with portable work zone sign stands specifically designed for one another.

Provide portable work zone sign stands, portable signs and sheeting that meet NCHRP 350 for Category II traffic control devices and are listed on the NCDOT Approved Products List.

Provide portable work zone signs and stands that are crash tested together as a system by the manufacturer. Poor performance of portable work zone signs or portable work zone sign stands at any site, whether or not related to a specific contract, will be grounds for non-acceptance of a product on any project under contract.

**(C) Flashing Arrow Boards**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Flashing Arrow Boards	1089-6

Use arrow boards that are on the NCDOT Approved Product List.

Poor performance of arrow boards at any site, whether or not related to a specific contract, will be grounds for non-acceptance of a product on any project under contract.

**(D) Portable Changeable Message Signs**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Portable Changeable Message Signs	1089-7

Use portable changeable message signs that are on the NCDOT Approved Products List.

Poor performance of portable changeable message signs at any site, whether or not related to a specific contract, will be grounds for non-acceptance of a product on any project under contract.

**(E) Drums**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Drums	1089-5

Provide drums that are on the NCDOT Approved Products List.

**C-5558****ITS-54****Guilford County****(F) Cones**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Cones	1089-4

Provide cones that are on the NCDOT Approved Products List.

**(G) Barricades**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Barricades	1089-3

Provide barricades that meet NCHRP 350 for Category II traffic control devices and are on the NCDOT Approved Products List.

**(H) Flaggers**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Flaggers	1089-10

**(I) Truck Mounted Attenuators**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Truck Mounted Impact Attenuators	1089-9

Use TMAs that meet NCHRP 350 Test Level II or III for work zone traffic control devices and are on the NCDOT Approved Products List.

Historical performance of the TMA will help determine the future use of the material by the Department, even if the TMA has been approved. Poor performance of TMA at any site, whether or not related to a specific contract, will be grounds for non-acceptance of a product on any project under contract.

**(J) Skinny Drums**Refer to Division 10 of the *Standard Specifications*:

<b>Item</b>	<b>Section</b>
Skinny Drums	1089-5

Provide skinny drums that are on the NCDOT Approved Products List.

### 3.4. CONSTRUCTION METHODS

#### (A) Work Zone Traffic Control Devices

Ensure all traffic control devices inspected and approved before using them on the project. Install temporary traffic control devices before construction operations begin and during the proper phase of construction. Maintain and relocate temporary traffic control devices during the time they are in use. Keep these devices in place as long as they are needed and immediately remove thereafter. When operations are performed in stages, install only those devices that apply to the present conditions.

#### (B) Work Zone Signs

##### (1) Work Zone Signs (Barricade Mounted)

Mount approved composite or roll-up signs to barricade rails so that the signs do not cover more than 50% of the top two rails or 33% of the total area of the three rails. Mount signs at least 1 foot from the ground to the bottom of the sign.

##### (2) Work Zone Signs (Portable)

Install the portable work zone sign and sign stand to stand plumb within 10° left and right, within 20° front and back and be capable of standing erect in windy conditions.

Install roll-up or approved composite signs at least 1 foot from the bottom of the sign to the edge of pavement elevation on two-lane two-way roadways and at least 5 feet from the bottom of the sign to the edge of pavement elevation on multi-lane roadways.

Clean the sign face prior to use.

When not in use for periods longer than 30 minutes, lay the portable work zone sign flat on the ground and collapse the sign stand and lay it flat on the ground.

#### (C) Flashing Arrow Boards

Use arrow boards that have the capability to display mode selections.

Do not use straight-line caution or chevron displays.

Mount flashing arrow boards on trucks, trailers, or other mobile units.

Expedite repairs due to failure, malfunction or damage to an arrow board. Furnish another arrow board approved by the Engineer during the repair time. Repair or replace arrow boards immediately; otherwise, suspend all construction activities requiring the use of the sign until the sign is restored to operation.

Perform all maintenance operations recommended by the manufacturer of the sign.

#### (D) Portable Changeable Message Signs

Mount all portable changeable message signs on a trailer or truck so as to support the message board in a level position and in accordance with the Plans. Align and sight the portable changeable message sign to provide optimal driver visibility. Messages on a portable changeable message sign shall consist of no more than 2 phases, and a phase shall consist of no more than 3 lines of text. Each phase shall be capable of being understood by itself, regardless of the order in which it is read. Messages shall be centered and uppercase within each line of the legend. If more than one portable changeable message sign is simultaneously legible to road users, then only one of the signs shall display a sequential message at any given time. As guidance, the

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display time for each phase shall be at least 2 seconds, and the sum of the display times for both of the phases shall be no more than 8 seconds. Sign operator will adjust the display rate so the 2 phase message can be understood by the motorist approaching the sign at the posted speed limit. Relocate the units for the various stages of construction as shown in the Plans or as needed to adequately inform the motorists.

Provide an experienced operator for the portable changeable message sign during periods of operation to ensure that the messages displayed on the sign panel are in accordance with the Plans and in accordance with message content guidelines. Ensure that the message sign is illuminated properly to meet the existing light conditions, and that all adjustments for operation of the sign are made as needed to properly guide motorists.

Expedite repairs due to failure, malfunction, or damage to a portable changeable message sign. Furnish another portable changeable message during the repair time. Repair and/or replace portable changeable message sign immediately; otherwise, suspend all construction activities requiring the use of the sign until the sign is restored to operation.

Perform all maintenance operations recommended by the manufacturer of the sign. Include the periodic cleaning of the sign face and associated solar panels in maintenance operations.

**(E) Drums**

Use the same type of reflective sheeting on all drums installed at any one time during the life of the project. Spacing of these devices is equal in feet to the speed limit in the taper and twice the speed limit in the tangent sections

Use a ballasting method in accordance with the manufacturer's specification. When using tire ballasting method, use approved manufacturer's tires and place the tires flush with the ground.

Immediately replace any drum, ballast or reflective sheeting that are torn, crushed, discolored or otherwise damaged.

**(F) Cones**

Use reflective adhesive sheeting on all cones used between dusk and dawn. Use the same type of reflective sheeting on all cone collars installed at any one time during the life of the project. Do not use cones in the upstream taper of lane or shoulder closures for multilane roadways and use for no longer than 3 consecutive days.

Use ballasting methods in accordance with manufacturer's specification. Cones may be used on all facilities for daytime and nighttime work with speed limits at or below 55 mph. If used at night, the cones shall have adhesive reflective sheeting and shall meet the height requirements in the *Roadway Standard Drawings*.

Cones may be used instead of drums, where allowed in the TMP plans or by the Engineer, on facilities with speed limits above 55 mph, if both the work is performed during daylight conditions and the devices are removed after each work period. Drums shall be used in the tapers.

The maximum spacing for cones on multi-lane roadways is equal in feet to the posted speed limit.

Immediately replace any cone that is torn, crushed, discolored or otherwise damaged.



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At the end of the workday, properly close the road where construction equipment accesses a road closure through Type III barricades.

Use sandbags or other approved ballasting methods to prevent overturning of barricades by the wind. If needed, place sandbags or other acceptable ballasting on the feet of the frame. Do not ballast barricades with objects such as rocks or chunks of concrete.

Do not anchor barricades to any pavement surfaces unless such anchoring method has passed the crash test requirement of NCHRP 350 for work zone category II devices.

Point the striped diagonals on the barricade rails in the direction of traffic flow.

**(H) Flaggers**

Provide the service of properly equipped and qualified flaggers (see *Roadway Standard Drawings* No. 1150.01) at locations and times for such period as necessary for the control and protection of vehicular and pedestrian traffic. Anyone who controls traffic is required to be qualified. Qualification consists of each flagger receiving proper training in the set-up and techniques of safely and competently performing a flagging operation. Qualification of flaggers is to be done by an NCDOT approved training agency or other approved training provider. For a complete listing of these, see the Work Zone Traffic Control's webpage.

Prior to beginning work on the project, a Qualification Statement that all flaggers used on the project have been properly trained through an NCDOT approved training resource shall be provided to the Engineer.

Use flagging methods that comply with the guidelines in the MUTCD.

**(I) Truck Mounted Attenuator**

Before use, furnish the Engineer detailed brochures, specifications, and other manufacturer's data that completely describes the performance criteria, installation, and instructions for the TMA.

Use only TMAs that meet the crash test requirements of *Standard Specifications* Article 1089-9(A).

Do not park TMAs against rigid objects (i.e. bridge piers or portable concrete barrier) except as a temporary safety measure and in no case for longer than 72 hours. Install the TMA on a truck that is fully operational, in good running order, and in accordance with the manufacturer's specifications.

Use the appropriate lighting and delineation on the truck and TMAs as shown in the contract.

Repair or replace within 24 hours any attenuator that becomes crushed or otherwise damaged so that it will perform its intended purpose. Suspend all construction activities until the attenuator is repaired or replaced. Provide safe control of traffic until the attenuator has been repaired by using approved methods.

**(J) Skinny Drums**

Use the same type of reflective sheeting (Type III High Intensity Prismatic or greater) on all skinny drums installed at any one time during the life of the project. Use ballasting methods in accordance with the manufacturer's specification.

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Immediately replace any skinny drum, ballast or reflective sheeting that are torn, crushed, discolored or otherwise damaged.

Skinny drums may be used instead of cones on all facilities with speed limits of 55 mph and below. Spacing of these devices is equal in feet to the speed limit in the taper and twice the speed limit or every other skip in the tangent sections.

Skinny drums may be used instead of cones and drums where allowed in the TMP or by the Engineer on facilities with speed limits above 55 mph, if all the following apply:

- 1) The work is performed during daylight conditions,
- 2) The devices are removed after each work period and
- 3) Drums are used in the tapers.

Do not use skinny drums on control-of-access facilities with speed limits above 55 mph that either involve night work or allow devices to remain in place overnight.

Do not use skinny drums for tapers on multilane or control-of-access roadways with speed limits above 55 mph.

Do not intermix with drums or cones unless directed by the Engineer or the TMP.

**(K) Law Enforcement**

Use uniformed law enforcement officers and marked law enforcement vehicles equipped with blue lights mounted on top of the vehicle and law enforcement vehicle emblems to direct or control traffic as required by the Plans or by the Engineer.

Use a law enforcement officer(s) when an existing traffic signal must be taken out of operation in order to remove and replace the existing cabinet and controller. Use a law enforcement officer(s) when a traffic signal must be deactivated while constructing a conduit entrance into an existing cabinet foundation (subject to the Engineer's prior approval), while overlaying an existing cabinet foundation with a new preformed foundation and while removing and replacing an existing foundation with a new preformed foundation in the same location.

**(L) Pedestrian Safety**

Install measures for separating pedestrian traffic from the work area and from adjacent vehicular traffic where pedestrian paths are evident or sidewalks are present. Use protective barricades, warning and guidance devices and signs to provide a safe, well-defined passageway for pedestrians. When a sidewalk must be closed temporarily to perform construction work, refer to Chapter 6D, "Pedestrian and Worker Safety," and Typical Applications 28 and 29 (TA-28 and TA-29) of the 2009 Edition of the *Manual on Uniform Traffic Control Devices* (MUTCD 2009) for appropriate pedestrian traffic control measures. The MUTCD 2009 is available online at the following web address: <http://mutcd.fhwa.dot.gov>

**3.5. MAINTENANCE AND INSPECTION****(A) Work Zone Traffic Control Devices**

Submit a proposed traffic control device maintenance schedule and checklist for approval prior to construction. Perform continuous maintenance and scheduled inspections of traffic control devices. Review and maintain all traffic handling measures to ensure that adequate provisions are in place for the safety of the public and workers.

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Maintenance activities include cleaning, repair or replacement of temporary traffic control devices that are damaged, torn, crushed, discolored, displaced or deteriorated beyond effectiveness.

If there are traffic control devices in use, perform inspection on a daily basis.

If the name and telephone number of the agency, Contractor or supplier is shown on the non-retroreflective surface of all channelizing devices, use letters and numbers that are a non-reflective color and not over 2 inches in height.

### **3.6. FAILURE TO MAINTAIN TRAFFIC CONTROL**

Failure to maintain temporary traffic control measures and traffic control devices in accordance with this Project Special Provision may result in formal notification of noncompliance. Implement remedial action immediately for imminent danger situations as directed. Implement remedial action within 48 hours after notification of a safety issue that is not an imminent danger situation. See Articles 107-21 and 108-7 of the *Standard Specifications*.

Failure to comply may result in having the work performed with available forces and equipment. In cases of willful disregard for the safety of the public, the Engineer may proceed immediately to implement the measures necessary to provide the appropriate level of traffic control to ensure that the safety of all concerned parties is maintained.

### **3.7. MEASUREMENT AND PAYMENT**

Nominal dimensions will be used to compute sign panel areas.

*Work zone signs (barricade mounted)* will be measured and paid for as the actual number of square feet satisfactorily installed on barricades and accepted by the Engineer. Payment will be made for the initial installation only. Relocation of signs will be considered incidental to the measurement of the quantity of signs.

*Work zone signs (portable)* will be measured and paid for as the actual number of square feet satisfactorily installed and accepted by the Engineer. Payment will be made for the initial installation only. Relocation of signs will be considered incidental to the measurement of the quantity of signs.

No direct payment will be made for portable work zone sign stands. All portable work zone sign stands will be incidental to the work of providing work zone signs.

*Flashing arrow board* will be measured and paid for as the maximum number of boards that have been satisfactorily placed and accepted by the Engineer in use at any one time during the life of the project as required by the contract. Relocation, repair, replacement and maintenance of arrow boards is considered incidental to the work of this section of the Project Special Provisions.

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*Portable changeable message sign* will be measured and paid for as the maximum number of portable changeable message signs acceptably placed and in operation, at any one time during the life of the project. Payment for *portable changeable message sign* will be made on the following schedule:

- 70% of the unit bid upon placing the unit in service.
- 20% of the unit bid when the project is 50% complete.
- 10% of the unit bid when the project is 100% complete.

Relocation, replacement, repair and maintenance of portable changeable message signs is considered incidental to the work of this section of the Project Special Provisions.

*Drums* will be measured and paid for as the maximum number of drums acceptably placed and in use at any one time during the life of the project. Relocation, repair, replacement and maintenance of cones will be incidental to the work of this section of the Project Special Provisions.

*Cones* will be measured and paid for as the maximum number of cones acceptably placed and in use at any one time during the life of the project. Relocation, repair, replacement and maintenance of cones will be incidental to the work of this section of the Project Special Provisions.

*Barricades (Type III)* will be measured and paid for as the maximum number of linear feet of barricades acceptably placed and in use at any one time during the life of the project. Measurement will be made of the total length of each barricade along one rail. Relocation, repair, replacement and maintenance of barricades will be incidental to the work of this section of the Project Special Provisions.

*Flagger (hour)* will be measured and paid for as the actual number of hours that each flagger is satisfactorily provided and accepted by the Engineer during the life of the project. Flagging conducted for the convenience of the Contractor's operations is not compensated. The Department will pay for flaggers, including those used at Y-lines that are used in conjunction with a lane closure. Flaggers used for operations not involving a lane closure will be incidental to that operation and no payment will be made. Flaggers used for hauling operations, where the only need for a lane closure is due to the hauling operation, will be incidental to that operation and no payment will be made. Any flagger used for less than one hour will be incidental to that operation.

*TMA* will be measured and paid for as the maximum number of TMAs acceptably placed and in use at any one time during the life of the project for all operations other than moving and mobile operations. TMAs will be incidental to all moving and mobile operations. In the case of emergency situations, TMAs will not be paid for when payment has already been made for a stationary unit. Relocation of TMAs will be incidental to the measurement of the quantities of TMAs and no separate payment will be made.

*Skinny drum* will be measured and paid for as the actual number of skinny drums satisfactorily placed, accepted by the Engineer and in use at any one time during the life of the project. Relocation, repair, replacement and maintenance of skinny drums is considered incidental to the work of this section of the Project Special Provisions.

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*Law enforcement* will be measured and paid for as the actual number of hours that each law enforcement officer is provided during the life of the project as approved by the Engineer and subject to the following conditions:

- Measurement and payment will not exceed 3 hours per police officer provided to direct traffic at a given signalized intersection during the removal and replacement of a controller cabinet.
- Measurement and payment will not exceed 1 hour per police officer provided to direct traffic at a given signalized intersection while constructing a new conduit entrance into an existing cabinet foundation, overlaying an existing cabinet foundation with a new preformed foundation or replacing an existing foundation with a new preformed foundation in the same location.

There will be no direct payment for marked law enforcement vehicles as they are considered incidental to the pay item.

No measurement will be made of orange plastic mesh construction fencing or other approved methods of protecting open excavations/hazards from pedestrian intrusion as such measures will be considered incidental to the excavation work. No measurement will be made of temporary pedestrian footpaths required to maintain pedestrian movement around removed sections of sidewalk as such measures will be considered incidental to the excavation work and the replacement of the removed section of sidewalk.

If the Contractor fails to maintain acceptable traffic control measures or temporary traffic control devices and the Engineer implements measures necessary to provide the appropriate level of traffic control, the actual cost of performing said work will be deducted from the monies due the Contractor on the contract.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Work Zones Signs (Barricade Mounted)	Square Foot
Work Zones Signs (Portable)	Square Foot
Flashing Arrow Board	Each
Portable Changeable Message Sign	Each
Drums	Each
Cones	Each
Barricades (Type III)	Linear Foot
Flagger	Hour
TMA	Each
Skinny Drum	Each
Law Enforcement	Hour

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#### 4. PAVEMENT MARKINGS

##### 4.1. DESCRIPTION

Furnish and install pavement markings in accordance with the Plans.

Remove existing pavement markings in accordance with the Plans.

##### 4.2. 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 Signing and Delineation 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.

##### 4.3. CONSTRUCTION METHODS

###### (A) General

Refer to and fully comply with Section 1205 of the *Standard Specifications*.

Do not use handliners or any other non-truck mounted pavement marking machine to install pavement markings for long line applications of any one line longer than 1000 feet.

###### (B) Testing Procedures

All pavement marking materials and placement will be tested by the Department. Install pavement markings in order to meet the retroreflectivity requirements as measured by a Department approved 30 m mobile or handheld retroreflectometer.

###### (C) Application Equipment

###### (1) General for all 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.

###### (2) Glass Bead/Element Dispensing Equipment

Apply drop-on beads/elements to the surface of pavement long line markings using an automatic high pressurized bead dispenser or a pressurized mechanical feed, attached to the marking equipment. Hand liner type equipment is exempt from this requirement. Locate the bead/element applicator at the proper distance behind the

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application of pavement marking material to provide the proper amount of retroreflectivity. Equip the bead applicator with an automatic cut-off control synchronized with the cut-off control of the marking material.

Spread the beads/elements uniformly over the entire surface of the pavement marking material such that they are partially embedded in the pavement marking. A 60% bead embedment depth provides optimum retroreflectivity.

**(D) Weather Limitations and Seasonal Limitations**

Do not place pavement markings when moisture tests conducted on the pavement show signs of moisture presence on the pavement, or it is anticipated that damage causing moisture may occur during the installation and drying periods.

**(E) Time Limitations for Replacement**

<b>TIME LIMIT FOR REPLACEMENT</b>		
<b>Facility Type</b>	<b>Marking Type</b>	<b>Replacement Deadline</b>
Full-control-of-access multi-lane roadway (4 or more total lanes) and ramps, including Interstates	All markings	By the end of each workday's operation if the lane is opened to traffic
Multi-lane roadways (3 or more lanes) and ramps	Center Line, Lane Line, Railroad symbols, Stop bars and school symbols	By the end of each workday's operation if the lane is opened to traffic (temporary paint may be used)
	Edge Lines, gore lines and all other symbols	By the end of the 3rd calendar after obliteration
Two-lane, two-way roadways	All centerline markings, railroad, Stop bars and school symbols	By the end of the 5th calendar day after obliteration
	Edge Lines and all other symbols	By the end of the 15th calendar day after obliteration

A multilane facility is defined as any roadway having more than two lanes to include a two-lane / two-way roadway with a center two-way left turn lane.

**(F) Premarking/Interim/Temporary Markings**

Premarking (or layout markings) are small paint spots used by striping contractors to establish locations of pavement markings. Premark each installation of the final pavement marking materials before application on new pavement and when required to replace existing pavement marking, except when existing markings are visible. Get the premarking inspected and approved by the Engineer before placing the pavement marking materials.

Interim paint is a thin layer of pavement marking paint applied at the striping contractor's option to maintain traffic, instead of durable pavement markings. Apply interim paint to comply with time limitations for placement if final pavement markings cannot be placed. Interim markings shall be no more than 1/4" less than the specified line width of the existing markings.

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Place temporary paint markings for detours, lane shifts, milled surfaces and lifts of asphalt other than the final pavement surface.

Review and record the existing pavement markings before resurfacing and reestablish the new pavement markings using the record of existing markings in conjunction with the *Roadway Standard Drawings*, unless otherwise directed. Submit the record or existing pavement markings 7 calendar days before the obliteration of any pavement markings.

**(G) 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 before 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 blasting methods or grinding methods. Ensure that the surface is free of all residue, laitance and debris before applying the pavement marking. When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air immediately before installing the pavement markings.

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 at least 2" wider than the pavement markings in such a way as to not cause any noticeable change in the appearance of the pavement markings.

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.

**(H) Application of Pavement Markings**

**(1) General for all types 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 *Roadway Standard Drawing* No. 1205.01, Sheet 2 of 2 for details.



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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

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.

Protect the pavement markings until they are track free. Repair any markings tracked by a vehicle by acceptable methods.

Remove all pavement marking materials spilled on the road surface by acceptable methods.

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

(2) Glass Bead/Element Application

“Drop-on” is the method where glass beads are dispensed by a pressurized mechanical feed or high pressure means onto the pavement marking as it is applied to the pavement. Drop-on bead dispensing for symbols stop bars and characters may be accomplished by gravitational methods.

**(I) Pavement Markings Observation Period**

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

Maintain responsibility for the pavement markings for a 12 month observation period beginning upon the satisfactory completion and acceptance by the Engineer of all pavement marking work required in the plans. Guarantee the markings under the payment and performance bond in accordance with Article 105-17 of the *Standard Specifications*.

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During the 12-month pavement marking (PM) observation period, provide pavement marking material that shows no signs of failure due to blistering, chipping, bleeding, discoloration, smearing or spreading under heat or poor adhesion to the pavement materials. Pavement markings that bonded during application and were approved, but debond due to snowplowing will be considered a failed marking. Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 12-month PM observation period.

**(J) Removal of Pavement Markings**

This work includes the removal of all types of pavement marking lines, symbols, and characters including removal for long life marking preparation. This work does not include removal of removable tape pavement markings.

Remove pavement marking lines, characters, and symbols by acceptable methods to the Engineer that will not materially or structurally damage the surface or the texture of the pavement. Leave the pavement surface in a condition that will not mislead or misdirect the motorist.

Where existing pavement markings are to be removed and replaced by other pavement markings, do not begin removal until adequate provisions have been made to complete the installation of the replacement markings. Remove pavement markings such that the surface is in proper condition for adequate bonding of the new markings. Promptly remove any material deposited on the pavement as a result of removing pavement markings as the work progresses by acceptable methods. Provide the equipment necessary to control dust and the accumulation of debris resulting from the removal process. The removal equipment shall provide dust control and the capture of the removed material shall be done utilizing a separate vacuum equipped vehicle or other approved system. Perform the recovery process within the same operation as the removal. Do not let traffic use the lane where the removal is taking place until the recovery system is finished. Should the recovery system fail, cease removal operations until the recovery system is properly operating. The Contractor is responsible for all cleanup and proper disposal of all removed debris from the project site.

When using a grinding method for pavement removal, the equipment shall have multiple heads working in tandem to provide adequate preparation of the surface to accept the new marking material.

Do not apply polyurea pavement markings over existing pavement marking materials. Polyurea may be installed over existing polyurea only on asphalt as long as the existing polyurea is bonded. Application over all other existing pavement marking materials will require the at least 95% of the existing pavement marking material to be removed. However, if one 15 mil application of paint was placed on asphalt pavement less than 6 months old, do not remove the existing paint pavement markings.

Do not apply thermoplastic pavement markings over existing pavement marking materials. Thermoplastic may be installed over existing thermoplastic on asphalt. Application over existing pavement marking materials other than thermoplastic will require the existing pavement marking material to be removed so that a minimum of 85% of the existing pavement marking surface is removed. Before applying thermoplastic pavement markings over the existing thermoplastic pavement markings, remove at least 25% of the oxidized existing thermoplastic. However, if one

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15 mil application of paint was placed on asphalt less than 6 months old, do not remove the existing paint pavement markings.

Use black color #37038 in paint or tape, as determined by Contractor, to cover any remaining conflicting pavement marking after removal from asphalt pavement surfaces. Do not use black paint or tape on concrete pavement surfaces. The black paint will not have a defined shape or edges with a width not exceeding double of the existing lines.

**(K) Pavement Marking Installer Qualifications**

Ensure 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. A certified crewmember shall be present anytime this work is being performed. The certified crewmember is not required to be the same person throughout the life of the contract.

**4.4. THERMOPLASTIC (ALKYD/MALEIC)**

**(A) Application Equipment**

**(1) General**

Use equipment to install hot thermoplastic pavement marking material that includes the following features: Use application equipment 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 Signing and Delineation Unit.

**(2) Premelting Kettle:**

Use equipment to install hot thermoplastic pavement marking material that includes an oil-jacketed or air-jacketed premelt kettle 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.

**(3) 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.

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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.

**(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) of the *Standard Specifications*.

**(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.

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 no more than 2 passes of the application equipment. Arrowheads may be applied by multiple passes of the application equipment, not to exceed 3 passes.

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. Produce in place markings with the minimum retroreflective values shown in the table below, as obtained with a Department approved 30 m mobile or handheld retroreflectometer. Retroreflective measurements will be taken within 30 days after final placement of the pavement marking.

<b>REFLECTOMETER REQUIREMENTS FOR THERMOPLASTIC</b>		
<b>Item</b>	<b>Color</b>	<b>Reflectivity</b>
Standard Glass Beads	White	375 mcd/lux/m <sup>2</sup>
	Yellow	250 mcd/lux/m <sup>2</sup>

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 interim pavement marking paint at the proper width may be placed before installing 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

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produce a dry film thickness of 5 to 8 mils. Apply drop-on glass beads at a rate of 1 to 3 lbs/ gal of paint.

Provide drainage openings at intervals of 250 ft in edge lines placed on the inside of curves and in edge lines on the low side of tangents. Provide openings that are no more than 12" and at least 6" in length.

Produce a cross sectional thickness of the thermoplastic markings above the surface of the pavement in accordance with the table below.

<b>THICKNESS REQUIREMENT</b>	
<b>Thickness</b>	<b>Location</b>
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, yield line symbols and arrow symbols.

**(D) Thermoplastic Marking Observation Period**

In addition to the requirements of PM Observation Period subsection above, maintain responsibility for minimum retroreflective values for a 30-day period beginning upon the Engineer's acceptance of all markings on the Project. Guarantee retroreflective values of the markings during the 30-day period under the payment and performance bond in accordance with Article 105-17 of the *Standard Specifications*.

**4.5. MAINTENANCE**

Replace pavement markings that prematurely deteriorate, fail to adhere to the pavement, lack reflectorization, or are otherwise unsatisfactory, during the life of the project or during the 180-day PM observation period as determined by the Engineer.

Upon notification from the Engineer, winterize the project by placing an initial or additional application of paint pavement marking lines in accordance with Article 1205-8 of the *Standard Specifications*.

**4.6. MEASUREMENT AND PAYMENT**

\_\_\_\_\_ *pavement marking symbols* will be measured and paid as the actual number of pavement marking symbols satisfactorily placed and accepted by the Engineer.

*Removal of pavement marking lines* will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily removed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet derived by multiplying the nominal length of a line by the number of marking lines satisfactorily removed. No payment will be made for the removal of removable pavement marking tape.

*Removal of pavement marking symbols & characters* will be measured and paid as the actual number of pavement marking symbols and characters satisfactorily removed and accepted by the Engineer.

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Payment at the contract unit price for the various items in the contract will be full compensation for all the items covered by this section. No direct payment will be made for: the work involved in applying the lines, including surface preparation; reapplication of molten pavement marking crossed by a vehicle; removal of all pavement marking materials spilled on the roadway surface; and repair of markings tracked by a vehicle.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Thermoplastic Pavement Marking Symbol, 90 mils	Each
Removal of Pavement Marking Lines, 24”	Linear Foot
Removal of Pavement Marking Symbols & Characters	Each

**C-5558****ITS-71****Guilford County****5. SIGNAL HEADS****5.1. DESCRIPTION**

Furnish, install vehicle LED signal heads, visors, interconnecting brackets, wire entrance fittings, mounting assemblies, signal cable, lashing wire, grounding systems, and all necessary hardware.

**5.2. MATERIALS****(A) General**

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

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.

Fabricate tunnel and traditional visors for vehicle signal heads from ultraviolet and heat-stabilized virgin polycarbonate material. Fabricate tunnel and traditional visors for pedestrian signal heads 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 595C, 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 1¼-inch vertical conduit entrance hubs with the hubs capped on the lower plate and 1½-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.

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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 (QPL) 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 – Light Emitting Diode (LED) Pedestrian Traffic Signal Modules.

(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 as 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,
6. Evidence of approval of the product to bear the Intertek ETL Verified product label for LED traffic signal modules.

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 or City. Repaired or refurbished modules may not be used to fulfill the manufacturer's warranty obligations. Provide manufacturer's warranty documentation to the Department during evaluation of product for inclusion on the ITS and Signals 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



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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 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 stainless steel cable attachment assemblies to secure the brackets to the mast arms. Ensure all fastening hardware and fasteners are fabricated from stainless steel.

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.

**C-5558****ITS-74****Guilford County****(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 this project shall appear on the current NCDOT ITS & Signals 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 2012 or most recent ITS & Signals QPL. 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:

<b>Module Type</b>	<b>Max. Wattage at 165° F</b>	<b>Nominal Wattage at 77° F</b>
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  $\pm 1\%$  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.

**(2) LED Arrow Signal Modules**

Provide 12-inch omnidirectional arrow signal modules. All makes and models of LED modules purchased for use on this project shall appear on the current NCDOT ITS & Signals 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 2012 or most recent ITS & Signals QPL. In addition, provide manufacturer's certification in accordance with Article 106-3 of the *Standard Specifications*, that each module meets or exceeds the requirements 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:

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

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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 12 Watts or less.

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

**(C) LED U-Turn Arrow Signal Modules:**

Provide modules in the following configurations: 12-inch left u-turn arrow signal modules and 12-inch right u-turn arrow signal modules.

Modules are not required to be listed on the ITS and Signals Qualified Products List. 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 have minimum maintained luminous intensity values that are not less than 16% of the values calculated using the method described in section 4.1 of the VTCSH Circular Supplement.

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

<b>Module Type</b>	<b>Max. Wattage at 165° F</b>	<b>Nominal Wattage at 77° F</b>
12-inch red u-turn arrow	17	11
12-inch green u-turn arrow	15	15

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

Note: Use a wattmeter having an accuracy of  $\pm 1\%$  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.

**(D) LED Bi-Modal Green-Yellow Arrow Signal Modules**

Provide 12-inch omnidirectional bi-modal arrow signal modules. Ensure both green and yellow arrow indications are in each module with a clear lens that is integral to the unit. Ensure both indications display an incandescent style look.

Modules are not required to be listed on the ITS and Signals QPL. Ensure that both indications along with the module meet or exceed the requirements in sections 1, 2, 3, 4 and 5 of the 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:

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<b>Arrow Type</b>	<b>Nominal Wattage at 77° F</b>
12-inch yellow arrow	12
12-inch green arrow	11

Note: Use a wattmeter having an accuracy of  $\pm 1\%$  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.

**(E) 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.

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.

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

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an assembly that uses LEDs as the light source in lieu of an incandescent lamp. Use LEDs that are of the latest 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.

Design all modules to operate using a standard 3 - wire field installation. Provide spade terminals 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 date of manufacture (month & year) or some other method of identifying date of manufacture.

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 2012 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 Indicators - Light Emitting Diode (LED) Signal Modules" dated August 04, 2010 (hereafter referred to as PTCSI Pedestrian Standard) and other requirements stated in this specification.

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

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

Note: Use a wattmeter having an accuracy of  $\pm 1\%$  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.

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.

Ensure the countdown display continuously monitors the traffic controller to automatically learn the pedestrian phase time and update for subsequent changes to the pedestrian phase time.

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Ensure the countdown display begins normal operation upon the completion of the preemption sequence and no more than one pedestrian clearance cycle.

**(F) 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.

**5.3. CONSTRUCTION METHODS****(A) General**

Bag new vehicle signal heads with burlap bags or bags made of non-ripping material specifically designed for covering signal heads until signal heads are placed in operation. Do not use trash bags of any type.

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

Adjust each signal head vertically and horizontally so that light output will be of maximum effectiveness for traffic and pedestrians. Do not tilt signal heads forward.

**(B) Vehicle Signal Heads**

Install vehicle signal heads such that the top of the signal housing located over any portion of a highway that can be used by motor vehicles is no more than 25.6 ft above the pavement.

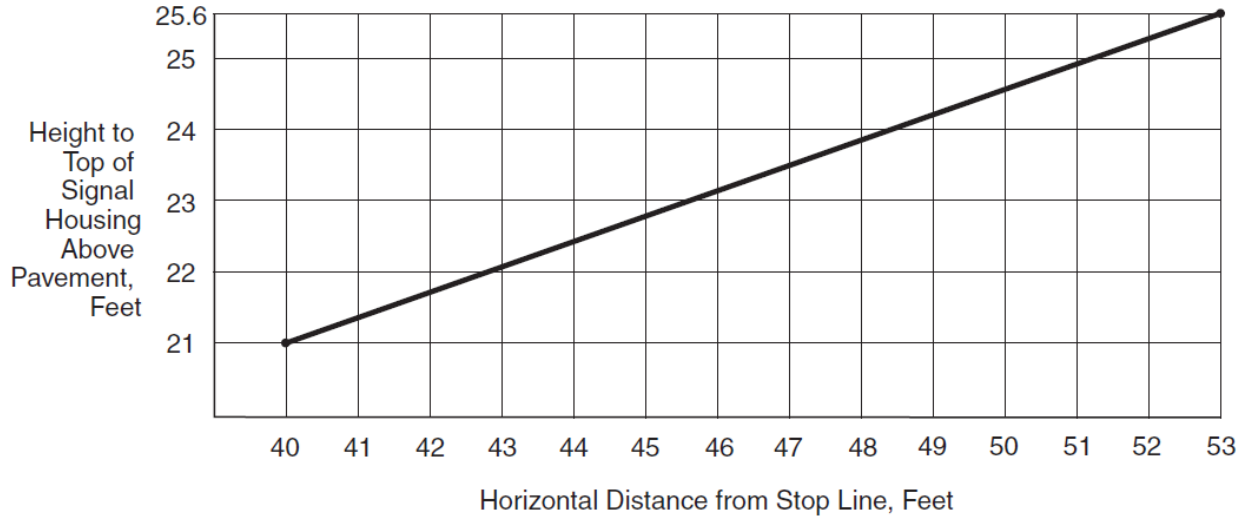
Install vehicle signal heads such that the maximum mounting height to the top of the signal housing is as shown in the graph below if the location is between 40 ft and 53 ft from the stop line.

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**Maximum Mounting Height of Signal Heads  
Located Between 40 Feet and 53 Feet from Stop Line**



**Graph of maximum mounting height of signal heads.**

Install vehicle signal heads such that the bottom of the signal housing and any related attachments to the signal head located over any portion of a highway that can be used by motor vehicles is at least 15 feet (preferably at least 16.5 feet) above the pavement directly below the signal head.

- 1) Install vehicle signal heads such that the bottom of the signal housing (including brackets) of a signal head that is vertically arranged and not located over a roadway is as follows:
  - (a) A minimum of 8 ft and a maximum of 19 ft above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
  - (b) A minimum of 8 ft and a maximum of 19 ft above the median island grade of a center median island if located on the near side of the intersection.
- 2) Install vehicle signal heads such that the bottom of the signal housing (including brackets) of a signal head that is horizontally arranged and not located over a roadway is as follows:
  - (a) A minimum of 8 ft and a maximum of 22 ft above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
  - (b) A minimum of 8 ft and a maximum of 22 ft above the median island grade of a center median island if located on the near side of the intersection.

Where vehicle signal heads are installed on messenger cable, install mounting hardware consisting of 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.

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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.

Wrap signal cable to messenger cable with at least 4 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 at any other point between signal heads and controller cabinet.

Coil sufficient signal cable beside each vehicle signal head to accommodate head shifts during various construction phases. For final signal head locations, coil 36 inches on each side of signal head if signal cable comes from both directions. If signal cable terminates at the signal head, coil 36 inches of signal cable on the same side as the cable run.

**(C) Pedestrian Signal Heads**

Install signs with mounting hardware immediately above pedestrian pushbuttons.

Mount the pushbutton or accessible pedestrian signal (APS) at a minimum height of 3.5 ft but no higher than 4.0 ft above the adjacent pedestrian travelway.

Connect each pushbutton with a separate run of lead-in cable between the pushbutton and the termination panel in the controller cabinet. Bond pushbutton housing and all metal components to cabinet ground using lead-in cable ground.

Mount pedestrian signal heads so that the bottom of the signal housing, including brackets, is not less than 7 ft or more than 10 ft above sidewalk level. Position and adjust the heads to provide maximum visibility at the beginning of the controlled crosswalk. Ensure pedestrian signal heads and vehicular signal heads mounted on the same support are physically separated from each other.

**5.4. 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 furnished, installed, and accepted.

*Vehicle signal head* (\_\_\_\_\_with bi-modal section) will be measured and paid as the actual number of signal heads of each type, size and number of sections with a bi-modal section furnished, installed and accepted.

No measurement will be made of visors, wire entrance fittings, interconnecting brackets, mounting assemblies, pedestrian pushbuttons, and pedestrian signal signs as these will be considered incidental to furnishing and installing vehicle and pedestrian signal heads.

*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 for drip loops, coiled sections, aluminum wrapping tape or lashing wire as these will be considered incidental to furnishing and installing signal cable.



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Payment will be made under:

**Pay Item**

Vehicle Signal Head (12", 3 Section)

Vehicle Signal Head (12", 4 Section)

Vehicle Signal Head (12", 5 Section)

Vehicle Signal Head (12", 3 Section with Bi-Modal Section)

Pedestrian Signal Head (16", 1 Section w/Countdown)

Signal Cable

**Pay Unit**

Each

Each

Each

Each

Each

Linear Foot

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Furnish and install messenger cable (span wire) with cable clamps, machine bolts, eyebolts, 3-bolt clamps, J-hooks, eye nuts, split-bolt connectors, metal pole clamps, stainless steel bands, and all necessary hardware.

Furnish and install pole grounding systems consisting of #6 AWG solid bare copper wire, messenger bonding clamps, hot-dipped galvanized wire staples, ground rods, and exothermic welding.

**6.2. MATERIALS****(A) General**

Material, equipment, and hardware furnished under this section shall be pre-approved on the ITS & Signals QPL.

**(B) Messenger Cable**

Comply with ASTM A475 for extra high strength grade wire strand, Class A zinc coating. Fabricate messenger cable from seven steel wires twisted into a single concentric strand.

**(C) Pole Line Hardware**

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

Provide other pole line hardware constructed of hot-dipped galvanized steel conforming to ASTM A153.

Provide machine bolts, eyebolts, and thimble eye bolts with minimum tensile strength of 12,400 lbs. Provide hot-dipped galvanized nuts, 3" x 3" curved square washers, and thimbleyelets.

Provide suspension clamp fabricated from hot-dipped galvanized steel with minimum length of 5 3/4". Ensure clamp has a groove rated for the messenger cable size it is intended to secure. Provide J-hook fabricated from 3/8" thick hot-dipped galvanized steel flat or oval stock with sufficient hook radius to cradle 11/16" diameter cable. Provide two 1/2" diameter hot-dipped galvanized bolts and nuts to tighten the clamp around the messenger cable. Provide one 5/8" diameter hot-dipped galvanized bolt of sufficient length to attach J-hook and clamp to the wood pole with a 3" x 3" curved square washer and double nuts.

Provide 3-bolt clamp fabricated from hot-dipped galvanized steel with minimum length of 5-3/4". Ensure clamp has 2 parallel grooves rated for the messenger cable size it is intended to secure. Provide three 5/8" diameter hot-dipped galvanized bolts and nuts to tighten the clamp around the messenger cable.

Provide parallel groove clamp consisting of high strength, high conductivity non-copper bearing aluminum alloy clamp halves with interlocking fingers to prevent mismatch. Ensure clamp halves have molded grooves to secure #8-1/0 AWG stranded copper wires. Provide clamps with grooves prefilled with antioxidant joint compound. Provide 3/8" hex head, square shank, galvanized steel bolt with galvanized steel lock washer and nut.

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Provide 1/2" and 3/4" wide, .030" thick Type 316 stainless steel straps with Type 316 stainless steel buckles.

Provide either 0.05" x 0.30" aluminum wrapping tape or 0.06" diameter Type 316 stainless steel lashing wire for lashing cables to messenger cable. Ensure aluminum wrapping tape is 1350 alloy, O-temper, with 12,800 psi tensile strength. Use 0.045" diameter Type 316 stainless steel lashing wire to lash fiber-optic communications cable to messenger cable.

Provide hot-dipped galvanized steel clamp with groove sized for 1/4" to 3/8" messenger cable for securing lashing wire(s) to messenger cables at ends of each spiraled run. Ensure clamp hardware is hot-dipped galvanized steel.

Provide galvanized metal pole clamps and stainless steel banding hardware for attaching pole line hardware (e.g., strandvises, three-bolt clamps, etc.) to metal signal poles.

Refer to the following article 1091-2, "Wire", of the *Standard Specifications*.

**(D) Grounding Electrodes**

Provide grounding electrodes (i.e., ground rods) as indicated in these Project Special Provisions and on the Plans. Provide 5/8" diameter, 10-foot long, copper-clad steel ground rods with 10 mil thick copper cladding.

**6.3. CONSTRUCTION METHODS**

**(A) General**

Install guy assemblies before installing messenger cable.

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

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

For messenger cable crossing over railroad tracks, provide a minimum of 27 feet of vertical clearance, unless otherwise specified.

For permanent installations, 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 sag of surrounding utilities. Otherwise, allow 3% to 4% sag of the span length between poles.

For mid-run spans using wood poles, attach messenger cable to the pole with a 3-bolt cable clamp with J-hook consisting of 5/8" diameter machine bolts, J-hooks, washers and square nuts to attach messenger cable to wood poles. Provide machine bolts that are 3" longer than the pole diameter. For mid-run spans using metal or other Department-approved poles, attach messenger cable to the pole with a 3-bolt clamp with J-hook secured to the metal pole via a pole band clamp. Refer to *Metal Pole Standard Drawing Sheet M6* found on the Department's website.

When terminating spans at wood poles, connect messenger cable to a dead-end strandvise attached to the pole via a 5/8" diameter shoulder eye bolt or 5/8" diameter shoulder angle bolt with 5/8" eye nut as shown in *Roadway Standard Drawing No. 1720.01*. When terminating spans at metal or other Department-approved poles, connect messenger cable to a dead-end strandvise attached to the pole via a pole attachment clamp. Refer to *Metal Pole Standard Drawing Sheet M6* as shown in the previous paragraph. Do not install more than one messenger cable and

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strandwise assembly to a single metal or other Department-approved pole attachment clamp. During installation, ensure that messenger cable is centered and directly aligned at the pole clamp's attachment point such that the cable does not exert forces on the sides of the clamp's attachment point.

Do not drill holes in metal poles to attach messenger cable. Do not attach messenger cable to metal poles that are owned by anyone other than the City or the Department without prior approval of the Engineer and the pole owner. Where such attachments are approved, use attachment methods and hardware approved by the pole owner.

Maintain electrical continuity at all splices.

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

**(B) Messenger Cable for Signal Heads or Loop Lead-In Cable**

For messenger cable attached to joint use poles, install a new pole grounding system that complies these Project Special Provisions. If a pole ground exists on a 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 parallel groove clamps at each end. If existing poles do not have a pole grounding system, install a new pole grounding system that complies with the requirement of the "Wood Poles" section of the *Standard Specifications*, except use hot-dipped galvanized 1.5" wire staples to secure ground wire to pole, spacing the staples along the pole as follows:

- 4 inches apart from ground level to 8 feet above ground level;
- 24 inches apart from 8 feet above ground level to point adjacent to uppermost span.

**(C) Messenger Cable for Communications Cable**

For messenger cable attached to joint use poles, bond messenger cable to existing pole ground at each end and at 1300-foot intervals. Install bond using #6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or parallel groove clamp at each end. If existing poles do not have a pole grounding system, install a new pole grounding system that complies with the requirement of the "Wood Poles" section of the *Standard Specifications*, except use hot-dipped galvanized 1.5" wire staples to secure ground wire to pole, spacing the staples along the pole as follows:

- 4 inches apart from ground level to 8 feet above ground level;
- 24 inches apart from 8 feet above ground level to point adjacent to uppermost span.

**(D) Messenger Cable for Multiple Cables**

On multiple messenger cable arrangements, connect all messenger cable ends with #6 AWG minimum solid bare copper wire and bond with split bolt connectors or parallel groove clamp and terminate to pole ground.

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**6.4. 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, eye bolts, 3-bolt assemblies, eye nuts, split bolt connectors, metal pole clamps, stainless steel banding hardware, and pole grounding systems (including #6 AWG solid bare copper wire, messenger bonding clamps, hot-dipped galvanized wire staples, ground rods, or exothermic welding) as these will be considered incidental to furnishing and installing messenger cable. Bonding to an existing pole grounding system will be considered incidental to furnishing and installing messenger cable.

Payment will be made under:

**Pay Item**

Messenger Cable (1/4")

**Pay Unit**

Linear Foot

## 7. UNDERGROUND CONDUIT

### 7.1. 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.

### 7.2. MATERIALS

#### (A) General

Except for HDPE conduit, furnish material, equipment, and hardware under this section that is pre-approved on the ITS and Signals QPL.

Refer to the following articles of the *Standard Specifications*:

Backfill 1018-2

Graded Stone 545-2 and 545-3

#### (B) Conduit Bodies, Boxes and Fittings

Use conduit bodies, boxes, and fittings that meet UL Standard 514A or 514B for electrical and communications installations.

#### (C) Conduit Types

##### (1) Rigid Metallic Conduit

Provide rigid hot dipped galvanized steel conduit that meets UL Standard 6 with rigid full weight sherardized or galvanized threaded fittings.

##### (2) PVC Conduit

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

##### (3) Solid Wall HDPE Conduit

Use HDPE conduit that conforms to UL Standard 651B. Provide conduit meeting the requirements of the table below with minimum wall thickness ratios corresponding to EPEC-40 (Schedule 40), EPEC-80 (Schedule 80) or EPEC-B (SDR 13.5) as listed in UL Standard 651B, Table 5.1, 5.2 and 5.3.

Provide HDPE conduit with an outer diameter to minimum wall thickness ratio that complies with ASTM D 3035, Standard Dimension Ratio (SDR) 13.5.

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<b>HDPE CONDUIT SIZE</b>	
<b>Conduit Trade Size</b>	<b>Furnish</b>
1"	EPEC-40
1-1/4"	EPEC-40
1-1/2"	EPEC-B (SDR 13.5)
2"	EPEC-B (SDR 13.5)
2-1/2"	EPEC-B (SDR 13.5)
3"	EPEC-B (SDR 13.5)
4"	EPEC-B (SDR 13.5)
5"	EPEC-80
6"	EPEC-80

Ensure the PE resin compounds used in manufacturing the conduit meet or exceed the cell classification PE 334420C (black with 2% minimum carbon black) or PE 334420E (colored conduit with UV inhibitors) in ASTM D3350 and the table below.

<b>RESIN PROPERTIES</b>		
<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Density	0.940 - 0.947g/cm <sup>3</sup>	ASTM D1505 ASTM D792 ASTM D4883
Melt Index (condition 190/2.16 is acceptable)	< 0.4 grams/10 minutes	ASTM D1238
Flexural Modulus	80,000 psi, min.	ASTM D790
Tensile Strength	Tensile Strength 3,000 psi, min.	ASTM D638
Elongation	Elongation 400%, min.	ASTM D638
Slow Crack Growth Resistance	An ESCR as per condition B, 10% IGEPAL requirement of F50>24 hrs is allowable	ASTM D1693
Hydrostatic Design Basis	"0" for Non-Pressure Rated Pipe	ASTM D2837
UV Resistance (Outdoor Conduit Only)	Stabilize with at least 2% by weight carbon black or colored with UV Inhibitor	ASTM D4218

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Furnish conduits in the colors for the applications shown in the table below. For conduits manufactured with stripes, ensure the stripes are uniformly located around the conduit with 120 degrees of separation. Do not use “Solid Yellow” or “Black with Yellow Stripes” conduit.

<b>CONDUIT COLORS</b>		
<b>Conduit Contents</b>	<b>Preferred Solid Color</b>	<b>Alternate</b>
Signal Cable	Black	None
Loop Lead-in Cable	White	Black with White Stripes
Communications Cable (Copper, Fiber Optic, Coaxial)	Orange	Black with Orange Stripes
Electrical Power Cable	Red	Black with Red Stripes

Ensure the HDPE conduit is resistant to benzene, calcium 1 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 factory lubricated, low friction, conduit with a coefficient of friction of 0.10 or less in accordance with Telcordia GR-356. Ensure the supplied conduit is identified and certified as meeting, UL Standard 651B. Ensure the conduit is marked at least with the following information on 10 ft or less intervals:

- 1) Material: HDPE
- 2) Trade Size: i.e., 2"
- 3) Conduit Type: SDR 13.5 or EPEC-B
- 4) Manufacturer’s name or trademark
- 5) Manufacturer’s identity code to identify manufacturing date, facility, etc.
- 6) UL symbol or UL listing number

Furnish coilable conduit that is supplied on reels in continuous lengths for transportation and storage outside. Ensure that the process of installing the coilable conduit on the reel does not alter the properties or performance of the conduit for its intended purpose.

**(D) Conduit Plugs, Pull Line, and Tracer Wire**

Furnish conduit plugs that provide a watertight barrier when installed in conduit. Furnish conduit plugs sized in accordance with conduit. Ensure conduit plug provides a means to secure a pull line to the end of the plug. Provide removable and reusable duct plugs. Conduit plugs are not required to be listed electrical devices.

For all spared conduits, furnish 3/4”, pre-lubricated, woven polyester tape, pull line with minimum rated tensile strength of 2,500 lb. Pull lines are not required to be listed electrical devices.



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

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

**(E) Mechanical Couplings for HDPE Conduit**

Provide mechanical couplings that are both watertight and airtight for joining two segments of HDPE conduit of like diameter. Provide couplings designed to accommodate pneumatic methods of cable installation. Provide couplings suitable for burial underground and which meet the following requirements:

- The coupling shall not fail by leakage when subjected to sustained internal pressure testing as noted in ASTM F 2176.
- The coupling shall not fail by leakage when subjected to sustained external pressure testing as noted in ASTM F 2176.
- The coupling assemblies tested shall be able to comply with the tensile loading requirements as specified in ASTM F 2176.
- As specified in ASTM F 2176, the coupling shall not fail when conditioned at low temperature conditions of 10° F and tested by an impact with a force of 20 ft-lb using Type “B” as described in Test Method ASTM D 2444.

**(F) Duct and Conduit Sealer**

Use duct and conduit sealer or mastic which is a putty-like compound and:

- Is permanently non-hardening, non-oxidizing, and non-corrosive to metals, rubber, plastic, lacquer and paints;
- Is readily workable for thumbing into openings and forming into seals around wires inside conduits and openings around conduits;
- Has a service temperature range of minus 30°F to 200°F;
- Is clean, non-poisonous and non-injurious to human skin;
- Seals against water, dust and air and shall adhere to wood, glass, plastics, metal, rubber and painted surfaces; and
- Is non-conductive.

### **7.3. CONSTRUCTION METHODS**

**(A) General**

Except where the Plans call for a specific installation method or where the Engineer directs otherwise, underground conduit may be installed by either trenching, directional drilling or plowing at the option of the Contractor but will be measured and paid for as “underground conduit,” regardless of installation method (see “Measurement and Payment” subsection).

Refer to Section 1 of these Project Special Provisions for additional requirements concerning work within and adjacent to historic districts.

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

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

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

All conduits installed in a common trench or bore must be the same size and all conduits in a continuous longitudinal run must be the same size. Do not intermix different size conduits in the same run.

Install a minimum of two conduits (i.e., at least one for fiber-optic cable plus one dedicated spare) for all underground routes unless the Plans show otherwise. Exceptions on plans may include short runs to CCTV cameras, short PVC runs to controller cabinets from main trunk line, or installations under railroad tracks.

Install junction boxes in underground conduit runs as shown on the Plans. Do not exceed 150 feet between junction boxes in any underground conduit route that conveys traffic signal or lead-in cable and 1,000 feet between junction boxes in any underground conduit route that conveys communications cable without the prior approval the Engineer.

#### **(1) Conduit Entering Junction Boxes**

Terminate conduits installed for communications cables (fiber optics, Ethernet and coaxial) in oversized or special-sized junction boxes as shown on the Plans. Do not install other conduits in these junction boxes 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 conduit plugs. Seal conduits containing fiber-optic communications cable, Ethernet cable, signal cable and lead-in cable with duct and conduit sealer.

#### **(2) Tracer Wire**

Install tracer wire in all conduits containing fiber-optic cable, unless otherwise indicated on the Plans or the Engineer directs otherwise. Pull tracer wire simultaneously in 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. Splice tracer wire only in cabinets and junction boxes using waterproof butt splice connectors. Coil and store 10 feet of spare tracer wire in junction boxes. Label all tracer wires entering an equipment cabinet. For a given tracer wire run between two controller cabinets, bond the tracer wire to the equipment ground inside the controller cabinet at one end of run only; do not bond both ends of the tracer wire in a continuous run to cabinet grounds at each end of the run. Establish a consistent convention for which end the tracer wire will be bonded along a give roadway or corridor. For example, bond the end of the tracer wire closest/to (in the direction of) the High Point TOC.

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**(3) Ground Surface Restoration**

Upon completion of conduit installation and backfilling of all trenches and other excavations, restore the disturbed ground to its original condition as determined and approved by the Engineer. For paved areas, replace removed or damaged pavement with in kind materials, matching the elevation, color, texture/finish and general appearance of the surrounding pavement. Refer to Section 1 of these Project Special Provisions for additional requirements concerning sidewalks and curbs in historic districts. For unpaved areas, backfill excavations with removed material, tamp the backfilled material and rake smooth the top 1½ inches. Finish unpaved areas flush with surrounding natural ground and to match the original contour of the ground. Seed with same type of grass as surrounding area and mulch the newly seeded area. If unpaved area was not grassed, replace the original ground cover in kind as directed by the Engineer.

Complete repairs to and restoration of all ground (paved and unpaved) disturbed by construction within five consecutive calendar days following initial removal. If the Contractor fails to repair and restore the ground in accordance with these Project Special Provisions within the time frame specified, the Department reserves the right to make the necessary repairs, and all expenses incurred by the Department in making the repairs and restoring the ground will be deducted from payment due the Contractor, plus **\$500 liquidated damages per occasion, per day, or any portion** thereof, until corrected.

**(4) Plan of Record Drawings**

Upon completion of the conduit system for communications, furnish the Engineer with a plan of record drawing detailing both the horizontal and vertical (i.e. depth) locations of the conduit system.

**(B) Trenching****(1) General**

Install PVC, HDPE, or rigid metallic conduit for all underground runs as specified in the Plans. Install rigid metallic conduit for all trenched underground runs located inside railroad right-of-way, unless otherwise specified. Clean existing underground conduit to be incorporated into a new system by drawing a mandrel through the conduit followed by a swab. Clear obstructions or blockages in an existing underground conduit designated for reuse by using compressed air, water jetting, rod and mandrel or other method as approved by the Engineer. Once obstruction/blockage has been cleared, perform aforementioned cleaning procedure to clean out any remaining materials which may cause cable abrasions. 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 longitudinally in the trench 6 to 12 inches below the unpaved ground surface or below the underside of the paved surface.

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. If ditches are present, install conduit a minimum of 4 feet from the bottom of the ditch line.

Maintain a minimum trench depth of 30” (or 12” in areas blocked by rock or impenetrable obstructions) below finished grade or 6” below roadway sub-base, whichever is deeper. Upon completion, restore surface to like-original condition within five consecutive calendar days of

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

Use HDPE conduit in trenched areas unless otherwise specified in the Plans. Use 2-inch PVC or rigid galvanized conduit between junction boxes adjacent to the controller cabinet and the 2-inch conduit stub-outs from the cabinet foundation.

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

### **(2) Unpaved Trenching**

Install conduit in unpaved areas. Rake smooth the top 1-1/2 inches and seed with same type of grass as surrounding area. Finish unpaved areas flush with the surrounding natural ground. Restore damaged grassed areas. Seed and mulch, using methods and material approved by the Engineer, within five consecutive calendar days following initial damage to grassed areas, unless the Engineer approves otherwise due to weather and soil conditions. If the Contractor fails to repair the grassed areas in accordance with these Project Special Provisions within the time frame specified, the Department reserves the right to make the necessary repairs, and all expenses incurred by the Department in making the repairs and restoring the grassed area will be deducted from payment due the Contractor, plus **\$500 liquidated damages per occasion, per day, or any portion thereof**, until corrected.

Adapt operations to variations in weather or soil conditions as necessary for the successful establishment and growth of the grasses. When the Engineer determines that weather and soil conditions are unfavorable, including but not limited to extremely wet or frozen soil, do not distribute any limestone or fertilizer and do not sow any seed. During seasons of the year when temperatures are not conducive to germination and growth of the type of grass seed to be planted, seed and mulch the disturbed areas with temporary seeding that will germinate and grow under the prevailing temperatures until such time that permanent seeding can be established, as approved and directed by the Engineer.

As directed by the Engineer, apply additional seed or completely reseed areas which have been previously seeded and mulched but which have been damaged, have failed to successfully establish a stand of vegetation or have an unsatisfactory cover of vegetation. Perform supplemental and repair seeding promptly at all locations and times as directed by the Engineer.

### **(3) Paved Trenching**

On concrete surfaces, replace the entire joint of concrete and match the original concrete as to color and finish unless otherwise specified. On all other surfaces, neatly cut and replace the

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width of trench with like material. Refer to Section 1 of these Project Special Provisions for additional requirements concerning sidewalks and curbs in historic districts. Place graded stone material to temporarily maintain pedestrian traffic where repairs cannot be performed immediately.

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 of the *Standard Specifications*.

Complete repairs to all paved areas removed for construction within five consecutive calendar days following initial removal. If the Contractor fails to repair the paved area in accordance with these Project Special Provisions within the time frame specified, the Department reserves the right to make the necessary repairs, and all expenses incurred by the Department in making the repairs and restoring the paved area will be deducted from payment due the Contractor, plus **\$500 liquidated damages per occasion, per day, or any portion thereof**, until corrected.

**(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.

**(D) Directional Drilling**

**(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.

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For the following structures, the minimum clearance requirements are:

<b>MINIMUM CLEARANCE REQUIREMENTS FOR STRUCTURES</b>	
<b>Man-made Structure</b>	<b>Minimum Clearance Requirement</b>
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 60" or less	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

At points where HDPE conduit will traverse under the East Fork Deep River, maintain a minimum depth of 10 feet from top of conduit to bottom of river bed at all points along the bore. In addition, maintain a depth of at least 10 feet below the surface of the river banks.

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, storm sewer systems or bodies of water (streams, rivers, ponds and lakes). Prevent drilling fluid/slurry from accumulating on or flowing onto pedestrian walkways, driveways, and streets. Disposal on public or railroad right-of-way or railroad drainage ditches/facilities is prohibited. Immediately remove all drilling fluids/slurry that are accidentally spilled.

Provide all drilling equipment, tooling, personnel and techniques necessary to complete the installation of the underground conduit through directional drilling for all soil conditions encountered, all drilling depths specified and all drilling lengths specified in these Project Special Provisions and as shown in the Plans.

## **(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.

For directional drilling beneath the East Fork Deep River, locate all drilling equipment materials, launch hole and receiving pit outside of the 50-foot buffer from top of bank required for Randleman Lake watershed.

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No geotechnical investigations have been performed at the sites of proposed directional drill operations for this project. Prior to performing the directional drilling operation, field investigate the site of the proposed directional drill conduit, including but not limited to walking the bore path and talking to adjacent property owners, to ascertain the soil conditions that may be encountered and to review the site's topography. Ensure that the equipment, tooling, personnel expertise and techniques used at each site are sufficient to complete the directional drill operation successfully, regardless of soil conditions encountered. At all times, have alternate drill heads available in case the soil conditions do not match expected conditions.

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. 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. Use back reamer that 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 Project Special Provisions 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.

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.

### **(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% 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. Disposal on public or railroad right-of-ways or within public or railroad drainage ditches/facilities is prohibited. Disposal in streams, rivers, ponds, lakes and wetlands is also prohibited.

### **(E) Maximum Length of Directional Drill**

The length of a directional drill shall not exceed 1,000 feet measured horizontally along the route of the directionally drilled conduit(s), unless otherwise approved by the Engineer. For

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routes longer than 1,000 feet, begin a successive directional drill where the first directional drill reaches 1,000 feet and install an oversized heavy-duty junction box where the two directional drilled conduit runs meet. The spacing of junction boxes in a directionally drilled route shall not exceed 1,000 feet.

**(F) Splicing and Coupling of HDPE Conduit**

Install a continuous HDPE conduit free from splices or couplings between junction boxes whenever possible. However, splicing or coupling of HDPE conduit may be permitted, subject to the prior approval of the Engineer, to complete an underground HDPE conduit run when the end of an HDPE reel is reached. However, splicing in the middle of a directional drill operation is prohibited.

Join the HDPE conduit ends by installing mechanical couplings in accordance with the manufacturer's instructions or by splicing the conduits using either a butt-fusion welder or an electro-fusion welder. Submit the proposed method of coupling or splicing the conduits to the Engineer for review and approval prior to joining any HDPE conduits.

Otherwise, install an oversized junction box where the ends of the HDPE conduits meet in lieu of joining the ends through splicing and coupling. Install an oversized junction box where the number of conduits in the underground run changes and where a directionally drilled conduit meets a trenched conduit. For example, install an oversized junction box where two directionally drilled conduits meet a single run of trenched conduit.

**7.4. 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.

*Underground conduit (qty)(size)* will be measured in horizontal linear feet of underground conduit installation of each type furnished, installed, and accepted, without regard to the installation method. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

No measurement will be made of 1" underground conduit that conveys electrical service wire between a service riser and a disconnect/meter and between a disconnect and an equipment cabinet as such work will be considered incidental to furnishing and installing a new electrical service, furnishing and installing and CCTV cabinet disconnect or modifying an existing electrical service. (See "Electrical Service" section of these Project Special Provisions).

*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 made in linear feet. When directional drilling is used where the Plans call for "Underground Conduit", directional drilling will be measured and paid for as Underground Conduit. There will be no additional compensation for field-investigating site conditions nor for providing any specialized equipment, tooling, personnel or techniques necessary to complete the installation of the underground conduit through directional drilling for the soil conditions encountered, including but not limited to rock, or for deep or long bores. There will be no additional requirements for any special



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measures required to protect bodies of water such as rivers, streams, ponds and lakes when drilling beneath as required by local, state and federal rules and regulations.

No measurement will be made of vertical segments, non-metallic conduit, metallic conduit, conduit sealing material, pull lines, duct plugs, marker tape, and miscellaneous fittings, as these will be considered incidental to conduit installation.

No measurement will be made of clearing existing blockages and obstructions from existing conduits nor for cleaning existing conduits prior to installation of new communications cable inside the existing conduits as such work will be considered incidental to furnishing and installing the communications cable.

No measurement will be made of restoration of paved roadways/driveways and unpaved ground surfaces with like materials, including but not limited to backfill, graded stone, paved materials, seeding and mulching, as this work will be considered incidental to conduit installation. No measurement will be made of removing, stockpiling and resetting existing granite curb as such work will be considered incidental to conduit installation. The Department will make no payment for a given underground conduit run until all repairs to paved and unpaved surfaces damaged/disturbed during the installation of the underground conduit have been completed and accepted.

Repair and replacement of existing sidewalk will be measured and paid for in accordance with the "Equipment Cabinet Foundations" section of these Project Special Provisions.

No measurement will be made of horizontal segments between the base of a riser and an adjacent junction box or base-mounted cabinet foundation that are 10 feet or less in length measured from the center of the riser to the center of the junction box or from the center of the riser to the center of the vertical sweep through the cabinet foundation as these will be considered incidental to riser installation.

No measurement will be made of conduit segments between adjacent traffic signal system junction boxes that are 10 feet or less in length measured from center of junction box to center of junction box as these will be considered incidental to furnishing and installing the junction boxes.

Conduit will be paid for per linear foot based on quantity and size of conduits. As examples, an installation of a single 2" HDPE conduit would be paid as:

Directional Drill (1)(2") Linear Foot

No measurement or payment will be made for furnishing and installing and subsequently removing graded stone material for temporary maintenance of traffic where a portion of existing pavement has been removed as such work will be considered incidental to furnishing and installing underground conduit.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Tracer Wire	Linear Foot
Underground Conduit (1)(2")	Linear Foot
Underground Conduit (2)(2")	Linear Foot
Directional Drill (2)(2")	Linear Foot

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## 8. JUNCTION BOXES

### 8.1. DESCRIPTION

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

### 8.2. MATERIALS

#### (A) General

Provide electrical junction boxes with covers of the type and size indicated by the contract or the Plans for the termination of conduits, for splicing loop wires to loop lead-in cables and for splicing and storing fiber-optic communications cable.

Except for special-sized junction boxes, material, equipment, and hardware furnished under this section shall be pre-approved on the ITS and Signals QPL.

Provide #67 washed stone aggregates in conformance with Sections 545 and 1005 of the *Standard Specifications*.

#### (B) Polymer Concrete (PC) Junction Boxes

Provide polymer concrete (PC) boxes which are stackable, have bolted covers and have open bottoms. Ensure vertical extensions of 6" to 12" are available from the junction box manufacturer.

Use polymer concrete material made of an aggregate consisting of sand and gravel bound together with a polymer and reinforced with glass strands to fabricate box and cover components which are exposed to sunlight. Other thermosetting glass-reinforced materials may be used for components which are not normally exposed to sunlight.

Provide certification that the polymer concrete boxes and covers meet Tier 15 requirements of ANSI/SCTE 77. Provide certification that testing methods are compliant with ANSI/SCTE 77.

Provide junction box covers with the required logos on the cover as follows:

- For standard size junction boxes, provide covers with the standard *Traffic Signal* logo.
- For oversized and special-sized junction boxes, provide covers with the following log/imprint: *HPDOT – F.O.* (line 1), (336) 883-3225 (line 2).

Provide at least 2 size 3/8" diameter hex head stainless steel cover bolts to match inserts in the box. Provide pull slot(s) with stainless steel pin(s). Polymer concrete junction boxes are not required to be listed electrical devices.

#### (C) Replacement Covers for Existing Junction Boxes

Furnish polymer concrete covers that comply with the material requirements of the "Polymer Concrete (PC) Junction Boxes" subarticle above to replace existing reinforced concrete junction box covers that are damaged and deteriorated. Provide junction box covers with rounded corners that have a nominal dimensions of 17" (w) x 30" (l) x 2" (h) and that are compatible with the existing Brooks Products #66 concrete junction boxes. Ensure that covers will seat properly inside the frame of the existing junction box so that the top of the cover will be flush with the

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surrounding rim of the junction box without modifying the existing junction box or the new cover and without the use of gap-filling or leveling materials (i.e., shims, gaskets, adapters, filler rods, etc.). Field measure and inspect existing Brooks Products concrete junction boxes currently in use in High Point to confirm dimensions and replacement cover requirements. Furnish heavy duty covers that are pre-approved for use with the oversize junction boxes on the NCDOT ITS and Signals QPL.

Submit for the Engineer's approval a sample of proposed junction box replacement cover for approval prior to ordering and installing the replacement covers. Submit the sample along with the submittal data for the junction box replacement cover (see the "Submittal Data" section of these Project Special Provisions). Do not order or install any junction box replacement covers until sample has been approved by the Engineer.

**(D) Junction Box Sizes**

Provide junction boxes and covers of the following sizes as called for in the Plans:

<b>Junction Box Size</b>	<b>Minimum Inside Dimensions</b>
Standard Size	16"(l) x 10"(w) x 10"(d)
Oversized	30"(l) x 15"(w) x 24"(d)
Special-Sized	36"(l) x 24"(w) x 24"(d)

**8.3. CONSTRUCTION METHODS****(A) General**

Install junction boxes flush with finished grade. Backfill beneath and around the junction box using #67 washed stone as shown in NCDOT *Roadway Standard Drawing* No. 1716.01. Do not install sealant compound between junction boxes and covers.

Upon completion of junction box installation and backfilling of all excavations, restore the disturbed ground to its original condition as determined and approved by the Engineer. For paved areas, replace removed or damaged pavement with in kind materials, matching the elevation, color, texture/finish and general appearance of the surrounding pavement. Refer to Section 1 of these Project Special Provisions for additional requirements concerning sidewalks and curbs in historic districts. For unpaved areas, backfill excavations with removed material, tamp the backfilled material and rake smooth the top 1½ inches. Finish unpaved areas flush with surrounding natural ground and to match the original contour of the ground. Seed with same type of grass as surrounding area and mulch the newly seeded area. If unpaved area was not grassed, replace the original ground cover in kind as directed by the Engineer.

**Complete restoration of all ground disturbed during junction box installation within five consecutive calendar days following initial removal and excavation.** If the Contractor fails to repair and restore the disturbed ground in accordance with these Project Special Provisions within the time frame specified, the Department reserves the right to make the necessary repairs, and all expenses incurred by the Department in making the repairs and

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restoring the ground will be deducted from payment due the Contractor, plus **\$500 liquidated damage per occasion, per day, or any portion thereof**, until corrected.

Install standard size junction boxes as shown in the Plans and where underground splicing of electrical cables is necessary. Install standard size junction boxes within 3 feet of pole or pole foundation where transitioning from below ground to a riser assembly. Install standard size junction boxes within 5 ft of each end of each lateral run of conduit for electrical cables. When lateral runs for electrical cables are greater than 150 feet, install additional junction boxes to ensure distances between junction boxes does not exceed 150 feet.

Install oversized junction boxes as shown in the Plans in underground fiber-optic communications cable runs where the conduit run transitions from directionally drilled conduit to trenched conduit and where transitioning from below ground to a riser assembly. Install oversized junction boxes in underground fiber-optic communications cable runs at maximum intervals of 1,000 feet, or where shown in the Plans, whichever is less.

Install special-sized junction boxes at all underground splice enclosure locations in underground fiber-optic communications cable runs as shown in the Plans.

**(B) Replace Existing Junction Box Cover**

Where indicated in the Plans and/or directed by the Engineer, remove an existing damaged or deteriorated reinforced concrete junction box cover and replace it with a new polymer concrete heavy duty cover of same nominal dimensions and shape as the existing cover it is replacing. Do not replace an existing junction box cover unless the Plans specifically call for replacement or unless directed by and approved in advance by the Engineer. Properly dispose of the existing cover following removal.

**(C) GPS Coordinates**

Provide real world coordinates for all junction boxes and equipment cabinets installed or utilized under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet in the horizontal plane and 3.3 feet in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer.

Provide both digital copies and hard copies of all information regarding the location (including to but not limited to manufacturer, model number, City system ID number and NCDOT inventory number) in the Microsoft Excel spreadsheet using the format shown in example below. In addition to Excel format, provide a digital copy of the location information as an ESRI Shapefile (.SHP file format).

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City Sys ID#	NCDOT Inv #	Name	Location	Latitude	Longitude	Manufacturer	Model #
	05-0134	Equipment Cabinet	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5500	35.6873	McCain	Type-332
		Junction Box # 1 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5516	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 2 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5506	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 3 (Near Cabinet)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5501	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 4 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5486	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 5 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5493	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 6 (Phase 4 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5503	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)

#### 8.4. 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 for new junction boxes, washed stone, removal of existing junction boxes and grounding systems as these will be considered incidental to furnishing and installing junction boxes.

No measurement will be made of restoration of paved roadways/driveways and unpaved ground surfaces with like materials, including but not limited to backfill, washed stone, paved materials, seeding and mulching, as this work will be considered incidental to junction box installation. The Department will make no payment for a given junction box until all repairs to paved and unpaved surfaces damaged/disturbed during the installation of the junction box have been completed and accepted.

*Replace existing JB cover* (\_\_\_\_\_) will be measured and paid in actual number of junction box covers of each size and type furnished, installed on an existing junction box and accepted. No measurement will be made of removal and disposal of existing junction box covers that are replaced by new junction box covers as such work will be considered incidental to furnishing and installing the new junction box cover. No measurement will be made of junction box covers furnished and installed on new junction boxes as they will be considered incidental to furnishing and installing the new junction boxes. No measurement and payment will be made of replacing existing junction box covers where the Plans do not call for such replacement, unless the Engineer directs otherwise and approves in the cover replacement in advance.

Repair and replacement of existing sidewalk will be measured and paid for in accordance with the "Equipment Cabinet Foundations" section of these Project Special Provisions.

No measurement will be made of collecting and recording GPS coordinates for junction boxes and compiling this data in the prescribed Microsoft Excel spreadsheet as such work will be considered incidental to furnishing and installing junction boxes.

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Payment will be made under:

**Pay Item**

**Pay Unit**

Junction Box (Standard Size)

Each

Junction Box (Over-sized)

Each

Junction Box (Special-Sized)

Each

Replace Existing JB Cover (Over-sized)

Each

**9. EXTENSION OF EXISTING FIELD WIRING AT CONTROLLER CABINETS****9.1. DESCRIPTION**

Furnish and install terminal splice cabinets to splice and extend existing signal and loop lead-in cables (i.e., field wiring) to new controller cabinets. Furnish and install gel-filled splice connectors to splice and extend existing conductors inside new controller cabinets.

**9.2. MATERIALS****(A) Terminal Blocks**

Provide terminal block (i.e., terminal strips) constructed of electrical grade thermoplastic or thermosetting plastic with the terminals recessed between molded barriers for splicing and extending existing field wiring. Provide terminal blocks with the number of terminals required in these provisions or with a sufficient number to accommodate splicing and extending of incoming existing field wiring conductors. Each terminal shall have two terminal screws that have a minimum outside diameter of 3/16 inches. A removable shorting bar shall be provided between the screws of each terminal. Both the screws and shorting bar shall be made of corrosion resistant nickel-plated brass. Provide separate terminal blocks for signal conductors and loop lead-in conductors.

**(B) Terminal Splice Cabinets**

Provide NEMA Type 3 or Type 4 enclosures fabricated of sheet steel or sheet aluminum with continuous weld construction and with a drip shield top. The steel enclosures shall be stainless steel. Aluminum enclosures shall have a standard mill finish.

Provide an enclosure with a terminal block having at least 20 terminals with each terminal having two terminal screws. Mount the terminal block on the back wall of the enclosure in such a manner that no mounting screws, nuts, etc., protrude through the enclosure. Center the terminal block both horizontally and vertically on the back wall of the enclosure in line with the long dimension of the enclosure. Install additional terminal blocks as necessary.

Provide an enclosure of sufficient size to accommodate entrances for a minimum of four 2-inch galvanized rigid metal conduits in the bottom of the enclosure. The dimensions of the enclosure shall not be less than 16" wide x 20" high x 8" deep. The enclosure shall have a hinged front door which opens to the side and which is secured by a Corbin No. 2 lock and latch. A door handle is not required.

Provide conduit entrances in the bottom of the cabinet only which are of the size and number required for the specific location where cabinet will be installed. Conduit entrances in the top or sides of the cabinet are prohibited. Conduit entrances may be either pre-drilled or field-drilled, but shall not exceed the number required for the location. Extra or spare entrances, capped or otherwise, are not acceptable. Field-verify the required number, size and position of entrances prior to drilling.

Provide all necessary hardware and mounting brackets for attaching the terminal splice cabinet on the pole. Such hardware shall provide for mounting the cabinet to metal or wood signal poles using at least two stainless steel bands (straps) of the size recommended by the manufacturer, one near the top of cabinet and one near the bottom.

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Furnish rigid galvanized conduit, fittings and conduit outlet bodies along with new pull boxes where required to replace existing short risers. Use conduits, fittings and conduit outlet bodies of same nominal size as the existing short risers being replaced. Furnish conduit fittings and outlet bodies as required to install existing risers into base of new terminal splice cabinet.

**(C) Gel-Filled Splice Connectors**

Furnish gel-filled connectors of the appropriate wire gauge to butt splice and extend the existing conductors of signal cables and loop lead-in cables inside controller cabinets.

**(D) Signal Cable and Loop Lead-In Cable**

Furnish new traffic signal cables and loop lead-in cables for extending existing cables from new terminal splice cabinet. Furnish equivalent size conductor signal cable. Furnish loop lead-in cable which complies with the "Lead-In Cable" section of these Project Special Provisions. Furnish new conductors and new cables that match the insulation color coding of the conductors in the existing cables to which they are being spliced.

**9.3. CONSTRUCTION METHODS**

**(A) General**

Prior to splicing and extending existing conductors or rerouting existing conductors through new conduits and risers, place permanent labels on all incoming and outgoing conductors in the controller cabinet using a naming convention such as Phase 1 Green, Phase 2 Yellow, Loop 2A, etc., unless the conductors are already labeled. Where there are existing labels on the conductors, confirm that they are labeled correctly and replace any labels that are incorrect.

Place similar permanent labels on the ends of all new conductors used to extend the existing conductors.

Perform standard megger tests on loops after splicing and extending loop lead-ins. Upon approval of the Engineer, replace lead-in cables or loop and lead-in cable assemblies that do not pass standard megger tests.

Maintain the color coding of individual conductors through the splice. Splice and extend existing conductors using new conductors with the same insulation color. Do not splice together conductors with different color insulation.

**(B) Inside Controller Cabinets**

Where a new controller cabinet is being mounted over existing conduit stubouts on an existing foundation or over existing riser bases at a pole-mounted location and the existing field wiring will not reach the terminal blocks provided inside the new cabinet, splice and extend the incoming and outgoing signal and loop lead-in conductors inside the controller cabinet using gel-filled butt splice connectors.

**(C) External to Controller Cabinets**

Where new controller cabinets are being installed in a different location from the existing cabinet location and the Plans do not call for re-cabling of the intersection, install, as shown on the Plans, a terminal splice cabinet to splice and extend existing signal and loop lead-in conductors as required to reach the new controller cabinet through new risers and conduits.

Do not splice and extend conductors external to the controller cabinet where the existing field wiring is of sufficient length to reach the new cabinet in its new location. An example would be



where the Plans call for the new cabinet to be placed on a new foundation located at the same or lesser distance from the adjacent signal pole as the existing base-mounted cabinet and foundation. At such locations, pull the existing cables out of the existing cabinet, risers and conduit and reroute them to the new cabinet via the new risers and conduits.

Use a terminal splice cabinet when an existing pole-mounted cabinet is being replaced with a new base-mounted cabinet and the Plans do not call for re-cabing the intersection. Use a terminal splice cabinet where an existing base-mounted cabinet is being replaced with a new base-mounted cabinet on a new foundation in a new location and the existing cabling is not long enough to reach the base of the new cabinet and the Plans do not call for re-cabing the intersection.

Do not route electrical service wire through the terminal splice cabinet.

**(D) Terminal Splice Cabinets**

Disconnect the conductors from the existing cabinet, remove the existing pole-mounted controller cabinet, but retain the existing risers, conduit outlet bodies and cables housed therein. Install the new terminal splice cabinet on the pole at same location as removed cabinet with bottom of splice cabinet at the same vertical height as the bottom of the removed cabinet. Install conduit entry holes into base of new cabinet and attach existing risers. Adjust existing conduits and modify/add conduit outlet bodies as necessary to attach to new cabinet. Splice the existing signal cables and loop lead-in cables to the new cables on the terminal splice block and extend new signal cables and new lead-in cables to new base mounted cabinet via two separate, new 2-inch rigid galvanized short risers and underground conduits as shown in the Plans. Use 16-14 AWG insulated solderless crimp terminals on the ends of conductors being spliced. Install the terminals with a ratcheting-type crimp tool. Bond the terminal splice cabinet to the equipment ground in the controller cabinet using a 14 AWG stranded THHN copper wire with green insulation. Do not put loop grounds and other grounds with neutral conductors.

At certain intersections with existing pole-mounted controller cabinets, existing lead-in cables or pedestrian signal cables are routed underground to existing pole-mounted cabinets and enter the bottom of existing cabinet via a short riser. A short riser is defined as a short section of vertical conduit between the bottom of a pole-mounted cabinet and the ground below that conveys cables between an underground conduit and the cabinet. Where these short risers are attached to the face of the pole, attach the short riser into a conduit entrance on the bottom of the new terminal splice cabinet and splice the existing cables to the new cables on the terminal block in the cabinet.

Where the existing short riser is “freestanding” (i.e., it is offset horizontally more than one inch from the face of the signal pole and is not secured to the face of the signal pole) or is damaged (i.e., crimped or severely bent), replace the existing short riser with a new short riser attached to the face of the pole as shown in the Plans. Feed the existing cables through the new conduit and short riser and into the new terminal splice cabinet. Splice the existing conductors to the new conductors on the terminal block.

**(E) Terminal Splice Cabinet Where Existing Cabinet is Base-Mounted**

Mount the terminal splice cabinet on the pole with the center of the cabinet 48 inches above the ground at the base of the pole. Install new risers to the terminal splice cabinet and short risers from the terminal splice cabinet to the underground conduits leading to the new controller

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cabinet foundation. Disconnect field wiring from existing base-mounted controller cabinet, carefully pull the cables out of the tops of the existing risers and reroute the existing cables through new risers to a terminal splice cabinet. Splice the existing signal cables and loop lead-in cables to the new cables on the terminal splice block and extend new signal cables and new lead-in cables to new base mounted cabinet via two separate, new 2-inch rigid galvanized short risers and underground conduits as shown in the Plans. Use 16-14 AWG insulated solderless crimp terminals on the ends of conductors being spliced. Install the terminals with a ratcheting-type crimp tool. Bond the terminal splice cabinet to the equipment ground in the controller cabinet using a 14 AWG stranded THHN copper wire. Do not put loop grounds and other grounds with neutral conductors.

Where a loop lead-in cable or pedestrian signal cable enters the existing cabinet foundation directly via an existing underground conduit instead of through a riser, take care to protect the existing cables and the conduit stubout so as not to damage them when removing the existing controller cabinet and its existing foundation. Pull the cables back out of the foundation stubouts from a junction box, handhole, or transformer base, if available, before removing the cabinet foundation. Upon removal of the cabinet foundation, install a junction box over the conduit stubouts and install new underground conduit(s) from the junction box to a stubout in the new cabinet foundation. Splice the loop lead-in cable to new lead-in cable in the junction box in accordance with *Roadway Standard Drawing No. 1725.01* and run the new lead-in cable from the junction box directly to the new controller cabinet via the new underground conduit. Do not splice and extend existing pedestrian signal cable. Remove the existing pedestrian signal cable and install new, continuous pedestrian signal cable from the pedestrian signal to the new controller cabinet via the existing and new underground conduits.

Where these short risers are attached to the face of the pole, attach the short riser into a conduit entrance on the bottom of the new terminal splice cabinet and splice the existing cables to the new cables on the terminal block in the cabinet.

#### **9.4. MEASUREMENT AND PAYMENT**

*Terminal Splice Cabinet* will be measured and paid for as the actual number of terminal splice cabinets, furnished, installed, and accepted.

No measurement will be made of new full-height risers attached to the bottom of terminal splice cabinet as these will be considered incidental to furnishing and installing terminal splice cabinets.

No measurement will be made of replacement of existing conduit bodies and fittings, and installation of new conduit bodies and fittings as these will be considered incidental to furnishing and installing terminal splice cabinets.

No measurement will be made of new short risers that replace of existing short risers as they will be considered incidental to furnishing and installing terminal splice cabinets.

When required to intercept existing underground conduit, new junction boxes will be paid for in accordance with the "Junction Boxes" section of these Project Special Provisions as approved by the Engineer.

No measurement will be made of additional signal cable/conductors and loop lead-ins, as the splicing of all existing signal conductors and loop lead-ins in the splice cabinet, extending them

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through new risers and conduits and connecting them to the new controller cabinet will be considered incidental to furnishing and installing terminal splice cabinets.

No measurement will be made of gel-filled splice connectors and additional signal and loop lead-in cable/conductors as the splicing and extending of conductors inside the controller cabinet will be considered incidental to furnishing and installing the new controller and cabinet.

No measurement will be made of testing of loops after splicing and extending lead-in cables as performing standard megger tests will be considered incidental to splicing and extending the lead-in cables.

Engineer-approved replacement of loops will be measured and paid as provided for under *Inductive Loop Sawcut* in accordance with the “Inductive Detection Loops” section of these Project Special Provisions. Engineer-approved replacement of loop lead-ins will be measured and paid as provided for under *Lead-In Cable* in accordance with the “Lead-In Cable” section of these Project Special Provisions.

Payment will be made under:

**Pay Item**

**Pay Unit**

Terminal Splice Cabinet

Each

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## 10. CCTV WOOD POLES

### 10.1. DESCRIPTION

Furnish and install wood poles with grounding systems and all necessary hardware for the mounting of CCTV camera assemblies.

### 10.2. MATERIALS

#### (A) General

Material, equipment, and hardware furnished under this section shall be pre-approved on the ITS and Signals QPL.

Furnish treated timber poles that meet the requirements of ANSI O5.1, except the timber shall be treated Southern Pine or treated Douglas Fir.

Treat poles in accordance with AWWA Standard U1, except require retention of preservative as below.

Give all poles a preservative treatment of either pentachlorophenol, or chromated copper arsenate. The same type of preservative shall be used throughout the entire length of the project.

Minimum retention for poles treated with pentachlorophenol will be 0.45 lb. by assay of dry chemical per cubic foot of wood. Minimum retention for poles treated with chromated copper arsenate will be 0.6 lb. by assay of dry chemical per cubic foot of wood.

Refer to the following sections of the *Standard Specifications*:

- 1091-6, "Grounding Electrodes"
- 1082, "Inspection Requirements"
- 1091-2, "Wire and Cable"
- 1082, "Structural Timber and Lumber"

#### (B) CCTV Wood Poles

Furnish Class 3 or better wood poles to mount CCTV cameras and cabinets that are of sufficient length to permit the CCTV camera to be mounted at the mounting height specified in the Plans. To provide for mounting heights of up to 40 feet above the ground at the base of the pole, furnish CCTV wood poles that are at least 55 feet in length. To provide mounting heights greater than 40 feet above ground at the base of the pole, furnish CCTV wood poles that are at least 70 feet in length. The Contractor is encouraged to visit the site of the proposed CCTV poles to confirm the length of pole required to attain the specified mounting prior to ordering the CCTV poles.

### 10.3. CONSTRUCTION METHODS

Install poles at locations shown on the Plans. Except where the Plans specify an exact location (i.e., show offsets and dimensions from known points), place the pole at an offset from the edge of travel way that is consistent with other fixed objects and utility poles along that side of the road, but in no case closer than 1.5 feet from the face of curb. Within intersection radii, install poles a minimum of 7 feet behind face of curb or 10 feet from the edge of travel way where there is no curb. If the Plans do not specify an exact locations, the pole is not within the intersection radius and there are no other poles along the side of the road where the pole is to be

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installed, locate the pole as far as practical from the edge of the roadway, using the setback distances in the following table as a guide:

Speed Limit	Desirable Minimum Setback Distance	
	from face of curb in curb & gutter section	from edge of travel way in shoulder section (no curb)
≤ 25 mph	8 feet	10 feet
30-35 mph	10 feet	12 feet
40 mph	12 feet	16 feet
45 mph	16 feet	18 feet
50 mph	20 feet	22 feet
55 mph	22 feet	24 feet
≥ 60 mph	n/a	30 feet

Measure the setback distance from the face of curb or edge of travel lane to the face of the pole.

Field conditions and site specific constraints may require the pole to be located at setback distances less than those listed above, subject to the approval of the Engineer.

**Mark final pole locations and receive approval from the Engineer before installing poles.**

Ensure poles are of sufficient length to maintain the minimum required clearances above the roadway, obstructions, and affected railroad tracks

Drill or auger a hole for placement of pole and to allow for compacting. Set CCTV wood poles at a minimum depth of 10 feet. Ensure the pole is within 2 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.

Install the CCTV pole grounding system as shown in the Plans.

#### **10.4. MEASUREMENT AND PAYMENT**

*CCTV wood pole* (\_\_\_) will be measured and paid for as the actual number of CCTV wood poles of each nominal length furnished, installed, and accepted regardless of length.

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

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
CCTV Wood Pole (55')	Each
CCTV Wood Pole (70')	Each

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## 11. GUY ASSEMBLIES

### 11.1. DESCRIPTION

Furnish and install guy assemblies with all necessary hardware.

### 11.2. MATERIALS

Material, equipment, and hardware furnished under this section shall be pre-approved on the ITS and Signals QPL.

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 triple-eye attachment, screw anchor with extension rod and triple-eye attachment, or expanding rock anchor with triple-eye 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 triple-eye guy attachments constructed of hot-dipped galvanized steel. Anchor assemblies with double-strand eyes may be used in lieu of those with the triple-eye feature when only one guy cable is to be attached. Ensure anchor assemblies are 7 feet minimum in length.

For type of anchor assembly furnished, ensure the following:

1) Expanding Anchor

Provide steel construction with protective paint or heat shrink of 6 mil plastic to protect metal during shipping and storage.

2) Screw Anchor

Provide hot-dipped galvanized steel construction.

3) Expanding Rock Anchors

Provide malleable iron and rust-resisting paint construction.

Provide 3-bolt clamp to match messenger cable size.

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

Provide guy cables consisting of messenger cable of the same size as the largest sized messenger cable to be guyed. Comply with the "Messenger Cable" section of these Project Special Provisions.

Refer to the "Pole Line Hardware" subsection of the "Messenger Cable" section of these Project Special Provisions.

### 11.3. CONSTRUCTION METHODS

#### (A) General

Comply with *Roadway Standard Drawing* (RSD) No. 1721.01 when constructing guy assemblies.

#### (B) Guy Assemblies for Signal Heads or Loop Lead-in Cable

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

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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 existing pole ground and to the messenger cable using parallel groove clamp or equivalent. If existing City or NCDOT poles do not have a grounding system, install a grounding system in accordance with the "Wood Poles" section of the *Standard Specifications*.

Do not use guy anchors as grounding electrodes.

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

When proposed guy assembly replaces an existing guy assembly, remove the existing guy assembly, including guy anchor if not reused for the new guy assembly.

**(C) Guy Assemblies for Communications Cable**

When installing messenger cable for supporting only communications cable, use approved one-bolt attachment method for attaching messenger cable and guy assembly.

Bond guy assembly to existing pole ground and to the messenger cable using parallel groove clamp or equivalent. If existing City or NCDOT poles do not have a grounding system, install a grounding system in accordance with the "Wood Poles" section of the *Standard Specifications*, except use hot-dipped galvanized 1.5" wire staples to secure ground wire to pole, spacing the staples along the pole as follows:

- 4 inches apart from ground level to 8 feet above ground level;
- 24 inches apart from 8 feet above ground level to point adjacent to uppermost span.

Do not use guy anchors as grounding electrodes. Do not attach to existing guy assemblies unless specifically approved by owner.

When proposed guy assembly replaces an existing guy assembly, remove the existing guy assembly, including guy anchor if not reused for the new guy assembly.

**11.4. MEASUREMENT AND PAYMENT**

*Guy assembly* will be measured and paid as the actual number of direct down guy (i.e., standard guy) assemblies furnished, installed, and accepted.

*Guy assembly* (\_\_\_\_) will be measured and paid as the actual number of guy assemblies of each type (aerial or sidewalk) furnished, installed, and accepted.

No measurement will be made of guy cable, guy guards, anchors, clamps, grounding systems, strandvises, 2" galvanized pipe, pole plates, other fittings, or the removal of existing guy assemblies as these will be considered incidental to furnishing and installing guy assemblies.



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Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Guy Assembly	Each
Guy Assembly (Aerial)	Each
Guy Assembly (Sidewalk)	Each

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Furnish and install riser assemblies with clamp-on, aluminum weatherheads, heat shrink tubing, temporary pipe caps, PVC adapters, reducing bushings, galvanized pole attachment fittings, stainless steel banding hardware, grounding and all necessary hardware.

**12.2. MATERIALS**

Furnish material, equipment, and hardware furnished under this section that is pre-approved on the ITS and Signals QPL.

Provide conduit for risers that is rigid hot dipped galvanized steel conduit that meets UL Standard 6 with rigid full weight sherardized or galvanized threaded fittings.

Refer to the following sections of the *Standard Specifications*:

- 1091-6, "Grounding Electrodes"
- 1091-2, "Wire and Cable"

In addition, refer to the "Pole Line Hardware" subsection of the "Messenger Cable" section of these Project Special Provisions.

Provide Schedule 40 PVC female adapter to connect an underground run of PVC conduit to the threaded end of a rigid metallic. Provide PVC female adapters that have the same nominal diameter as the underground conduit.. The interior surface of one end of the PVC female adapter shall be compatibly threaded to connect it to the threaded end of the rigid metallic riser without the aid of additional fittings, hardware or adhesives. The opposite end of the adapter shall be non-threaded to permit a slip fit, glued connection to the underground PVC conduit.

Furnish a rigid galvanized steel 3"-2" reducing bushing in addition to the PVC female adapter to join the new 2" rigid galvanized steel riser to the stubbed up existing 3" PVC conduit.

Furnish appropriately sized clamp-on aluminum weatherheads for electrical control and power cables.

Furnish heat shrink tubing for the installation of fiber-optic or coaxial cable in a new riser. Ensure the heat shrink tubing is made of modified polyolefin and includes a hot-melt adhesive. Provide tubing that has a length of at least 5" before heating. Ensure the heat shrink tubing will provide a watertight fit around individual cables and outer wall of the riser after heat is applied in accordance with the manufacturer's instructions.

Furnish heat shrink tubing retrofit kits for the installation of fiber optic cable or coaxial cables to an existing riser with existing cables. Ensure the heat shrink material is made of modified polyolefin and is supplied in a flat sheet design. Ensure the kit contains an apparatus to secure both ends of the flat sheet together to form a tube shaped cylinder. Ensure the securing apparatus is flexible to the point that it will allow the heat shrink material to conform to the shape and dimensions of the riser and cables once heat is applied and will not separate during the heating process. Provide heat shrink tubing retrofit kits with a hot-melt adhesive. Provide the flat sheet heat shrink material that has a minimum length of 5" prior to heating. Ensure the heat

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shrink tubing retrofit kit provides a watertight fit around individual cables and outer wall of the riser after heat is applied in accordance with the manufacturer's instructions.

Furnish all new 1" and 2" risers that will house fiber-optic communications cable with temporary pipe caps to seal the top of the riser and prevent rain from falling into riser until fiber-optic cable can be installed in the riser and heat-shrink tubing applied to the top of the riser. Provide riser caps constructed from heat-stabilized vinyl that fit snugly over the end of the end of the riser and that will not be easily dislodged by wind following installation. Furnish caps designed to remain in place through physical contact friction and that do not use adhesives or screws to remain securely in place. Provide caps sized to fit over each diameter (i.e., 1" and 2") of rigid galvanized conduit used for fiber-optic communications cable risers on this project.

### **12.3. CONSTRUCTION METHODS**

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

When installing risers that will house fiber-optic communications cable, immediately install a temporary pipe cap on the top of the riser to prevent rain from entering the riser until fiber-optic cable and heat-shrink tubing can be installed at a later time. Do not install risers if temporary caps cannot be installed at same time as risers. Do not install a communications cable riser and leave it uncapped/unsealed.

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

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

Use separate 1-inch riser with weatherhead for the following:

- Pedestrian signals;
- Electrical service;
- Composite cable routed to a CCTV camera from a CCTV cabinet; and
- CAT5 and 24V power cables routed between a CCTV cabinet and a nearby signal controller cabinet.

Use separate 2-inch risers with weatherhead for signal cables (bundled) and for lead-in cables. Install condulets on all risers for lead-in cable.

Use a separate riser with heat shrink tubing for fiber-optic communications cables and coaxial cable. For pole-mounted cabinets only, use 1-inch risers with heat shrink tubing for all new risers that will contain fiber-optic communications drop cables, unless the Plans call for use of a 2-inch riser with heat shrink tubing at a specific location. Connect 1-inch risers to the bottom of the pole-mounted cabinet using a pair of standard 90-degree elbows to form a 180-degree sweep up into the bottom of the cabinet. Standard 90-degree elbows for 1-inch conduit have a 5.75-inch radius and equal horizontal and vertical legs that measure approximately 8 inches each. Smaller elbows are prohibited. Larger elbows may only be used if approved by the Engineer. Prior to installing fiber-optic cable in the 1" riser, drill a small "weep hole" on the underside of each elbow using a 3/16-inch drill bit to allow any water that may enter

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the riser to drain out of the riser. Clean any metal shavings and fragments from each hole and touch-up each newly drilled hole and its perimeter using a zinc-rich paint.

For all other locations use 2-inch risers with heat shrink tubing. Install risers with heat shrink tubing so that cable can be installed without violating its minimum bending radius. Install fiber-optic cable so it does not share a riser with any other cable type.

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. Do not use a heat source with an open flame.

Remove existing weatherheads, sealing bushings, heat shrink tubing and riser caps and install heat shrink tubing retrofit kits on existing risers according to the installation procedures above.

Transition from rigid galvanized steel risers to underground PVC conduits below ground using an approved rigid galvanized steel sweeping elbow with PVC female adapter, unless the Plans call for an above-ground transition. Apply Teflon thread tape to the threads of rigid galvanized steel sweeping elbow before screwing the PVC adapter onto the threaded end of the elbow. Connect the threaded female end of the PVC adapter to the threaded male end of the rigid galvanized steel sweeping elbow without the use of additional fittings, hardware or adhesives. Connect the opposite, non-threaded end of the adapter to the underground PVC conduit using a slip fit, glued connection.

In certain locations, the Plans call for replacing cutting off and replacing an existing PVC riser with a new rigid galvanized steel riser above ground where the existing underground conduit connects directly to the riser beneath a paved surface. At such locations, disconnect and remove existing cables from the existing riser and cut-off the riser no more than 12" above ground. Apply Teflon thread tape to the threads of rigid galvanized steel riser before screwing the PVC adapter onto the threaded end of the new riser. Use a rigid galvanized 3"-2" reducing bushing to connect the riser to the PVC adapter where the existing underground conduit is 3" in diameter. Connect the opposite, non-threaded end of the PVC adapter to the underground PVC conduit using a slip fit, glued connection. Reinstall the existing cables in the new riser and existing underground conduit and reconnect cables or install new cables as called for by the Plans.

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

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

If the existing pole does not have a grounding system, install new grounding system in accordance with the "Wood Poles" section of the *Standard Specifications*, except use hot-dipped galvanized 1.5" wire staples to secure ground wire to pole, spacing the staples along the pole as follows:

- 4 inches apart from ground level to 8 feet above ground level;
- 24 inches apart from 8 feet above ground level to point adjacent to uppermost span.

#### **12.4. MEASUREMENT AND PAYMENT**

\_\_\_" Riser with \_\_\_\_\_ will be measured and paid as the actual number of risers of each type and size furnished, installed, and accepted.

No measurement will be made of weatherheads, heat shrink tubing, temporary pipe caps, bushings, conduit outlet bodies such as condulets, elbows, conduit fittings, PVC female adapters, reducing bushings, pole attachment fittings, weep hole-drilling, zinc-rich touch-up paint, and grounding systems as these will be considered incidental to furnishing and installing risers. No measurement will be made of temporarily removing from and subsequently reinstalling existing cables in a riser and cutting off and removing the above-ground portion of an existing PVC riser to replace it with a new rigid metal riser as such work will be considered incidental to installing the new riser.

No measurement will be made for horizontal sections of underground conduit that connect the riser to stub-outs in an adjacent cabinet foundation or to an adjacent junction box and that measure 10 feet or less in horizontal length from the center of the riser to the center of junction box or from the center of the riser to the center of the vertical sweep through the controller cabinet foundation. Such conduit will be considered incidental to furnishing and installing the riser assembly.

No measurement will be made for vertical conduit segments (i.e., short risers) extending from an entrance in the bottom of a pole-mounted cabinet to ground level below the cabinet to tie directly onto an underground conduit as such conduits will be considered incidental to furnishing and installing the pole-mounted cabinet.

No measurement will be made of 1" risers with weatherheads furnished and installed as part of new electrical services as they will be considered incidental to furnishing and installing new electrical services (see "Electrical Service" section of these Project Special Provisions).

*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 of removing existing weatherheads, sealing bushings, heat shrink tubing and riser caps from existing risers as such removals will be considered incidental to furnishing and installing heat shrink tubing retrofit kits.

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Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
1" Riser with Weatherhead	Each
2" Riser with Weatherhead	Each
1" Riser with Heat Shrink Tubing	Each
2" Riser with Heat Shrink Tubing	Each
Heat Shrink Tubing Retrofit Kit	Each

### 13. INDUCTIVE DETECTION LOOPS

#### 13.1. DESCRIPTION

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

#### 13.2. MATERIALS

Furnish material, equipment, and hardware furnished under this section that is pre-approved on the ITS and Signals QPL.

##### (A) Loop Sealant

Provide the Engineer with a Type 3 material certifications and material safety data sheets (MSDS) for the sealant in accordance with Article 106-3 of the *Standard Specifications*.

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° 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 10% 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° F.

Provide sealant with a usable life of at least ten minutes once mixed, when the ambient temperature is 75° F. Ensure sealant dries to tack-free state in less than 2 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% of published properties for the cured material.

Ensure one part sealant cures within 30 days to attain 95% 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 #14 AWG copper conductors fabricated from 19 strands that comply with ASTM B3 before insulating. Ensure stranded conductors use either concentric or bunch stranding, and

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comply with circular mil area and physical requirements of ASTM B8 or ASTM B174 for bunch stranding.

Provide insulating compound that is cross-linked thermosetting black polyethylene in accordance with 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 3,000 Hertz, 7,500 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 complies with the following:

- Encasing tube fabricated of polyethylene compound conforming to ASTM D1248 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" Conduit

**(C) Conduit**

Comply with the "Underground Conduit" section of these Project Special Provisions for PVC conduit.

**13.3. CONSTRUCTION METHODS**

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

Notify Engineer one week before installing inductive detection loops.

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

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. Do not sawcut or drill holes for conduit or wires through granite curb. See additional requirements for work in historic districts in Section 1 of these Project Special Provisions.

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 at <https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx>.



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Embed loop conductors in saw slot with loop sealant. Seal saw slot and dispose of excess sealant in an environmentally safe manner.

Between where loop conductor pairs leave the saw cut in pavement and enter a junction box, 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.

**13.4. MEASUREMENT AND PAYMENT**

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

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

Payment will be made under:

**Pay Item**

Inductive Loop Sawcut

**Pay Unit**

Linear Foot

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Furnish and install lead-in cable with all necessary hardware to be used in conjunction with, but not limited to, inductive detection loops, pedestrian pushbutton assemblies or railroad circuitry.

**14.2. MATERIALS**

Furnish material, equipment, and hardware furnished under this section that is pre-approved on the ITS and Signals QPL.

Furnish lead-in cable with two conductors of #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 1% of actual cable length. Ensure character height of the markings is approximately 0.10 inch.

Refer to the "Pole Line Hardware" subsection of the "Messenger Cable" section of these Project Special Provisions.

**14.3. CONSTRUCTION METHODS**

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

Where railroad preemption is required, install lead-in cable from signal controller cabinet to railroad company furnished and installed lockable junction box.

Except where the plans call for splicing and extending existing lead-in cable conductors inside a new controller cabinet or for using a terminal splice box to splice and extend existing lead-in cable to a new cabinet location, splicing of lead-in cable will be allowed only for runs in excess of 750 feet. Splice lead-in cable in terminal splice boxes, junction boxes, condulets on poles or controller cabinets.

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. After successful completion of megger test, test loop system resistance using an electronic ohmmeter to verify loop system resistance is less than 0.00885 ohms per foot.

Where the Plans call for using existing upstream detection loops on an approach to a signalized intersection for both local intersection and system detection (i.e., shared local/system loops), field verify that each such loop is wired to a separate lead-in cable all the way back to the controller cabinet. If proposed shared loops are wired to a common lead-in cable, install new lead-in cables necessary to rewire each loop to a separate, unique lead-in cable, then splice each loop to its respective lead-in cable, as approved by the Engineer. Perform said field

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investigations of proposed shared loops, and, as necessary, install new lead-in cables and resplice loop wires to lead-in cables to separate share system/local loops onto separate lead-in cables, regardless of whether or not Plans specifically call for installation of new lead-in cable at a given intersection. Notify the Engineer of findings from field investigations and obtain Engineer's approval prior to installing any new lead-in cables and rewiring proposed share local/system loops.

**14.4. MEASUREMENT AND PAYMENT**

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

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

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Lead-in Cable	Linear Foot

## 15. FIBER-OPTIC CABLE

### 15.1. DESCRIPTION

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

### 15.2. MATERIALS

#### (A) General

Refer to the "Pole Line Hardware" subsection of the "Messenger Cable" section of these Project Special Provisions for lashing wire, wrapping tape and hardware used for installation of aerial fiber-optic cable.

#### (B) SMFO Communications Cable

Furnish single-mode fiber-optic communications cable that is pre-approved on the ITS and Signals QPL.

Furnish single-mode fiber-optic cable manufactured into a loose buffer tube design installed around a central strength member where the cable complies with RUS CFR 1755.900 and ICEA 640 requirements. Ensure the manufacturer is ISO 9001 and TL9000 registered and that the manufacturer's cable is RUS listed. The operating temperature range of the cable shall be -40°F to +158°F.

Furnish individual fibers manufactured from silica and dopant materials with each fiber having a color coated finish that is compatible with local injection detection (LID) devices. Distinguish each fiber from others by color coding that meets EIA/TIA-598. Furnish single mode fiber that does not exceed attenuation ratings of 0.25 dB/km at 1550 nm and 0.35 dB/km at 1310 nm and complies with ITU G.652D and IEC 60793-2-50 Type B.1.3 industry standards for low water peak, single mode fiber. Provide fibers that are useable and with a surface, sufficiently free of imperfections and inclusions to meet optical, mechanical and environmental requirements.

Ensure the core central strength member is a dielectric glass reinforced rod and that the completed cable assembly has a maximum pulling rating of 600 lbf during installation (short term) and 180 lbf long term installed.

Construct buffer tubes (nominal size of 2.5 mm) manufactured from a polypropylene copolymer material to provide good kink resistance and allows the buffer tube to maintain flexibility in cold temperature over the expected lifetime of the cable. Except for 6-fiber drop cables, provide exactly 12 fibers per buffer tube in all cables regardless of the total number of fibers the cables contain. Do not provide cables with any other fiber count per buffer tube. Ensure that all buffer tubes are filled with a water-blocking gel or water swellable material. Construct the cable such that the buffer tubes are stranded around the central strength member in a reverse oscillating arrangement to allow for mid-span entry. Distinguish each buffer tube from others by color coding that meets EIA/TIA-598. Use filler tubes to maintain a circular cross-section of the cable. Ensure the filler tubes are the same nominal size as the buffer tubes. Apply binders (water swellable yarn, aramid fiber, etc.) with sufficient tension to secure buffer tubes and filler tubes to the central member without crushing the buffer tubes. Ensure that binding

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material is non-hygroscopic, non-wicking and dielectric with low shrinkage. Ensure the binders are of a high tensile strength that is helically stranded evenly around cable core.

Ensure the cable core is protected from the ingress of moisture by a water swellable material or that is filled with a water blocking compound that is non-conductive. Ensure the water swellable material (when activated) or the water blocking compound is free from dirt and foreign matter and is removable with conventional nontoxic solvents. Furnish at least one ripcord to aid in the process of removing the outer jacket. Furnish the outer jacket constructed of a medium-density polyethylene material to provide reduced friction and enhanced durability. Ensure the polyethylene material contains carbon black to provide UV protection and does not promote the growth of fungus. Ensure the cable jacket is free of slits, holes or blisters and the nominal outer jacket thickness is  $> 0.050$ ".

Ensure the completed cable assembly contains identifications markings printed along the outside cover of the jacket every 2 feet. Ensure the character height of the markings is approximately  $0.10$ ". Provide length markings in sequential feet and within one percent of actual cable length.

Mark each cable with the following:

- (1) Sequential length marks in feet as specified
- (2) The name of the manufacturer
- (3) "OPTICAL CABLE"
- (4) Month/year of manufacture
- (5) Number(s) of and type(s) of fibers
- (6) Cable ID Number for product traceability

**(C) Drop Cable**

Provide drop cable meeting the material requirements list in "SMFO Communications Cable" subsection above with the exceptions herein to provide communications links between splice enclosures and the Ethernet edge switches through interconnect centers mounted in controller cabinets and in CCTV cabinets. Furnish drop cables containing a minimum of six individual fibers.

To facilitate installation in 1" risers at pole-mounted cabinet locations, furnish low bend radius drop cable that complies with RUS-CRF 1755.900 and is RUS listed. A low bend radius cable is defined as a fiber-optic cable whose manufacturer-specified minimum bend radius does not exceed 5.75 inches when loaded and 4 inches when installed for a 6-fiber cable. Ensure drop cable has the same operating characteristics as the SMFO cable it is to be coupled with.

On one end of the cable, furnish LC connectors for termination of all drop cable fibers on connector panel mounted inside an equipment cabinet. Provide either factory preassembled drop cables with SMFO pigtailed and LC connectors already attached or field install the pigtailed and connectors. For field installed connectors, provide cabinet-mounted interconnect centers that are pre-equipped with factory-preassembled connector panels, SMFO pigtailed with LC connectors and splice trays; then fusion splice all drop cable fibers to the SMFO pigtailed.

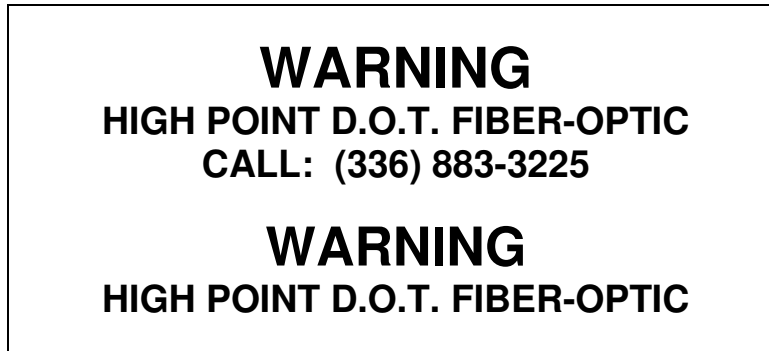
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Ensure attenuation of drop cable at 1310 nm does not exceed 0.4 dB/km and the attenuation at 1550 nm does not exceed 0.3 dB/km. Ensure attenuation loss for complete drop cable does not exceed a mean value of 1.5 dB.

**(D) Communications Cable Identification Markers**

Furnish 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 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. Provide communications cable wraps that permit writing with an indelible marking pen.

Furnish cable identification markers with the following text for signal system communications cables:



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

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

*Colors: Black text on yellow background*

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

**(E) Fiber-Optic Cable Storage Guides**

Furnish fiber-optic cable storage guides (snowshoes) that are pre-approved on the ITS and Signals QPL.

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 the 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 snowshoes are stackable so that multiple cable configurations are possible.

**(F) Aerial Cable Protectors**

Furnish aerial cable protectors designed to protect aerial fiber-optic communications cable from damage caused by tree limb abrasion. Provide cable protectors that are designed to fit over the cable as a wrap-around protective sleeve, that have a round shape and are fabricated with cable tie slots spaced approximately 12 inches apart along the entire length. Size the cable protectors to fit properly over cable(s) lashed to messenger cable in accordance with the

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manufacturer's guidelines. Provide cable protectors that are constructed of rugged, durable dielectric material such as high density PVC that is black in color, formulated for outdoor use and has special additives to prevent degradation from ultraviolet light. Provide aerial cable protectors that are designed for a service life of at least 10 years.

### **15.3. CONSTRUCTION METHODS**

#### **(A) General**

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

Install 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 cable is not damaged during storage, handling, and installation. Do not violate minimum bending radius of 20 times the radius of cable diameter or 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. Store the 20 feet of spare cable inside the cabinet. Measure slack cable by extending cable straight out of cabinet door. No splicing is permitted at any field cabinets other than splicing drop cable fibers to SMFO pigtails in cabinet-mounted interconnect centers inside traffic signal controller cabinets and CCTV cabinets.

Keep cable ends sealed at all times during installation to prevent effectively 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 cable manufacturer's recommended and maximum pulling tension. Do not exceed manufacturer's recommended pulling tension. Use pulling grips containing a breakaway rotating swivel. Coil cable in a figure-8 configuration whenever cable is unreeled for subsequent pulling.

Install fiber-optic cable in separate risers with heat shrink tubing (1-inch or 2-inch as shown on the Plans) or separate conduits. Do not share risers or conduits containing fiber-optic cable with other non-fiber-optic cable unless the Plans specify otherwise or the Engineer directs or approves otherwise.

Seal all conduits containing fiber-optic communications cable in junction boxes and cabinet bases with duct and conduit sealer. Comply with the requirements for duct and conduit sealer in the "Underground Conduit" section of these Project Special Provisions.

#### **(B) Existing Hi tran and Off-Street Parking Division FO Cables**

At several locations in downtown High Point, fiber-optic cables owned by the High Point Transit System (Hi tran) and by the City's Off-Street Parking Division follow the same aerial

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and underground routes as the existing traffic signal system communications cables. Often these Hi tran and Off-Street Parking Division fiber-optic cables are lashed to the same messenger cable or occupy the same underground conduits and junction boxes as the existing traffic signal system communications cables. **Do not disturb, unlash, cut, remove or damage the Hi tran and Off-Street Parking Division fiber-optic cables**, except as required for the rerouting of the existing cables as they enter the Municipal Building in accordance with the “Building Modifications and Fiber-Optic Cable Termination” section of these Project Special Provisions. The Contractor will be held responsible for any damage to the existing Hi tran and Off-Street Parking Division fiber-optic cables caused by the Contractor’s construction activities and procedures. The Contractor will be required to replace in kind any Hi tran and Off-Street Parking Division fiber-optic cables that he/she damages at his/her expense.

While the Plans note some areas where Hi tran and Off-Street Parking Division cables are known to be present, these notes are for general information purposes to alert the Contractor to possible presence of these existing cables where construction will be occurring. These advisory notes are neither precise nor complete identification of all such existing cables and all locations where these cables may be present. Prior to beginning any cable construction in these areas, coordinate with the City to confirm routing of the Hi tran and Off-Street Parking Division cables and ensure proper identification of the different use cables that share the same messenger, risers, underground conduits and junction boxes. Do not cut or remove any existing fiber-optic communications cable in these areas without prior approval of the City. Clearly label or tag the cable to be removed prior to removal. In addition, a minimum of two weeks in advance of cutting and removing any existing signal system communications cable in these areas, the City’s Traffic Signal System Supervisor who will, in turn, coordinate with Hi tran and the City’s Off-Street Parking Division, to allow them to have a representative present at the time of cutting and removing.

Unless directed otherwise by the Engineer, do NOT remove the existing traffic signal communications cable(s) and supporting messenger cable when the Hi tran and Off-Street Parking Division fiber-optic cables are lashed to the same messenger. In lieu of removal, cut the existing traffic signal system communications cable but not the supporting messenger at the ends of the coincident route and abandon the traffic signal system cable in place.

**(C) Existing NCDOT Triad Region ITS FO Cables**

There are existing NCDOT Triad Region ITS fiber-optic communications cables whose routes coincide with routes of the existing High Point traffic signal system communications cable in some areas. These NCDOT ITS cables also splice into the existing signal system cable at two locations to homerun back to the City’s TOC via the signal system trunk cable. In addition, NCDOT uses some fibers in the existing signal system communications cable to route communications to some NCDOT CCTV cameras on US 311/I-73 via the City’s TOC. Except where the Plans require re-splicing the existing NCDOT ITS cable to the new signal system cable at the intersections of Eastchester Drive and Centennial Street and of Brentwood Street and Green Drive, **do NOT disturb, unlash, cut, remove or damage the existing NCDOT Triad Region ITS fiber-optic cables**. The Contractor will be held responsible for any damage to the existing NCDOT Triad Region fiber-optic cables caused by the Contractor’s construction activities and procedures. The Contractor will be required to replace in kind any NCDOT Triad Region ITS fiber-optic cables that he/she damages at his/her expense Refer to Section 1 of these Project Special Provisions for additional requirements.



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Unless directed otherwise by the Engineer, do NOT remove the existing traffic signal communications cable(s) and supporting messenger cable when the NCDOT Triad Region ITS fiber-optic cables are lashed to the same messenger. In lieu of removal, cut the existing traffic signal system communications cable but not the supporting messenger at the ends of the coincident route and abandon the traffic signal system cable in place.

Refer to the "Fiber-Optic Splice Centers" section of these Project Special Provisions for additional requirements pertaining to splicing of these existing NCDOT Triad Region ITS fiber-optic cables to new signal system fiber-optic cables at intersections of Eastchester Drive and Centennial Street and of Brentwood Street and Green Drive.

**(D) Aerial Installation**

Install one communications cable identification marker on the signal system communications cable within 36 inches of pole attachment points and at locations where more than one cable originates or terminates. At splice enclosures, install a communications cable marker on one of the cables where it enters or exits the splice enclosure and ensure that the marker is installed so that it is visible (but not necessarily readable) from the ground below. At fiber-optic cable storage guides (i.e., snow shoes), install a communications cable marker at each end, 6 inches or less from the inner edge of each snow shoe, to identify the cable being stored.

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

Machine lashing of any cable is not permitted along any messenger cable span to which a traffic signal or overhead sign is or will be attached. Either reuse existing 0.05" x 0.30" aluminum wrapping tape or furnish and install new aluminum wrapping tape.

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

Use a breakaway swivel so as not to exceed 80% of the maximum allowable pulling tension specified by the cable's manufacturer if cable is pulled by mechanical means. Do not allow cable to contact the ground or other obstructions between poles during installation.

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 each fiber-optic cable on all cable runs that are continuous without splices as shown in the Plans. Obtain approval for spare cable storage locations. Store spare fiber-optic cable on fiber-optic cable storage guides (snow shoes) that are separate from any storage guides being used to store NCDOT Triad Region, Hi tran, and Off-Street Parking fiber-optic communications cables.

Locate spare cable storage in the middle of spans between termination points. Do not store spare fiber-optic cable over the roadway or driveways.

**(E) Underground Installation**

Install fiber-optic cable underground in conduit using cable pulling lubricants recommended by the fiber-optic cable manufacturer. Where more than one fiber-optic cable is being installed in a multiple conduit underground run, ensure that at least one conduit remains empty for future use by installing more than one cable in a conduit as needed, unless directed otherwise by the Engineer.

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

Use a breakaway swivel so as not to exceed 80% of the maximum allowable pulling tension specified by the cable's manufacturer if cable is pulled by mechanical means.

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

Be advised that electrical power service conductors may be present in existing junction boxes and manholes that house traffic signal cable and fiber-optic communications cable. While the Plans note some junction boxes where electrical conductors are known to be present, these advisory notes are neither precise nor complete identification of all such locations and are intended only to promote a general awareness of the possibility of encountering these conductors. Take proper precautions to protect personnel and equipment when working in junction boxes and manholes where electrical service conductors are present.

Comply with all OSHA<sup>®</sup> regulations related to confined spaces when working inside manholes, ensuring that workers in manholes have proper training and certification when required. Provide OSHA<sup>®</sup>-compliant manhole guardrails to protect all open manholes along with fresh air blowers and hoses. Pump water out of manholes as necessary. High voltage electrical power cables are present in some existing manholes (vaults), including the vaults through which the conduits leading into the Municipal Building pass. Ensure that only workers trained and certified to work in confined spaces in the presence of such power cables enter such manholes and vaults and that they are wearing appropriate protective gear.

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.

Inside all junction boxes, install communications cable identification markers on each communications cable entering the junction box. For the existing fiber-optic communications cable inside the bridge-mounted conduit over the railroad on Elm Street between High Avenue and Broad Avenue that will be cut and left in place, install communications cable identification markers on the both ends of existing fiber-optic communications that is left in place inside the conduits.

In a junction box where no splice enclosure is required, store 50 feet of each fiber-optic cable on all cable runs as shown in the Plans.

**In a junction box where a splice enclosure is required but not immediately installed, store 50 feet of fiber-optic cable intended for the splice as shown in the Plans.**

If a blockage is encountered when attempting to install a communications cable inside an existing conduit in accordance with the Plans, use compressed air, water jetting, rod and mandrel or other Engineer-approved method to clear the obstruction or blockage in the existing underground conduit. Once obstruction/blockage has been substantially cleared, draw a mandrel through the conduit followed by a swab to clean out any remaining materials which may cause cable abrasions. Use a mandrel constructed of aluminum or stainless steel that is at least 6 inches in length and has an outer diameter that is approximately 1/2 inch less than the inside diameter of the conduit being cleared.

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Subject to the Engineer's approval, the existing communications cable being removed may be used as a pull line to install the new fiber-optic communications cable and accompanying tracer wire in its place in existing underground conduits.

**(F) Indoor Installation**

Install the fiber-optic cable in existing risers and conduits between the underground building entrance and the enclosed communications racks being installed inside the TOC and the Signal Shop using cable pulling lubricants recommended by the fiber-optic cable manufacturer. Obtain approval of cable pulling lubricant and method of pulling before installing the fiber-optic cable.

Use a breakaway swivel so as not to exceed 80% of the maximum allowable pulling tension specified by the cable's manufacturer if cable is pulled by mechanical means. Keep tension on cable reel and pulling line at start of each pull. Do not release tension if pulling operation is halted. Restart pulling operation by gradually increasing tension until cable is in motion.

For pulling cable through junction boxes and cabinets, feed cable by manually rotating the reel. Do not pull cable through cabinets, junction boxes, handholds, or openings in conduit unless otherwise approved. Inside all junction boxes and cabinets, install communications cable identification markers on each communications cable entering the junction box.

Store 30 feet of each fiber-optic cable inside the enclosed communications racks inside the TOC after terminating the cables in the rack-mounted splice centers housed therein.

**(G) Installation of Drop Cable**

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

At aerial splice enclosures, install the aerial splice enclosure and corresponding cable storage guide 50 feet apart and store between the splice enclosure and corresponding cable storage guide 50 feet of slack cable for each cable entering and exiting the splice enclosure.

At below ground splice enclosures, coil 50 feet of slack cable for each cable entering and exiting the splice enclosure in the manhole or junction box where enclosure is located. Coil and store any drop cable in excess of what is needed for storage in the manhole or junction box in the base of the equipment cabinet. Where fiber-optic cables are installed but not immediately spliced, store 50 feet of drop cable and 50 feet of fiber-optic trunk cable inside the manhole or junction box to facilitate subsequent splicing in the splice enclosure. Cap and seal ends of cables that have yet to be spliced or terminated with a waterproof heat-shrink cap/seal as approved by the Engineer.

At the equipment cabinet end of drop cable, terminate all fibers by splicing them to factory-assembled SMFO pigtailed with LC connectors and connecting the pigtailed to the connector panel in the rack-mounted interconnect center. Label all connectors, pigtailed and the connector panel. At the aerial or underground splice location, cap off all unused fibers and label to correspond with the connector panel. After termination, coil and store in the base of the equipment cabinet 20 feet of drop cable plus any additional drop cable in excess of what is needed for overhead storage.

Where the Plans call for a fiber-optic drop cable to be installed in an existing riser, remove all existing cables from the riser and remove the existing weatherhead, sealing bushing or heat shrink tubing. Install the new fiber-optic drop cable in the existing riser and install new heat

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shrink tubing at the top of the existing riser using a heat shrink tubing retrofit kit. If the riser contains existing fiber-optic communications cable, carefully remove the fiber-optic cable from the riser so as not to violate its minimum bending radius or otherwise damage the cable.

Temporarily coil and store the existing fiber-optic cable overhead in a manner approved by the Engineer until the new drop cable can be spliced into the existing cable in an aerial splice enclosure. Once splicing has been completed, furnish and install fiber-optic cable storage guides and permanently store all remaining spare cable.

Using an OTDR, test the end-to-end connectivity of the drop cable from patch panel installed inside the signal or CCTV cabinet to the adjacent managed Ethernet switches. Comply with the OTDR testing and reporting requirements of the "Fiber-Optic Splice Centers" section of these Project Special Provisions when testing drop cable.

#### **(H) Aerial Cable Protector**

Where shown in Plans and as directed by the Engineer, at locations where aerial fiber-optic communications cables are subject to damage by tree limb abrasion, install cable protectors over the fiber-optic cable that are of sufficient length to protect the cable from the potential threat as directed by the Engineer. Do not install aerial cable protectors at any locations without the prior approval of the Engineer. Do not install cable protectors for lengths of application that are shorter or longer than approved/directed by the Engineer.

#### **15.4. MEASUREMENT AND PAYMENT**

*Communications cable (\_\_\_-fiber)* will be measured and paid as the actual linear feet of fiber-optic cable of each fiber count furnished, installed, and accepted according to the following conditions: 80% of the payment will be made upon acceptance of the installed cable and the remaining 20% of the payment will be made following splicing, testing and final acceptance (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* will be measured and paid as the actual linear feet of fiber-optic drop cable comprised of a minimum of 6 fibers that are furnished, installed, and accepted according to the following conditions: 80% of the payment will be made upon acceptance of the installed and spliced drop cable, and the remaining 20% of the payment will be made following final acceptance (including completion of the 60-day Observation Period).

*Aerial cable protector* will be measured and paid as the actual linear feet of aerial cable protector furnished, installed, and accepted. No measurement and payment will be made of any aerial cable protector installed without the prior approval of the Engineer or for cable protector installed at locations or for lengths of application other than approved or directed by the Engineer.

No measurement will be made for terminating, splicing, and testing fiber-optic cable, communications cable identification markers, fiber-optic cable storage guides, SMFO jumpers and pigtails, mechanical sealing devices and conduit seals/sealing putty, as these will be considered incidental to the installation of fiber-optic cable and drop cables.

No measurement will be made of removing existing cables from existing risers as such removals will be considered incidental to furnishing and installing the fiber-optic cables and drop cables.

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No measurement will be made of clearing a blockage or obstruction from an existing conduit necessary to install a communications cable in an existing underground conduit as such work will be considered incidental to installation of the communications cable.

No measurement will be for installing a pull tape inside of and sealing the ends of an existing conduit that will be retained for future use after removing an existing communications cable from that conduit as such work will be considered incidental to installation of new fiber-optic communications cable.

No measurement will be made for equipment (i.e., manhole guardrails, fresh air blowers, harnesses and retrieval systems, etc.), training, certifications and permits required to comply with OSHA<sup>®</sup> regulations and requirements when working inside manholes as they will be considered incidental to removing existing and installing new fiber-optic communications cable. No measurement will be made of pumping water out of manholes as such work will be considered incidental to removing existing and installing new fiber-optic communications cable.

No measurement will be made of training, certifications, protective attire and protective gear required for workers to perform work in junction boxes, manholes and vaults where electrical power is present as these items will be considered incidental the installation and removal of communications cable.

No measurement will be made of removing existing weatherheads, sealing bushings, heat shrink tubing and riser caps to install new fiber-optic drop cables in existing risers as such removals will be considered incidental to furnishing and installing heat shrink tubing retrofit kits. Heat shrink tubing retrofit kits will be measured and paid for in accordance with the "Riser Assemblies" section of these Project Special Provisions.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Communications Cable (24-Fiber)	Linear Foot
Communications Cable (36-Fiber)	Linear Foot
Drop Cable	Linear Foot
Aerial Cable Protector	Linear Foot

## 16. FIBER-OPTIC SPLICE CENTERS

### 16.1. DESCRIPTION

Furnish and install fiber-optic interconnect centers, fiber-optic splice enclosures, and all necessary hardware.

Modify existing fiber-optic interconnect centers and/or splice enclosures as shown in the plans. Refer to manufacturer's recommendations for opening, modifying and re-sealing the existing fiber-optic interconnect center and/or fiber-optic splice enclosure.

### 16.2. MATERIALS

Furnish material, equipment, and hardware furnished under this section that is pre-approved on the ITS and Signals QPL.

#### (A) Interconnect Center

Furnish compact, modular interconnect centers designed to mount inside equipment cabinets. Design and size interconnect centers to accommodate all fibers entering cabinets. Provide interconnect centers for controller cabinets and CCTV cabinets that are one rack unit (RU) high.

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

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

For connecting Ethernet edge switches to the interconnect center patch panels, furnish SMFO jumpers that are a minimum of 3 feet in length with factory-assembled LC connectors on one end (i.e., the interconnect center end) and, on the other end, factory-assembled connectors of the same type provided on the Ethernet edge switch. Ensure SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

#### (B) 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 oversized oval port that will accept two cables and 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 (i.e., uncut and unspliced) through the enclosure. Ensure enclosures allow sufficient space to prevent microbending of buffer tubes when coiled.

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

**(C) Existing Splice Enclosures**

When adding a new fiber-optic cable to an existing splice enclosure or otherwise modifying an existing splice inside an existing splice enclosure, furnish heat shrink cable shields that are compatible with the enclosure to ensure weather-tight seal where each new cable enters the existing enclosure and to replace any existing seals that are broken or removed while modifying the splice.

Provide splice trays that hold, protect, organize optical fibers, and secure fibers inside splice tray for new or modified splices inside existing splice enclosures and interconnect centers. Provide splice trays that are dielectric and that are compatible with the existing splice enclosure or interconnect center. Provide splice trays that are sized to accommodate all fibers entering the splice tray and to provide sufficient space to prevent microbending of optical fibers.

Furnish SMFO pigtailed for terminating new fibers on the connector panel of an existing interconnect center. For only the NCDOT CCTV along US 311 as called for in the plans, provide pigtailed containing connector panels that are a maximum of 6 feet in length with a factory-assembled ST connector on one end. For all other locations, provide pigtailed containing connector panels that are a maximum of 6 feet in length with a factory-assembled LC connector on one end. Ensure SMFO pigtailed meet the operating characteristics of the SMFO cable with which it is to be coupled. For only the NCDOT CCTV along US 311, reuse the existing connector panels with ST-type connectors in the existing interconnect center. For all other locations, provide connector panels with LC-type connectors that are compatible with the existing interconnect center.

For connecting Ethernet edge switches to the interconnect center patch panel, furnish SMFO jumpers that are a minimum of 3 feet in length with factory-assembled LC connectors on one end (i.e., the interconnect center end) and, on the other end, factory-assembled connectors of the same type provided on the Ethernet edge switch. Ensure SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

**16.3. CONSTRUCTION METHODS****(A) General (Workmanship Identification Information)**

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

- Splice location reference # or identification information (e.g., 07-xxxx tray 1 of 3, 07-xxxx tray 2 of 3, etc.);
- Date the splice was made;
- Name of company that performed the splicing;
- Name of person who performed the splicing.

**(B) Workmanship**

Upon cutting the cable and removing the outer jacketing material down to the individual buffer tubes, secure the central strength member to the enclosure so that no tensile force is applied to the fibers. Secure the individual buffer tubes to the splice trays by a method recommended by the manufacturer. Determine the length of each buffer tube needed to ensure

that the buffer tube can be looped a minimum of two times around the inside of the splice tray. Upon determining the length of buffer tube needed, remove the buffer tube to expose the individual fibers for fusion splicing. Adjust individual fiber lengths as necessary to ensure that once the fusion splicing process is completed the finished splices will align with the “splice block organizer” supplied within the splice tray. Ensure the splice block organizer has individual fusion splice space holders for each fiber splice.

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

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

Prior to installing the cover over the splice tray and placing it in its final resting location, take a MANDATORY digital photograph of the splice tray that shows the final workmanship. Ensure that the photograph shows the “Workmanship Identification Information” as well as the workmanship associated with installing and terminating the fiber. Ensure that the photograph is clear, in-focus and information captured is legible. Include digital copies of each photograph on a compact disc as part of the OTDR Test Results submittal.

**(C) Termination and Splicing within Interconnect Centers**

Terminate and fusion splice all fibers as shown in the Plans.

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

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

For all fibers designated to pass through interconnect center, neatly coil and express the fibers without cutting. For all buffer tubes designated to pass through interconnect center, neatly coil excess tubing inside interconnect center.

**(D) Interconnect Centers in Controller and CCTV Cabinets**

Install interconnect centers with connector panels, splice trays, storage for slack cable or fibers, mounting and strain relief hardware, and all necessary hardware. Mount the interconnect center in the rack inside the controller cabinet or CCTV cabinet at the location indicated in the Plans. Install SMFO jumpers between the appropriate connectors on the interconnect center and the Ethernet edge switch.

**(E) Termination and Splicing within Splice Enclosure**

Install splice enclosures with splice trays, basket containment assemblies, racking for slack cable or fibers, mounting and strain relief hardware, and all other necessary hardware. Install separate splice enclosures for the signal system fiber-optic cables.



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Do not install aerial splice enclosures and storage guides over roadways or driveways.

Fusion splice all fibers including fibers designated to be coupled with fibers from a drop cable. For all fibers designated to pass through splice enclosure, coil and express the fibers without cutting.

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

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 enclosure in accordance with manufacturer's recommended procedures at the conclusion of splicing procedure and before final placement of enclosure.

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

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

For underground, manhole and junction box facility installations, place the enclosure along with required spare cables in the facility in a neat and workmanship like manner. Install underground splice enclosures only in special-sized junction boxes unless the Plans indicate otherwise or the Engineer approves otherwise.

**(F) Modify Existing Splice**

Modify existing fiber-optic interconnect centers and/or splice enclosures as shown in the Plans. Terminate and splice new fibers and re-splice existing fibers within existing interconnect centers and splice enclosures as shown on the Plans. Use existing splice trays, where available, inside the splice center and install additional patch panels, splice trays and pigtails where necessary and fusion splice fiber connections as required by the Plans, then perform OTDR testing. Provide new splice trays that are compatible with the existing splice enclosures when previously unspliced buffer tubes are spliced. Install new fiber-optic jumpers and make connections to Ethernet edge switches and Ethernet core switch, other equipment and/or patch panels as necessary. Comply with all requirements of "Interconnect Center" and "Splice Enclosure" subsections above.

Install new fiber-optic jumpers and make connections to Ethernet edge switches, Ethernet core switch and other equipment and/or patch panels as necessary. Comply with all requirements of the "Interconnect Center" and "Splice Enclosure" subsections above.

Relocate existing aerial splice enclosure and corresponding existing fiber-optic cable storage rack(s) as shown on the Plans. Unlash existing, reroute and relash existing fiber-optic cable as required to relocate the existing aerial splice enclosure.

**(G) Splicing Existing NCDOT Triad Region ITS Cable to New Signal System Cable**

Comply with the requirements below when splicing the existing NCDOT Triad Region ITS fiber-optic cables to the new signal system cables at the intersections of Eastchester Drive at Centennial Street and Brentwood Street at Green Drive.

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**Notify the Engineer and coordinate with the Triad Regional ITS Engineer at (336) 315-7079 at least two weeks prior to the commencement of splicing or other work on these cables.** Provide the Triad Regional ITS Engineer updated splice details, updated field splicing location, and Contractor emergency contact information prior to beginning work. Do not disconnect the cable from the existing splice until ready to resplice the cable immediately to the new signal system cable in the new fiber-optic splice enclosure. The interruption of connectivity of these cables shall be limited to 48 hours or less, and shall occur only on a non-holiday, non-High-Point-Market weekend. **Liquidated damages** for failure to restore communications in an existing NCDOT ITS fiber-optic communications cable within 48 hours are **\$1500 per 24-hour period or any portion thereof.**

Repair at own expense, any damage to NCDOT fiber within 48 hours of notification of the incidence of damage. **Liquidated damages** for failure to repair a damaged NCDOT ITS fiber-optic communications cable and restore communications within 48 hours are **\$1500 per 24-hour period or any portion thereof.**

As shown in the Plans, disconnect the NCDOT Triad Region cable from the existing splice center inside an existing cabinet, pull the cable back to the new splice location, and splice the existing cable to the new signal system fiber-optic cable inside a new fiber-optic interconnect center. Relash the existing NCDOT cable to the messenger cable.

#### **(H) Testing**

Provide written notification to the Engineer a minimum of 10 working days before beginning the OTDR tests.

After splicing is completed, perform bi-directional OTDR tests on each fiber, including unused fibers. Install a 1,000-foot pre-tested launch cable between the OTDR and fiber-optic cable to be tested and a 1,000-foot pre-tested destination cable on the end of the fiber-optic cable to be tested. Ensure each launch cable has been tested and is compatible with the fiber-optic cable being installed. Provide the Engineer with test results of the launch cable before use. Retest or replace launch cable at the Engineer's request.

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-optic properties of the cable have been impaired, take appropriate actions up to and including replacement of the fiber-optic 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 two hard copies of each of the OTDR trace results and electronic copies of all trace results along with digital photographs showing workmanship for each splice on a compact disc. Furnish the manufacturer's make, model number and software version of the OTDR used for testing.

Provide the Engineer with two copies of the software needed to view the OTDR traces electronically.

#### **16.4. MEASUREMENT AND PAYMENT**

*Interconnect center* will be measured and paid as the actual number of fiber-optic interconnect centers furnished, installed, and accepted according to following conditions: 80%

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of the payment will be made upon acceptance of the installed interconnect centers and the remaining 20% of the payment will be made following final acceptance (including completion of the 60-day observation period).

*Splice enclosure* will be measured and paid as the actual number of fiber-optic splice enclosures that are furnished, installed, and accepted, regardless of installation location (i.e., aerial, underground, manhole, or junction box), according to following conditions: 80% of the payment will be made upon acceptance of the installed splice enclosures and the remaining 20% of the payment will be made following final acceptance (including completion of the 60-day Observation Period).

*Modify existing splice* will be measured and paid as the actual number of existing fiber-optic splice enclosures, interconnect centers and splice centers where existing splices are reconfigured, new fibers are spliced to existing fibers and new fibers are terminated in the existing splice center. Measurement will be made per existing splice enclosure without regard to type and location of splice enclosure and without regard to the number of splices and terminations required at each location. Payment for modify existing splice will be full compensation for all materials and work required to modify the existing splices in accordance with the plans. No measurement will be made of cable addition kits, grommet inserts, heat shrink tubing, splice trays and splice protectors as such work will be considered incidental to modifying the existing splice. No measurement will be made of relocating an existing aerial splice enclosure and associated fiber-optic cable storage guide(s) as such work will be considered incidental to modifying the existing splice.

Where the Plans call for pulling back and reinstalling an existing fiber-optic communications cable, the temporary disconnecting (unsplicing) of the existing cable from an existing splice enclosure or interconnect and the subsequent resplicing of the existing cable in the same existing splice enclosure will be considered incidental to modifying the existing splice. Where the Plans call for the existing cable to be re-installed and respliced to new fiber-optic cable(s) in a new splice enclosure or interconnect center, such work will be considered incidental to furnishing and installing the new splice enclosure or interconnect center. No separate measurement will be made for the initial work to disconnect the existing cable from the existing splice, uninstall (unlash) and pull the existing cable back, to temporarily store the pulled-back existing cable, and to reroute and reinstall the existing cable as such work will be considered incidental to modifying the existing splice or furnishing and installing the new splice enclosure/interconnect center.

No measurement will be made of fusion splices, splice trays, splice protectors, pigtails, jumpers, connector panels, labeling, photographs, testing and corrective actions, repairs and replacements needed due to exceeding the maximum allowable attenuation or other defects, as these will be considered incidental to furnishing and installing fiber-optic interconnect centers and splice enclosures, and modifying existing splices.

No measurement will be made for removal of existing interconnect centers as such work will be considered incidental to furnishing and installing fiber-optic interconnect centers.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Interconnect Center	Each
Splice Enclosure	Each
Modify Existing Splice	Each

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**17. CABLE MARKERS****17.1. DESCRIPTION**

Furnish and install delineator markers (tubular marker posts) and junction box markers with all necessary hardware and adhesives to warn of buried fiber-optic communications cable.

**17.2. MATERIALS****(A) Delineator Markers**

Furnish material, equipment, and hardware under this section that is pre-approved on the ITS and Signals QPL.

Furnish delineator markers, also referred to as tubular marker posts that are approximately 6 feet long and constructed of Type III, high-density polyethylene (HDPE) 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 delineator posts.

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

<b>W A R N I N G</b>	<b>F I B E R  O P T I C  C A B L E S</b>
<b>BEFORE EXCAVATING OR IN AN EMERGENCY CALL (336) 883-3225</b>	
<b>CITY OF HIGH POINT TRAFFIC SIGNAL SYSTEM</b>	

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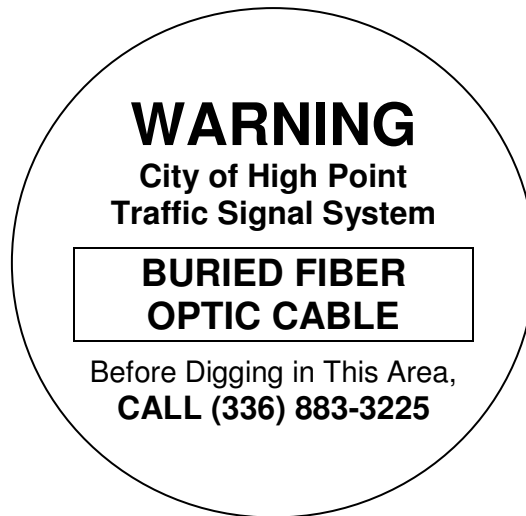
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**(B) Junction Box Markers**

Furnish durable, non-reflective junction box markers, also known as curb markers, fabricated from UV-resistant, non-metallic materials other than ceramic material, such as polyurethane or high impact polypropylene or other high impact plastic. Provide junction box markers that are designed for outdoor use, that are waterproof, that resist fading, that are temperature stable and that resist chemical and mechanical abrasion. Furnish junction box markers with a quick-setting adhesive designed for use with the junction box markers supplied and designed to permanently adhere junction box markers to Portland cement concrete, steel, and cast iron as well as other non-porous hard surfaces. Do not provide markers that require intrusive fasteners to secure the marker to the surface. Do not provide adhesives that are not designed for use with the junction markers supplied. Provide junction box markers that do not require special tools such as torches, tamping machines or drills or hardware or special surface preparation for installation. Furnish junction box markers from a manufacturer that has been producing such junction box markers (i.e., curb markers) for a minimum of 10 consecutive years. Provide junction box markers with a manufacturer's warranty of 10 years or more.

For marking existing junction boxes whose covers lack identifying imprints, provide junction box markers that contain the text and symbols, text emphasis and text proportions depicted in the following example format:



Overall Junction Box Marker Dimensions: 2.5" diameter

Text: Black

Background: Light Gray (to blend with concrete and granite surfaces)

Submit samples of proposed junction marker to the Engineer for approval before installation. In lieu of designing a custom junction box marker, the Contractor may submit for the Engineer's approval a stock/standard junction box marker format (i.e., off-the-shelf format) from the junction box marker manufacturer that differs from the example format proposed above but that still embodies the content and intent conveyed by the example format.

Have the junction box marker manufacturer provide a list of references along with contract information for at least five different municipal government agencies and/or state departments of transportation that have installed the proposed manufacturer's markers and can attest to the

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performance of the manufacturer's markers over a continuous period of no less than seven years. Submit these references to the Engineer for review in conjunction with submission of the sample.

### **17.3. CONSTRUCTION METHODS**

#### **(A) Cable Markers in Historic Districts**

Obtain the Engineer's approval prior to installing any cable markers within historic districts. The Engineer may modify the application criteria described herein or delete the requirement for some or all cable markers based upon the requirements of the particular historic district.

#### **(B) Delineator Markers**

Submit sample of proposed delineator markers for approval before installation.

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

Install delineator markers at locations specified on the plans. Do not install delineator markers at locations other than those specified in the Plans without the prior approval of the Engineer.

#### **(C) Junction Box Markers**

Apply junction box markers to the surface of existing covers (i.e., lids) on all existing junction boxes that will be retained and reused to house fiber-optic communications cable for the High Point signal system. Do not apply junction box markers to new covers that replace existing covers or that are installed with new junction boxes, unless the Engineer directs otherwise, since new covers will be imprinted with identifying information and contact phone number.

Clean surface to which the junction box marker will be applied. Make sure application surface is dry and free of any loose debris or cracks. Apply adhesive to back side of the junction box marker in accordance with manufacturer's instructions. Apply additional adhesive when surface is uneven or textured in order to fill voids and assure secure adhesion. Position the marker in the approximate center of the junction box cover and orient the marker so that its text is parallel to short side of the cover. Apply the junction box marker to the application surface and press firmly. Ensure that entire edge around perimeter of marker is sealed to the application surface.

### **17.4. MEASUREMENT AND PAYMENT**

*Delineator marker* will be measured and paid for as the actual number of delineator markers (tubular marker posts) furnished, installed, and accepted.

No measurement will be made of junction box markers and junction box marker adhesive as they will be considered incidental to furnishing and installing underground conduit and underground communications cable.

Payment will be made under:

#### **Pay Item**

Delineator Marker

#### **Pay Unit**

Each

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## 18. REMOVE EXISTING COMMUNICATIONS CABLE

### 18.1. DESCRIPTION

Remove existing communications cable. Remove existing communications cable splice boxes/cabinets and associated risers and in-ground junction boxes as designated in the Plans.

### 18.2. MATERIALS

Furnish rigid galvanized threaded pipe caps or rigid galvanized threaded pipe plugs to seal the ends of vertical conduits after “short risers” underneath pole-mounted cabinets are cutoff near ground level.

Furnish pipe caps or pipe plugs to seal the ends (i.e., tops) of 2” rigid galvanized steel risers from which fiber-optic cable and heat shrink tubing (or sealing bushing) are removed but not reinstalled (i.e., vacated existing fiber-optic cable risers). Provide heat-stabilized vinyl or plastic, non-threaded pipe cap or other Engineer-approved removable seal for top of vacated communications cable risers that are not removed. Refer to the “Risers” section of these Project Special Provisions for additional requirements for such riser caps.

Furnish heavy duty, dielectric, heat-shrink end caps designed to seal off and provide mechanical and mechanical protection to the ends of electrical and telecommunications cables. Provide end caps appropriated sized for the cables that they will be sealing.

### 18.3. CONSTRUCTION METHODS

#### (A) General

Do not reuse any removed communications cable, messenger cable, junction boxes, pole attachment hardware or abandoned risers on the project, unless otherwise specified.

Only remove existing communications cable where called out in the Plans and where directed by the Engineer; otherwise, do not remove the existing communications cable.

**Do not cut or remove existing Hi tran, City Off-Street Parking Division and NCDOT Triad Region fiber-optic communications cables.** Contact the City of High Point Department of Transportation a minimum of two weeks prior to removing the existing signal system communications cable for assistance in identifying and confirming the cable to be removed. Clearly label or tag the cable to be removed prior to removal. In addition, notify Hi tran, Off-Street Parking Division, and NCDOT Triad Region a minimum of two weeks in advance of removing existing signal system cable in the downtown to allow them to have representatives present during the removal process.

Exercise due care when removing the cable and provide all measures necessary to prevent damage to the existing fiber-optic cables belonging to Hi tran, City Off-Street Parking Division and NCDOT Triad Region ITS that reside in the existing underground conduit system and junction boxes and are lashed to the same messenger cable as the signal system communications cables.. The Contractor will be responsible for the cost of any repairs to the existing cables due to damage incurred during the process of removing the existing signal system communications cable and installing the new fiber-optic communications cable.

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Refer to Section 1 and the “Fiber-Optic Cable” section of these Project Special Provisions for additional requirements pertaining to the existing Hi tran, City Off-Street Parking Division and NCDOT Triad Region ITS fiber-optic cables.

**(B) Existing Hi tran and Off-Street Parking Division FO Cables**

At several locations in downtown High Point, fiber-optic cables owned by the High Point Transit System (Hi tran) and by the City’s Off-Street Parking Division follow the same aerial and underground routes as the existing traffic signal system communications cables. Often these Hi tran and Off-Street Parking Division fiber-optic cables are lashed to the same messenger cable or occupy the same underground conduits and junction boxes as the existing traffic signal system communications cables. **Do not disturb, unlash, cut, remove or damage the Hi tran and Off-Street Parking Division fiber-optic cables.** The Contractor will be held responsible for any damage to the existing Hi tran and Off-Street Parking Division fiber-optic cables caused by the Contractor’s construction activities and procedures. The Contractor will be required to replace in kind any Hi tran and Off-Street Parking Division fiber-optic cables that he/she damages at his/her expense.

While the Plans note some areas where Hi tran and Off-Street Parking Division cables are known to be present, these notes are for general information purposes to alert the Contractor to possible presence of these existing cables where construction will be occurring. These advisory notes are neither precise nor complete identification of all such existing cables and all locations where these cables may be present. Prior to beginning any cable construction in these areas, coordinate with the City to confirm routing of the Hi tran and Off-Street Parking Division cables and ensure proper identification of the different use cables that share the same messenger, risers, underground conduits and junction boxes. Do not cut or remove any existing fiber-optic communications cable in these areas without prior approval of the City. Clearly label or tag the cable to be removed prior to removal. In addition, notify Hi tran and the City’s Off-Street Parking Division a minimum of two weeks in advance of cutting and removing any existing signal system communications cable in these areas to allow them to have representatives present at the time of cutting and removing.

Unless directed otherwise by the Engineer, do NOT remove the existing traffic signal communications cable(s) and supporting messenger cable when the Hi tran and Off-Street Parking Division fiber-optic cables are lashed to the same messenger. In lieu of removal, cut the existing traffic signal system communications cable but not the supporting messenger at the ends of the coincident route and abandon the traffic signal system cable in place.

**(C) Existing NCDOT Triad Region ITS FO Cables**

There are existing NCDOT Triad Region ITS fiber-optic communications cables whose routes coincide with routes of the existing High Point traffic signal system communications cable in some areas. These NCDOT ITS cables also splice into the existing signal system cable at two locations to homerun back to the City’s TOC via the signal system trunk cable. In addition, NCDOT uses some fibers in the existing signal system communications cable to route communications to some NCDOT CCTV cameras on US 311/I-73 via the City’s TOC. Except where the Plans require re-splicing the existing NCDOT cable to the new signal system cable, **do NOT disturb, unlash, cut, remove or damage the existing NCDOT Triad Region ITS fiber-optic cables.** The Contractor will be held responsible for any damage to the existing NCDOT Triad Region fiber-optic cables caused by the Contractor’s construction activities and



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procedures. The Contractor will be required to replace in kind any NCDOT Triad Region ITS fiber-optic cables that he/she damages at his/her expense Refer to Section 1 of these Project Special Provisions for additional requirements.

Unless directed otherwise by the Engineer, do NOT remove the existing traffic signal communications cable(s) and supporting messenger cable when the NCDOT Triad Region ITS fiber-optic cables are lashed to the same messenger. In lieu of removal, cut the existing traffic signal system communications cable but not the supporting messenger at the ends of the coincident route and abandon the traffic signal system cable in place.

**(D) Removal of Aerial Communications Cable**

Removal of existing aerial communications cable includes removal and proper disposal of aerial splice enclosures, messenger cable and mounting hardware, associated guy assemblies, splice boxes and splice cabinets as well as vacated risers attached to splice boxes and cabinets that are being removed. Communications cable removal also includes removal of existing PVC risers that are vacated when the communications cable is removed. Retain and cap/plug tops of all other existing rigid galvanized steel risers vacated when communications cable is removed, unless the Engineer directs otherwise. Removal of guy assemblies includes the removal of guy anchors if not used by any other guy assembly.

Unless otherwise directed by the Engineer, remove and properly dispose of existing wood poles that are vacated upon removal of the existing communications cable (i.e., where the communications cable was the only attachment to the pole).

**(E) Removal of Underground Communications Cable**

Removal of existing underground communications cable includes proper disposal of junction boxes, if required. Where junction boxes have been removed, backfill hole to 95% of surrounding density and finish level with surrounding ground.

When removing existing communications cable from an underground conduit that will be retained for future use, install a pull tape in the vacated underground conduit in conjunction with or immediately following removal of the existing cable. Seal the ends of the vacated conduit with an approved duct plug or duct and conduit sealer following installation of the pull tape.

When the Contractor has made reasonable attempts to remove an existing communications cable but is unable to do so as confirmed by the Engineer, carefully cut the existing cable close to the end of the conduit/duct, leaving just enough cable exposed to apply a heat shrink end cap over the end of the cable. Clean and prepare end of cable in accordance with heat shrink cable end cap manufacturer's instructions. Install a heat shrink cap appropriately sized for the cable being sealed over the end of the cable, then abandon the cable in the existing conduit/duct. Remove and dispose of the severed cable remnant.

At pole-mounted controller cabinets that have an existing short riser that conveys existing communications cable directly into the bottom of the cabinet from an underground conduit run and that short riser will not be retained for installation of a new fiber-optic drop cable, remove the short riser and existing communications cable as follows:

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1. Disconnect the communications cable inside the pole-mounted controller cabinet.
2. Disconnect the short riser from the bottom of the cabinet and then cut off the short riser and communications cable flush with the sidewalk below the cabinet or at least 6 inches below ground where there is no sidewalk.
3. Where the short riser free-standing (i.e., offset from and not attached to pole from ground bottom of cabinet) and is within sidewalk below the cabinet, cut-off the short riser below grade (i.e., beneath the sidewalk) and replace the affected slab of sidewalk. Where the freestanding riser is in an unpaved area, cut off the short riser below ground and back fill over the top. If the short riser is attached to the pole (not offset), install a cap or plug the short riser at its current height.

Subject to the Engineer's approval, existing communications cable being removed may be used as a pull line to install the new fiber-optic communications cable in its place in the existing underground conduit. Comply with the installation requirements in the "Fiber-Optic Cable" section of these Project Special Provisions when installing then new fiber-optic cable in existing underground conduit.

#### **18.4. MEASUREMENT AND PAYMENT**

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

No additional measurement will be made for multiple communications cables being removed from the same underground conduit or same pole. No payment will be made for communications cable that cannot be removed and is abandoned in place.

No measurement will be made of the removal of messenger cable, pole attachment hardware, guy assemblies, aerial splice enclosures, wood poles, stub poles, risers (where removal is required by this Project Special Provision or by the Engineer) and in-ground junction boxes vacated upon removal of the existing communications cable, as these will be considered incidental to the removal of the existing communication cable.

No measurement will be made for installing a pull tape inside of and sealing the ends of an existing conduit that will be retained for future use after removing an existing communications cable from that conduit as such work will be considered incidental to installation of new fiber-optic communications cable.

*Remove splice cabinet* will be measured as the actual existing communications cable splice boxes and cabinets successfully removed, disposed of and accepted without regard to the size or type of cabinet/box, mounting location or mounting method. Such payment includes removal and disposal of cabinet/box mounting brackets and hardware.

No measurement will be made of the removal of risers vacated upon removal of existing splice boxes/cabinets and associated communications cable and of pipe caps and pipe plugs installed on vacated risers that are retained (left in place), as these will be considered incidental to the removal of the existing splice box/cabinet and the existing communications cable. No measurement will be made of conduit plugs.

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Payment will be made under:

**Pay Item**

Remove Existing Communications Cable

Remove Splice Cabinet

**Pay Unit**

Linear Foot

Each

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**19. CABLE TRANSFERS**

**19.1. DESCRIPTION**

Remove and reinstall existing communications cable for pole relocations.

**19.2. CONSTRUCTION METHODS**

During the project, transfers of existing communications cable from one pole to an adjacent pole or from one attachment point to a new attachment point on the same pole may be required. Perform transfers as directed by the Engineer.

For pole-to-pole transfers, remove existing cable from the pole and reinstall the cable and any existing attachment hardware on the adjacent second pole. Remove all communications hardware from first pole from which the cable was removed.

For attachment-point-to-attachment-point transfers on the same pole, drill a hole in the pole and install a strandvise for dead-end attachment of the cable as called for in the Plans, relocate the messenger cable from the existing 3-bolt clamp to the new strandvise, and remove the existing 3-bolt clamp. Install new guy assembly for dead-end span as shown in the Plans.

Furnish and install any new attachment hardware as required.

**19.3. MEASUREMENT AND PAYMENT**

*Cable transfer* will be measured and paid as the actual number of cable transfers with attachment hardware from one pole to an adjacent pole or from one attachment point to a new attachment point on the same pole furnished, installed, and accepted.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Cable Transfer	Each

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## 20. SIGNS INSTALLED FOR SIGNALS

### 20.1. DESCRIPTION

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

### 20.2. MATERIALS

Comply with Articles 1092-1, Signs and Hardware, and 1092-2 Retroreflective Sheeting, of the *Standard Specifications*.

Use Grade C retroreflective 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° adjustable sign brackets or 3-bolt clamps as directed. Furnish aluminum, galvanized steel, or stainless steel sign supporting hardware.

For ground mounting, furnish steel, 3 lb., U-channel posts with hardware for ground mounting. Comply with Section 903, Ground Mounted Sign Supports of the *Standard Specifications*.

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

### 20.3. CONSTRUCTION METHODS

Install signs with approved mounting hardware. Comply with sign offsets and mounting heights as shown in the *MUTCD* and NCDOT *Roadway Standard Drawing* No. 904.50.

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

For ground mounting, comply with Section 903, Ground Mounted Supports of the *Standard Specifications*.

For mast arm mounting, install attachment brackets to allow adjustment so signs:

- Are aimed in required direction,
- Are plumb as viewed from respective approaches,
- May be tilted forward or backward as required, and
- May be raised or lowered on mast arm throughout full length of sign.

### 20.4. 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:

<b>Pay Item</b>	<b>Pay Unit</b>
Sign for Signals	Each

**C-5558****ITS-150****Guilford County****21. EQUIPMENT CABINET FOUNDATIONS****21.1. DESCRIPTION**

Furnish and install foundations for base-mounted equipment cabinets, including signal controller cabinets and CCTV cabinets, and all necessary hardware.

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

**21.2. MATERIALS**

Furnish preformed cabinet pad foundation material, equipment, and hardware under this section that is pre-approved on the ITS and Signals QPL.

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

Furnish cabinet foundations with chamfered top edges. Provide minimum Class B concrete in accordance with Article 1000-4, "Portland Cement Concrete for Structures and Incidental Construction," of the *Standard Specifications*.

Provide standard cabinet foundations in unpaved areas with a minimum pad area that extends 24" from front and back of cabinet base extenders and adapters, and 3" from sides of cabinet base extenders and adapters. For cabinet foundations installed within brick or concrete sidewalks, omit the 24" from the front and rear of the cabinet and provide a foundation that extends 3" from all four sides of the cabinet base extender as shown on the special detail in the Plans.

Furnish Class B Portland cement concrete in accordance with Article 848-2 of the *Standard Specifications*, to replace removed or damaged sections of existing sidewalk and restore locations to preconstruction condition.

Furnish replacement sidewalk pavers where required to restore locations to preconstruction condition that are of the same color, texture, shape, dimensions and materials as the damaged or modified items.

Provide replacement materials for other special pavement treatments or landscaping that are the same materials as the damaged or modified items to restore locations to preconstruction condition.

For repair of concrete sidewalks within historic districts that are removed or damaged by construction, provide concrete tinted to match the appearance of the existing sidewalk.

**21.3. CONSTRUCTION METHODS**

Comply with Section 825, "Incidental Concrete Construction – General," of the *Standard Specifications*.

Refer to Section 1 of these Project Special Provisions for requirements concerning construction within historic districts.

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Obtain approval for final cabinet foundation locations before pouring concrete base or installing a preformed cabinet base. Locate new cabinets so as not to obstruct sight distance of vehicles turning on red or create any ADA violations or pedestrian conflicts. Maintain 12 inches minimum from service pole to closest point on foundation unless otherwise approved.

Do not install foundations over uncompacted fill or muck. Hand-tamp soil before placing concrete or preformed cabinet base and ensure ground is level.

When using poured concrete foundations, use procedures, equipment, and hardware as follows:

- Use a minimum of four 1/2-inch diameter expanding type anchor bolts to secure cabinet to foundation.
- In unpaved areas, install cabinet foundations a minimum 4 inches above and 4 inches below finished grade. In paved areas, install foundations 1 inch above the paved surface at its highest point and 4 inches below the paved surface at its lowest point.
- Locate external stubbed out conduit at 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 identification arrow in foundation indicating direction of spare conduits.
- Ensure that conduits extend 2" to 3" above finished cabinet foundation.
- Give cabinet foundation a broom finish. Seal space between cabinet base and foundation with permanent, flexible, waterproof sealing material.

If using preformed cabinet pad, use loop sealant to seal the conduit stub-outs within the knock-out. Do not use preformed cabinet pad for cabinet foundations located within or adjacent to historic districts.

Restore the disturbed ground surrounding the new cabinet foundation to its original, preconstruction condition as determined and approved by the Engineer.

- For paved areas, replace removed or damaged pavement with in kind materials, matching the elevation, color, texture/finish and general appearance of the surrounding pavement. Refer to Section 1 of these Project Special Provisions for additional requirements concerning sidewalks and curbs in historic districts. Replace concrete sidewalk in whole slabs from joint to joint and comply with Article 848-3 of the *Standard Specifications*. Replace brick pavers using pavers of the same color, texture, shape, dimensions and materials as the damaged or modified items. Place graded stone material to temporarily maintain pedestrian traffic where repairs cannot be performed immediately. Comply with Article 545-4 of the *Standard Specifications*.
- For unpaved areas, backfill excavations with removed material, tamp the backfilled material and rake smooth the top 1½ inches. Finish unpaved areas flush with surrounding natural ground and to match the original contour of the ground. Seed with same type of grass as surrounding area and mulch the newly seeded area. If

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unpaved area was not grassed, replace the original ground cover in kind as directed by the Engineer.

**Complete repairs to and restoration of all ground (paved and unpaved) disturbed for construction within five consecutive calendar days following initial removal.** If the Contractor fails to repair and restore the ground in accordance with these Project Special Provisions within the time frame specified, the Department reserves the right to make the necessary repairs, and all expenses incurred by the Department in making the repairs and restoring the ground will be deducted from payment due the Contractor, plus **\$500 liquidated damages per occasion, per day, or any portion thereof**, until corrected.

#### 21.4. MEASUREMENT AND PAYMENT

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

*CCTV cabinet foundation* will be measured and paid as the actual number of CCTV cabinet foundations furnished, installed, and accepted.

*4" concrete sidewalk* will be measured and paid as the actual square yards of concrete furnished, installed and accepted. Measurement will be made along the surface of the completed and accepted work. Such price includes, but is not limited to, excavating and backfilling, sawing the existing sidewalk, furnishing and placing concrete, and constructing and sealing joints.

No measurement will be made of special finishing, staining and tinting of concrete sidewalk to match the appearance of existing sidewalk as such work will be considered incidental to furnishing and installing 4" concrete sidewalk.

*Brick pavers* will be measured and paid as the actual square feet of brick pavers furnished, installed and accepted.

No measurement or payment will be made for restoration of the surrounding unpaved ground surfaces in accordance with these Project Special Provisions as such work will be considered incidental to furnishing and installing signal cabinet foundations.

No measurement or payment will be made for furnishing and installing and subsequently removing graded stone material for temporary maintenance pedestrian traffic where a portion of an existing sidewalk has been removed as such work will be considered incidental to furnishing and installing signal cabinet foundations.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Signal Cabinet Foundation	Each
CCTV Cabinet Foundation	Each
4" Concrete Sidewalk	Square Yard
Brick Pavers	Square Foot



## 22. MODIFY CABINET FOUNDATIONS

### 22.1. DESCRIPTION

Where approved by the Engineer, install conduit entrances into existing foundations in accordance with the Plans and Project Special Provisions.

Modify existing foundations in accordance with the Plans and Project Special Provisions.

### 22.2. MATERIALS

Comply with the provisions of "Equipment Cabinet Foundations" section of these Project Special Provisions.

### 22.3. CONSTRUCTION METHODS

#### (A) General

Install new conduit entrances into existing cabinet foundations by core drilling foundations to install additional conduits. New entrances for conduits 1" or less in nominal diameter may be drilled in lieu of core-drilled, subject to the Engineer's approval. Where approved by the Engineer, the foundation may be chipped instead of drilled for conduit entrance.

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

#### (B) Install Conduit Entrance into Existing Foundation

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

Bond new metallic conduit to the cabinet grounding system.

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

#### (C) Modify Foundation

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

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.

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Drill holes approximately 6 inches deep on 12-inch centers into the existing foundation. Clean holes with compressed air only prior to applying epoxy and installing dowels. Do not clean holes with water or any other liquid. Install #4 dowels and epoxy into place. Provide dowels of the following lengths:

Foundation Extension	Length of Dowel
>16"	18"
>6" and ≤16"	11"
=6"	8"

Use concrete to install the maintenance technician pad.

Form the sides of the modified foundation to a minimum depth of 4 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.

As a minimum, enlarge the foundation to the distance specified for new cabinet foundations. 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, unless otherwise directed by the Engineer. Increase the pad enlargement beyond these minimum dimensions to match the width of the existing foundation along the side to which concrete is being added to maintain the rectangular shape of the pad.

Provide a 1-inch chamfer on all new outside edges.

Modify cabinet foundations located within or adjacent to historic districts as shown in the Plans using a concrete mix tinted to match the appearance of the existing concrete foundation being modified.

#### (D) Alternate Methods of Modifying Foundations

Where the Plans call for a new conduit entrance to be installed into an existing cabinet foundation or for the existing foundation to be modified by expanding it, the Contractor may, subject to the approval of the Engineer and at no additional cost to the Department, use one of the following methods in lieu of core-drilling and/or expanding the existing base:

- Remove the existing cabinet foundation and replace it with a new preformed cabinet pad in the same location.
- Overlay the existing cabinet foundation with a new preformed cabinet pad.
- Install a new cabinet foundation adjacent to the existing foundation.

Comply with the construction methods for each method described below.

**Do not use alternate methods for modifying foundations within or adjacent to historic districts. Comply with the Plans when modifying foundations within or adjacent to historic districts.**

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**(1) In Situ Replacement**

Carefully remove the existing concrete from around the existing conduit spread, taking care not to damage the conduit stubs or the existing field wiring. Construct additional conduit stub-out(s) where the Plans call for a new conduit entrance in the existing foundation. Once existing concrete has been completely removed and new stub-out(s) has been constructed, immediately set a preformed cabinet pad over the existing conduit spread and new stubout(s). Install preformed cabinet pad in accordance with the manufacturer's instructions. Reinstall existing controller and cabinet or install new controller and cabinet on the new preformed pad. Provide preformed cabinet pads that are listed on the ITS and Signals QPL.

**(2) Overlay Existing Foundation**

Where the top of the existing cabinet foundation is no more than 2 inches above the surrounding ground, overlay the existing foundation by setting a preformed cabinet pad over the existing conduit spread and existing foundation. Level and hand tamp the ground around the existing foundation and install the preformed pad in accordance with the manufacturer's instructions. Furnish and install couplings, nipples, and bushings (PVC or rigid galvanized steel) to extend the existing conduit stub-outs so that the tops of the conduits are 2-3 inches above the top of the preformed pad. Use existing field wiring, splicing and extending the field wiring inside the controller cabinet as needed (refer to Extension of Existing Field Wiring section of these Project Special Provisions). Install new conduit entrance(s) into the existing foundation if necessary.

Immediately reinstall the existing controller and cabinet or install the new controller and cabinet once the preformed pad is set in place.

Backfill around the perimeter of the new pad with topsoil to a point 4 inches below the top surface of the new pad. Gently slope the backfill to tie into the existing ground line with a gradual slope no steeper than 4:1; do not create an abrupt or unsightly mound. Ensure the preformed pad and backfill does not block the flow of runoff or impound water. Hand tamp the new soil and apply grass seed and mulch.

Do not use this method where the top of the existing cabinet foundation is more than 2 inches higher than the surrounding ground, unless the Engineer approves otherwise.

**(3) Construct New Foundation Adjacent to Existing Foundation**

Construct a new cabinet foundation with all necessary hardware adjacent to the existing foundation and rewire the cabinet using one of the following methods:

- Install new risers on adjacent cabinet pole, “pull back” existing field wiring to the top of the existing risers, reinstall existing wiring through the new risers to the new foundation and splice and extend field wiring with gel-filled butt splice connectors in base of new cabinet if necessary.
- Install new risers with terminal splice cabinet on adjacent cabinet pole, “pull back” existing field wiring to the top of the existing risers, and reinstall existing wiring through the new risers to the terminal splice cabinet. Inside the terminal splice cabinet, splice the existing wiring to new conductors from the new base-mounted controller cabinet.

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Comply with the “Signal Cabinet Foundations” section and the “Extension of Existing Field Wiring” section of these Project Special Provisions.

**(E) Ground Surface Restoration**

Restore the disturbed ground, both paved and unpaved, surrounding the modified cabinet foundation to its original condition as determined and approved by the Engineer. Comply with all requirements of the “Ground Surface Restoration” subsection of the “Equipment Cabinet Foundation” section of these Project Special Provisions.

**22.4. MEASUREMENT AND PAYMENT**

*Conduit entrance into existing foundation* will be measured as the actual number of conduit entrances drilled into existing cabinet foundations furnished, installed and accepted. As approved by the Engineer, law enforcement provided for directing traffic while a signal is inoperable during construction of conduit entrance into existing foundation will be measured and paid for separately in accordance with the “Temporary Traffic Control” section of these Project Special Provisions.

*Modify foundation for controller cabinet* will be measured as the actual number of existing cabinet foundations modified and accepted.

Alternate methods for adding conduit entrances to and modifying existing cabinet foundations will be measured and paid as *conduit entrance into existing foundation* and/or *modify foundation for controller cabinet*, as specified in the Plans for the given location. Such payment will be full compensation for all work required to add the conduit entrance and/or modify the cabinet foundation using one of the alternate methods described above. No separate measurement will be made of preformed cabinet pads, removal of existing foundations or splicing and extending existing field wiring required due to the use of an alternate method for adding a conduit entrance or for modifying an existing cabinet foundation.

Restoration of the surrounding ground surfaces, paved and unpaved, will be measured and paid for in accordance with the “Equipment Cabinet Foundations” section of these Project Special Provisions.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Conduit Entrance into Existing Foundation	Each
Modify Foundation for Controller Cabinet	Each

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## 23. CONTROLLERS WITH CABINETS

### 23.1. DESCRIPTION

Furnish and install controllers with cabinets and all necessary hardware. Furnish all pole or foundation mounting hardware, detector sensor cards, one Corbin Number 2 cabinet key, one police panel key, conflict monitors, surge protection, grounding systems, AC/DC isolator cards, auxiliary files (where required) and all necessary hardware. Install updates of local controller and operating system software.

### 23.2. MATERIALS - GENERAL

Furnish material, equipment, and hardware under this section that is pre-approved on the ITS and Signals QPL.

### 23.3. MATERIALS – TYPE 2070E CONTROLLERS

Conform to CALTRANS *Transportation Electrical Equipment Specifications* (TEES) (dated March 12, 2009, plus Errata 1 dated January 21, 2010) except as required herein.

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

The Department will provide local controller 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. The Department will provide updates to the local controller software for installation by the Contractor up through final acceptance of the project.

Provide Model 2070E controllers with the latest version of OS9 operating system software and device drivers, composed of the unit chassis and at a minimum the following modules and assemblies:

- MODEL 2070-1E, CPU Module, Single Board, with 8Mb Datakey (blue in color)
- MODEL 2070-2A or approved MODEL 2070-2E, Field I/O Module (FI/O)  
     Note: Configure the Field I/O Module to disable both the External WDT Shunt/Toggle Switch and SP3 (SP3 active indicator is “off”)
- MODEL 2070-3B, Front Panel Module (FP), Display B (8x40)
- MODEL 2070-4, Power Supply Module, 10 AMP
- MODEL 2070-7A, Async Serial Com Module (9-pin RS-232)

Provide all updates to the OS9 operating system software released up through final acceptance of the project at no additional cost to the Department.

Provide Model 2070E controllers that are capable of properly running the Department’s OASIS local controller software and that are capable of operating properly within an Ethernet communications system.

### 23.4. MATERIALS – GENERAL CABINETS

Provide a moisture resistant coating on all circuit boards.

Provide one 20 mm diameter radial lead UL-recognized metal oxide varistor (MOV) between each load switch field terminal and equipment ground. Electrical performance is outlined below.

PROPERTIES OF MOV SURGE PROTECTOR	
Maximum Continuous Applied Voltage at 185° F	150 VAC (RMS) 200 VDC
Maximum Peak 8x20µs Current at 185° F	6500 A
Maximum Energy Rating at 185° F	80 J
Voltage Range 1 mA DC Test at 77° F	212-268 V
Max. Clamping Voltage 8x20µs, 100A at 77° F	395 V
Typical Capacitance (1 MHz) at 77° F	1600 pF

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 395V at 20,000A with a nominal series inductance of 200µh. Ensure that the voltage does not exceed 395V. Provide devices that comply with the following:

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

### 23.5. MATERIALS – TYPE 170E CABINETS

#### (A) Type 170 E Cabinets General

Conform to the city of Los Angeles' Specification No. 54-053-08, *Traffic Signal Cabinet Assembly Specification* (dated July 2008), except as required herein.

Furnish model 336S pole-mounted cabinets configured for 8 vehicle phases, 4 pedestrian phases, and 6 overlaps. Do not reassign load switches to accommodate overlaps unless shown on electrical details. Provide 336S pole-mounted cabinets that are 46" high with 40" high internal rack assemblies.

Furnish model 332 base mounted cabinets configured for 8 vehicle phases, 4 pedestrian phases, and 6 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. Provide 336S pole mounted cabinets that are 46" high with 40" high internal rack assemblies.

Provide model 200 load switches, model 222 loop detector sensors, model 252 AC isolators, and model 242 DC isolators according to the electrical details. As a minimum, provide one (1) model 2018 conflict monitor, one (1) model 206L power supply unit, two (2) model 204 flashers,

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one (1) DC isolator (located in slot I14), and four (4) model 430 flash transfer relays (provide seven (7) model 430 flash transfer relays if auxiliary output file is installed) with each cabinet.

**(B) Type 170 E 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.

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

Provide surge suppression in the cabinet for each type of cabinet device. Provide surge protection for the full capacity of the cabinet input file. Provide surge suppression devices that operate properly over a temperature range of -40° F to +185° F. Ensure the surge suppression devices provide both common and differential modes of protection.

Provide a pluggable power line surge protector that is installed on the back of the PDA (power distribution assembly) chassis to filter and absorb power line noise and switching transients. Ensure the device incorporates LEDs for failure indication and provides a dry relay contact closure for the purpose of remote sensing. Ensure the device meets the following specifications:

Peak Surge Current (Single pulse, 8x20µs).....20,000A  
 Occurrences (8x20µs waveform).....10 minimum @ 20,000A  
 Maximum Clamp Voltage.....395VAC  
 Operating Current.....15 amps  
 Response Time.....< 5 nanoseconds

Provide a loop surge suppressor for each set of loop terminals in the cabinet. Ensure the device meets the following specifications:

Peak Surge Current (6 times, 8x20µs)  
 (Differential Mode).....400A  
 (Common Mode).....1,000A  
 Occurrences (8x20µs waveform).....500 min @ 200A  
 Maximum Clamp Voltage  
 (Differential Mode @400A).....35V  
 (Common Mode @1,000A).....35V  
 Response Time.....< 5 nanoseconds  
 Maximum Capacitance.....35 pF

Provide a data communications surge suppressor for each communications line entering or leaving the cabinet. Ensure the device meets the following specifications:

Peak Surge Current (Single pulse, 8x20µs).....10,000A

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- Occurrences (8x20µs waveform).....100 min @ 2,000A
- Maximum Clamp Voltage.....Rated for equipment protected
- Response Time.....< 1 nanosecond
- Maximum Capacitance.....1,500 pF
- Maximum Series Resistance.....15Ω

Provide a DC signal surge suppressor for each DC input channel in the cabinet. Ensure the device meets the following specifications:

- Peak Surge Current (Single pulse, 8x20µs).....10,000A
- Occurrences (8x20µs waveform).....100 @ 2,000A
- Maximum Clamp Voltage.....30V
- Response Time.....< 1 nanosecond

Provide a 120 VAC signal surge suppressor for each AC+ interconnect signal input. Ensure the device meets the following specifications:

- Peak Surge Current (Single pulse, 8x20µs).....20,000A
- Maximum Clamp Voltage.....350VAC
- Response Time.....< 200 nanoseconds
- Discharge Voltage.....<200 Volts @ 1,000A
- Insulation Resistance.....≥100 MΩ

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.

If additional surge protected power outlets are needed to accommodate fiber transceivers, modems, etc., install a UL listed, industrial, heavy-duty type power outlet strip with a minimum 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.

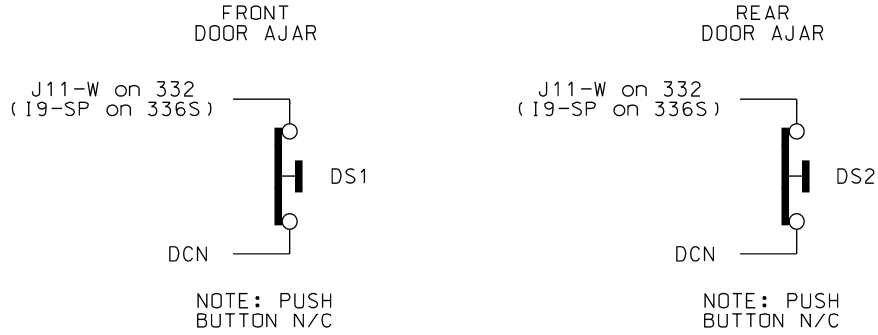
Provide a door switch in the front and a door switch in the rear of the cabinet that will provide the controller unit with a Door Ajar alarm when either the front or the rear door is open. Ensure the door switches apply DC ground to the Input File when either the front door or the rear door is open.



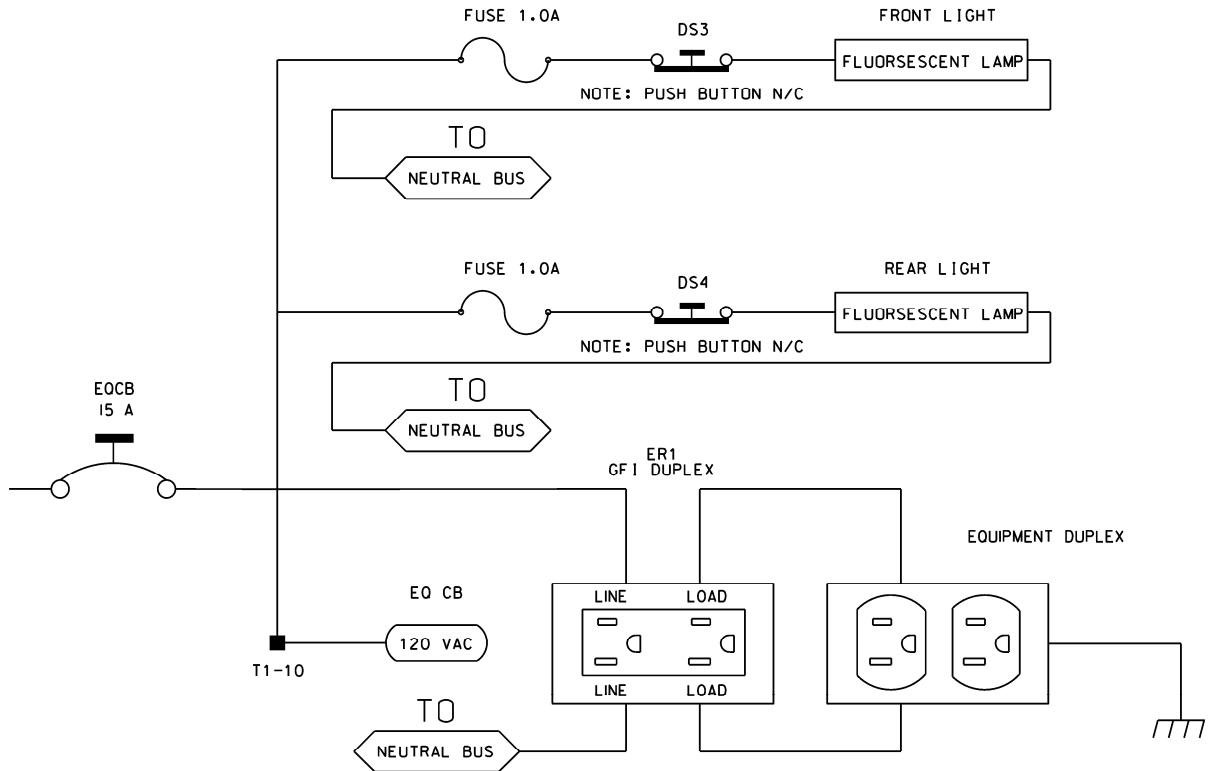
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Furnish a fluorescent fixture in the rear across the top of the cabinet and another fluorescent fixture in the front across the top of the cabinet at a minimum. Ensure that the fixtures provide sufficient light to illuminate all terminals, labels, 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. Install 16 watt T-4 lamps in the fluorescent fixtures. Provide a door switch to provide power to each fixture when the respective door is open. Wire the fluorescent fixtures to the 15 amp ECB (equipment circuit breaker).



Furnish a police panel with a police panel door. For model 336S cabinets, mount the police panel on the rear 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 the

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requirements of LA Specification No. 54-053-08, 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.

Ensure the 336S cabinet Input Files are wired as follows:

336 Cabinet Port-Bit/C-1 Pin Assignment														
Slot #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C-1 (Spares)	59	60	61	62	63	64	65	66	75	76	77	78	79	80
Port C-1	3-2 56	1-1 39	3-4 58	1-3 41	3-1 55	1-2 40	3-3 57	1-4 42	2-5 51	5-5 71	5-6 72	5-1 67	5-2 68	6-7 81
Port C-1	2-1 47	1-5 43	2-3 49	1-7 45	2-2 48	1-6 44	2-4 50	1-8 46	2-6 52	5-7 73	5-8 74	5-3 69	5-4 70	6-8 82

For model 332 base mounted cabinets, ensure terminals J14-E and J14-K are wired together on the rear of the Input File. Connect TB9-12 (J14 Common) on the Input Panel to T1-2 (AC-) on the rear of the PDA.

Provide detector test switches mounted at the top of the cabinet rack or other convenient location which may be used to place a call on each of eight phases based on the chart below. 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.

Connect detector test switches for cabinets as follows:

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

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Provide the PCB 28/56 connector for the conflict monitor unit (CMU) with 28 independent contacts per side, dual-sided with 0.156 inch contact centers. Provide the PCB 28/56 connector contacts with solder eyelet terminations. Ensure all connections to the PCB 28/56 connector are soldered to the solder eyelet terminations.

Ensure that all cabinets have the CMU connector wired according to the 332 cabinet connector pin assignments (include all wires for auxiliary output file connection). Wire pins 13, 16, R, and U of the CMU connector to a separate 4 pin plug, P1, as shown below. Provide a second plug, P2, which will mate with P1 and is wired to the auxiliary output file as shown below. Provide an additional plug, P3, which will mate with P1 and is wired to the pedestrian yellow circuits as shown below. When no auxiliary output file is installed in the cabinet, provide wires for the green and yellow inputs for channels 11, 12, 17, and 18, the red inputs for channels 17 and 18, and the wires for the P2 plug. Terminate the two-foot wires with ring type lugs, insulated, and bundled for optional use.

PIN	P1		P2		P3	
	FUNCTION	CONN TO	FUNCTION	CONN TO	FUNCTION	CONN TO
1	CH-9G	CMU-13	OLA-GRN	A123	2P-YEL	114
2	CH-9Y	CMU-16	OLA-YEL	A122	4P-YEL	105
3	CH-10G	CMU-R	OLB-GRN	A126	6P-YEL	120
4	CH-10Y	CMU-U	OLB-YEL	A125	8P-YEL	111

Do not provide the P20 terminal assembly (red monitor board) or red interface ribbon cable as specified in the LA Specification No. 54-053-08.

Provide a P20 connector that mates with and is compatible with the red interface connector mounted on the front of the conflict monitor. Ensure that the P20 connector and the red interface connector on the conflict monitor are center polarized to ensure proper connection. Ensure that removal of the P20 connector will cause the conflict monitor to recognize a latching fault condition and place the cabinet into flashing operation.

Wire the P20 connector to the output file and auxiliary output file using 22 AWG stranded wires. Ensure the length of these wires is a minimum of 42 inches. Provide a durable braided sleeve around the wires to organize and protect the wires.

Wire the P20 connector to the traffic signal red displays to provide inputs to the conflict monitor as shown below. Ensure the pedestrian Don't Walk circuits are wired to channels 13 through 16 of the P20 connector. When no auxiliary output file is installed in the cabinet, provide wires for channels 9 through 12 reds. Provide a wire for special function 1. Terminate the unused wires with ring type lugs, insulated, and bundled for optional use.

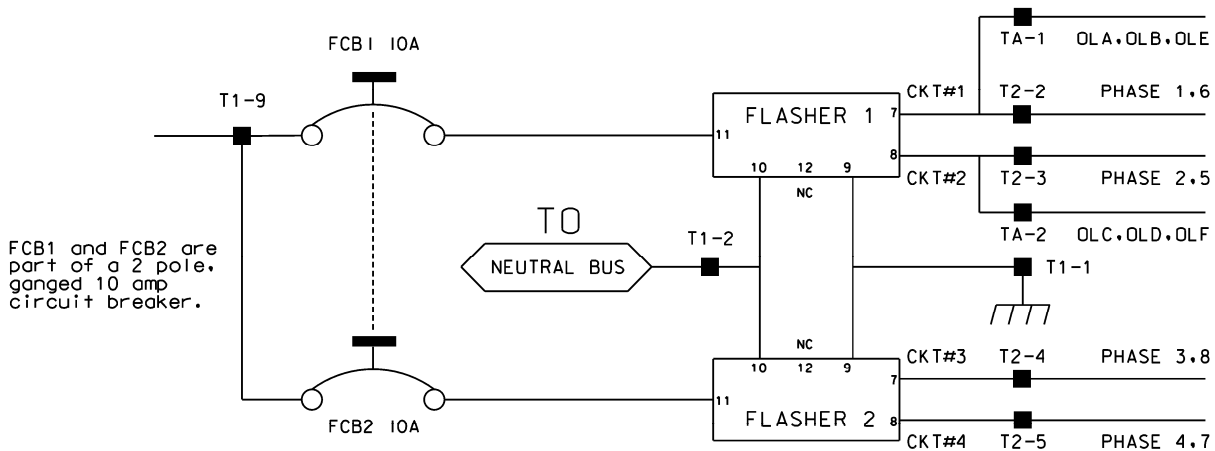
P20 Connector					
PIN	FUNCTION	CONN TO	PIN	FUNCTION	CONN TO
1	Channel 15 Red	119	11	Channel 16 Red	110
2	Channel 14 Red	104	12	Chassis GND	01-9
3	Channel 13 Red	113	13	N/C	
4	Channel 12 Red	AUX 101	14	Spec Function 1	
5	Channel 10 Red	AUX 124	15	Channel 11 Red	AUX 114
6	Channel 9 Red	AUX 121	16	Channel 8 Red	107
7	Channel 7 Red	122	17	Channel 6 Red	134
8	Channel 5 Red	131	18	Channel 4 Red	101
9	Channel 3 Red	116	19	Channel 2 Red	128
10	Channel 1 Red	125	20	Red Enable	01-14

Do not wire pin 12 of the load switch sockets.

Ensure the controller unit outputs to the auxiliary output file are pre-wired to the C5 connector. When no auxiliary output file is installed in the cabinet, connect the C5 connector to a storage socket located on the Input Panel or on the rear of the PDA.

In addition to the requirements of LA Specification No. 54-053-08, ensure relay K1 on the Power Distribution Assembly (PDA) is a four pole relay and K2 on the PDA is a two pole relay.

Provide a two-pole, ganged circuit breaker for the flash bus circuit. Ensure the flash bus circuit breaker is an inverse time circuit breaker rated for 10 amps at 120 VAC with a minimum of 10,000 RMS symmetrical amperes short circuit current rating. Do not provide the auxiliary switch feature on the flash bus circuit breaker. Ensure the ganged flash bus circuit breaker is certified by the circuit breaker manufacturer to provide gang tripping operation.



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Ensure auxiliary output files are wired as follows:

AUXILIARY OUTPUT FILE TERMINAL BLOCK TA ASSIGNMENTS	
POSITION	FUNCTION
1	Flasher Unit #1, Circuit 1/FTR1 (OLA, OLB)/FTR3 (OLE)
2	Flasher Unit #1, Circuit 2/FTR2 (OLC, OLD)/FTR3 (OLF)
3	Flash Transfer Relay Coils
4	AC -
5	Power Circuit 5
6	Power Circuit 5
7	Equipment Ground Bus
8	NC

Provide four spare load resistors mounted in each cabinet. Ensure each load resistor is rated as shown in the table below. Wire one side of each load resistor to AC-. Connect the other side of each resistor to a separate terminal on a four (4) position terminal block. Mount the load resistors and terminal block either inside the back of Output File No. 1 or on the upper area of the Service Panel.

ACCEPTABLE LOAD RESISTOR VALUES	
VALUE (ohms)	WATTAGE
1.5K – 1.9 K	25W (min)
2.0K – 3.0K	10W (min)

Provide Model 200 load switches, Model 204 flashers, Model 242 DC isolators, Model 252 AC isolators, and Model 206L power supply units that conform to CALTRANS' "Transportation Electrical Equipment Specifications" dated March 12, 2009 with Erratum 1.

**(C) Type 170 E Cabinet Physical Requirements**

Do not mold, cast, or scribe the name "City of Los Angeles" on the outside of the cabinet door as specified in LA Specification No. 54-053-08. Do not provide a Communications Terminal Panel as specified in LA Specification No. 54-053-08. Do not provide terminal block TBB on the Service Panel. Do not provide Cabinet Verification Test Program software or associated test jigs as specified in LA Specification No. 54-053-08.

Furnish unpainted, natural, aluminum cabinet shells for all locations. Ensure that all non-aluminum hardware on the cabinet is stainless steel or a Department approved non-corrosive alternate.

Ensure the lifting eyes, gasket channels, police panel, and all supports welded to the enclosure and doors are fabricated from 0.125 inch minimum thickness aluminum sheet and meet the same standards as the cabinet and doors.

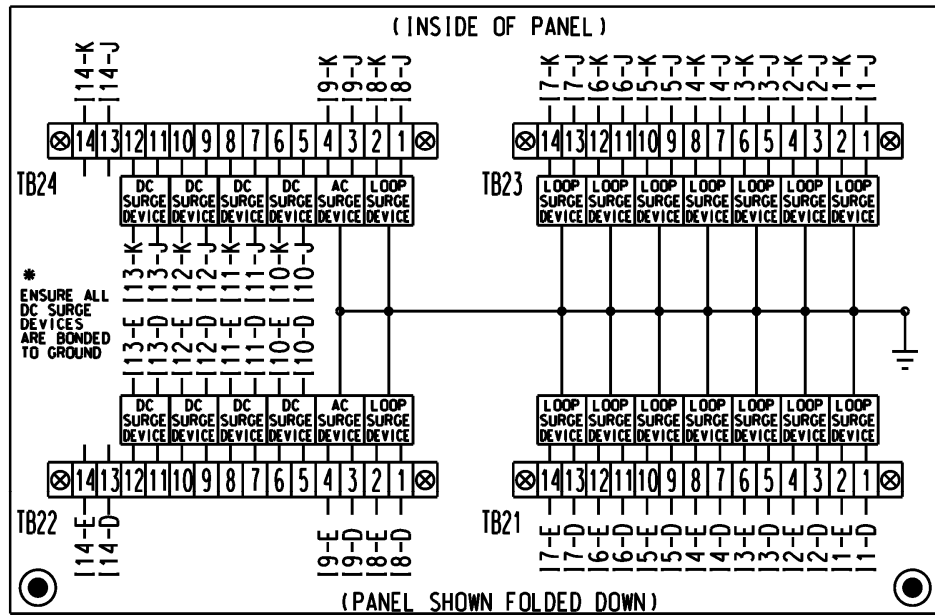
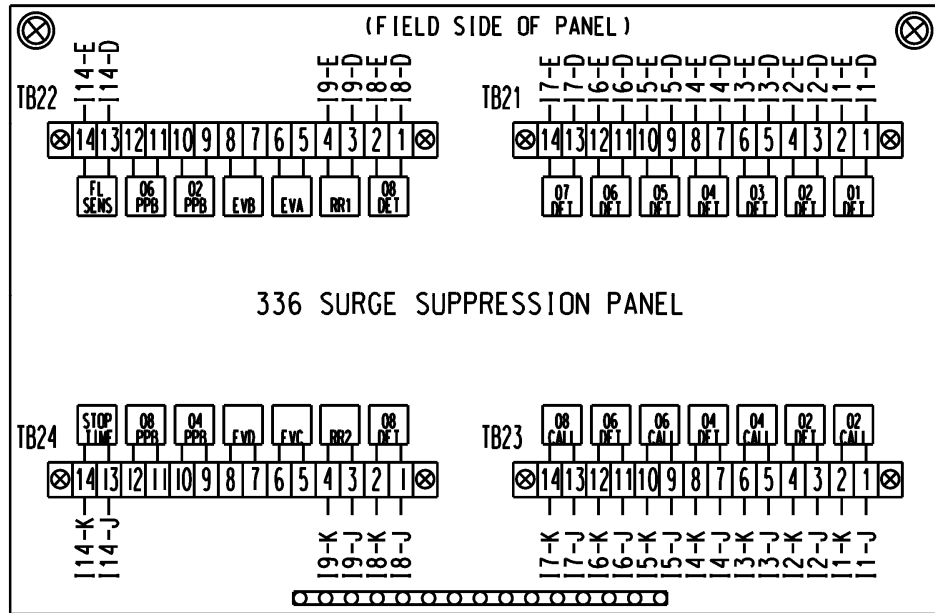
Provide front and rear doors with latching handles that allow padlocking in the closed position. Furnish 0.75 inch minimum diameter stainless steel handles with a minimum 0.5 inch shank. Place the padlocking attachment at 4.0 inches from the handle shank center to clear the lock and key. Provide an additional 4.0 inches minimum gripping length.

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Provide Corbin #2 locks on the front and rear doors. Provide one (1) Corbin #2 and one (1) police master key with each cabinet. Ensure main door locks allow removal of keys in the locked position only.

Provide a surge protection panel with 16 loop surge protection devices and designed to allow sufficient free space for wire connection/disconnection and surge protection device replacement. For model 332 cabinets, provide an additional 20 loop surge protection devices. Provide an additional two AC+ interconnect surge devices to protect one slot and eight DC surge protection devices to protect four slots. Provide no protection devices on slot I14.

For 336S pole-mounted cabinets, mount surge protection devices for the AC+ interconnect inputs, inductive loop detector inputs, and low voltage DC inputs on a swing down panel assembly fabricated from sturdy aluminum. Attach the swing down panel to the bottom rear cabinet rack assembly using thumb screws. Ensure the swing down panel allows for easy removal of the input file without removing the surge protection panel assembly or its parts. 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. Ensure the top row of terminals is connected to the upper slots and the bottom row of terminals is connected to the bottom slots. Provide a 15 position copper equipment ground bus attached to the field terminal side (outside) of the swing down panel for termination of loop lead-in shield grounds. Ensure that a Number 4 AWG green wire connects the surge protection panel assembly ground bus to the main cabinet equipment ground.



For 332 base-mounted cabinets, mount surge protection panels on the left side of the cabinet as viewed from the rear. Attach each panel to the cabinet rack assembly using bolts and make it easily removable. Mount the surge protection devices in vertical rows on each panel and connect the devices to one side of 12 position, double row terminal blocks with #8 screws. For each surge protection panel, terminate all grounds from the surge protection devices on a copper equipment ground bus attached to the surge protection panel. 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

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is next to each other. Indicate on the labeling the input file (I or J), the slot number (1-14) and the terminal pins of the input slots (either D & E for upper or J & K for lower).

Provide a minimum 14 x 16 inch pull out, hinged top shelf located immediately below controller mounting section of the cabinet. 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 2070E 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 2070E 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.

### **23.6. MATERIALS – MODEL 2018 ENHANCED CONFLICT MONITOR**

Furnish Model 2018 Enhanced Conflict Monitors that provide monitoring of 18 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 March 12, 2009 with Erratum 1 (hereafter referred to as CALTRANS' 2009 TEES) for a model 210 monitor unit and other requirements stated in this specification.

Ensure the conflict monitor is provided with a 18 channel conflict programming card. Pin EE and Pin T of the programming card shall be connected together. Pin 16 of the conflict programming card shall be floating. 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 condition 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 indicators for the following:

- AC Power (Green LED indicator)
- VDC Failed (Red LED indicator)
- WDT Error (Red LED indicator)
- Conflict (Red LED indicator)
- Red Fail (Red LED indicator)
- Dual Indication (Red LED indicator)
- Yellow/Clearance Failure (Red LED indicator)
- PCA/PC Ajar (Red LED indicator)
- Monitor Fail/Diagnostic Failure (Red LED indicator)
- 54 Channel Status Indicators (1 Red, 1 Yellow, and 1 Green LED indicator for each of the 18 channels)



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Provide a switch to set the Red Fail fault timing. Ensure that when the switch is in the ON position the Red Fail fault timing value is set to 1350 +/- 150ms (2018 mode). Ensure that when the switch is in the OFF position the Red Fail fault timing value is set to 850 +/- 150ms (210 mode).

Provide a switch to set the Watchdog fault timing. Ensure that when the switch is in the ON position the Watchdog fault timing value is set to 1.0 +/- 0.1s (2018 mode). Ensure that when the switch is in the OFF position the Watchdog fault timing value is set to 1.5 +/- 0.1s (210 mode).

Provide a jumper or switch to set the AC line brown-out levels. Ensure that when the jumper is present or the switch is in the ON position the AC line dropout voltage threshold is 98 +/- 2 Vrms, the AC line restore voltage threshold is 103 +/- 2 Vrms, and the AC line brown-out timing value is set to 400 +/- 50ms (2018 mode). Ensure that when the jumper is not present or the switch is in the OFF position the AC line dropout voltage threshold is 92 +/- 2 Vrms, the AC line restore voltage threshold is 98 +/- 2 Vrms, and the AC line brown-out timing value is set to 80 +/- 17ms (210 mode).

Provide a jumper or switch that will enable and disable the Watchdog Latch function. Ensure that when the jumper is not present or the switch is in the OFF position the Watchdog Latch function is disabled. In this mode of operation, a Watchdog fault will be reset following a power loss, brownout, or power interruption. Ensure that when the jumper is present or the switch is in the ON position the Watchdog Latch function is enabled. In this mode of operation, a Watchdog fault will be retained until a Reset command is issued.

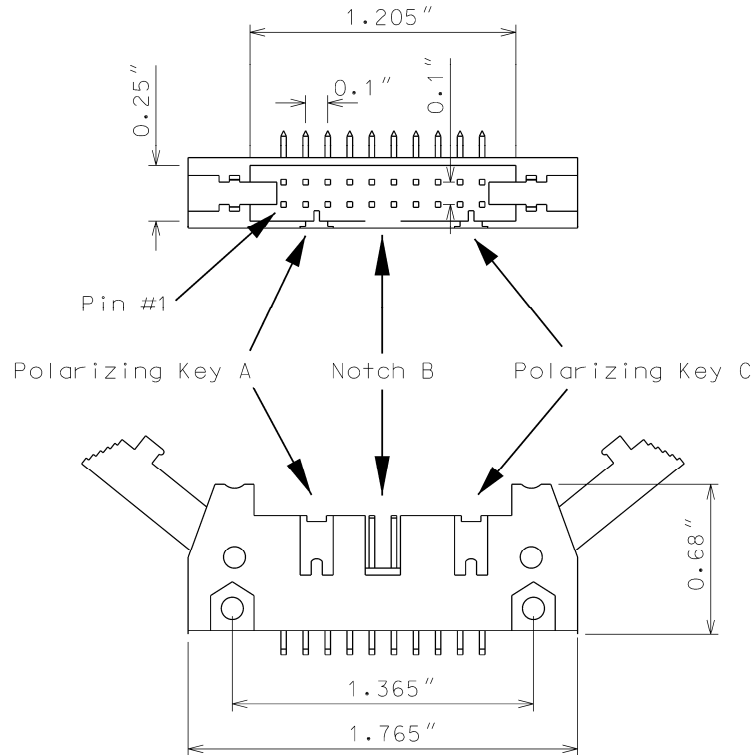
Provide a jumper that will reverse the active polarity for pin #EE (output relay common). Ensure that when the jumper is not present pin #EE (output relay common) will be considered 'Active' at a voltage greater than 70 Vrms and 'Not Active' at a voltage less than 50 Vrms (Caltrans mode). Ensure that when the jumper is present pin #EE (output relay common) will be considered 'Active' at a voltage less than 50 Vrms and 'Not Active' at a voltage greater than 70 Vrms (Failsafe mode).

In addition to the connectors required by CALTRANS' 2009 TEES, provide the conflict monitor with a red interface connector mounted on the front of the monitor. Ensure the connector is 20-pin, right angle, center polarized, male connector with latching clip locks and polarizing keys. Ensure the right angle solder tails are designed for 0.062" thick printed circuit board. Keying of the connector shall be between pins 3 and 5, and between 17 and 19. Ensure the connector has two rows of pins with the odd numbered pins are on one row and the even pins on the other row. Ensure the connector pin row spacing is 0.10" and pitch is 0.10". Ensure the mating length of the connector pins is 0.24". Ensure the pins are finished with gold plating 30μ" thick.

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Ensure the red interface connector pins on the monitor have 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 the removal of the P20 cable will cause the conflict 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’ 2009 TEES and the following additional faults. Ensure the conflict monitor will trigger upon detection of a fault and will remain in the triggered (in fault mode) state until the 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 2070E controller, ensure monitor will trigger and put the intersection into flash. If the absence of any indication condition lasts less than 700 ms when used with a 170 controller and 1200 ms when used with a 2070E controller, ensure conflict monitor will not trigger. Red fail monitoring shall be enabled on a per channel basis by the use of switches located on the conflict monitor. Have red monitoring occur when all of 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.
  - c) Pin #EE (output relay common) is not active.
2. **Short/Missing Yellow Indication Error (Sequence Error):** Yellow indication following a green is missing or shorter than 2.7 seconds (with  $\pm 0.1$ -second accuracy). If a channel fails to detect an “on” signal at the Yellow input for a minimum of 2.7 seconds ( $\pm 0.1$  second) following the detection of an “on” signal at a Green input for that channel, ensure that the monitor triggers and generates a clearance/short yellow error fault indication. Short/missing yellow (clearance) monitoring shall be enabled on a per channel bases by the use of switches located on the conflict monitor. This fault shall not occur when the channel is programmed for Yellow Inhibit, when the Red Enable signal is inactive or pin #EE (output relay common) is active.
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

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displays the proper failure indication (Dual Ind fault). If this condition is detected for less than 200 ms, ensure that the monitor does not trigger. G-Y-R dual indication monitoring shall be enabled on a per channel basis by use of switches located on the conflict monitor. G-Y dual indication monitoring shall be enabled for all channels by use of a switch located on the conflict monitor. This fault shall not occur when the Red Enable signal is inactive or pin #EE (output relay common) is active.

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 changed, ensure that the conflict monitor triggers and causes the program card indicator to flash. Ensure that configuration change faults are only reset by depressing and holding the front panel reset button for three seconds. 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  $\pm$  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. 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, an 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  $\pm$  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  $\pm$  0.5 seconds, the monitor shall enter a WDT error fault condition.

Ensure the conflict monitor will monitor an intersection with a minimum of four approaches using the four-section Flashing Yellow Arrow (FYA) vehicle traffic signal as outlined 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 pair for the following fault conditions: Conflict, Flash Rate Detection, Red Fail, Dual Indication, and Clearance. Provide a switch to select between the FYA mode 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

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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

If a FYA channel pair is enabled for FYA operation, the conflict monitor will monitor the FYA logical channel pair for the additional following conditions:

1. **Conflict:** Channel conflicts are detected based on the permissive programming jumpers on the program card. This operation remains unchanged from normal operation except for the solid Yellow arrow (FYA clearance) signal.

**Yellow Change Interval Conflict:** During the Yellow change interval of the Permissive Turn channel (flashing Yellow arrow) the conflict monitor shall verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active. These conflicting channels shall be determined by the program card compatibility programming of the Permissive Turn channel (flashing Yellow arrow). During the Yellow change interval of the Protected Turn channel (solid Green arrow) the conflict monitor shall verify that no conflicting channels to the solid Yellow arrow channel (clearance) are active as determined by the program card compatibility programming of the Protected Turn channel (solid Green arrow).

2. **Flash Rate Detection:** The conflict monitor unit shall monitor for the absence of a valid flash rate for the Permissive turn channel (flashing Yellow arrow). If the Permissive turn channel (flashing Yellow arrow) is active for a period greater than 1600 milliseconds, ensure the conflict monitor triggers and puts the intersection into flash. If the Permissive turn channel (flashing Yellow arrow) is active for a period less than 1400 milliseconds, ensure the conflict monitor does not trigger. Ensure the conflict monitor will remain in the triggered (in fault mode) state until the unit is reset at the front panel or through the external remote reset input. Provide a jumper or switch that will enable and disable the Flash Rate Detection function. Ensure that when the jumper is not present or the switch is in the OFF position the Flash Rate Detection function is enabled. Ensure that when the jumper is present or the switch is in the ON position the Flash Rate Detection function is disabled.
3. **Red Monitoring or Absence of Any Indication (Red Failure):** The conflict monitor unit shall detect a red failure if there is an absence of voltage on all four of the inputs of a FYA channel pair (RA, YA, FYA, GA).
4. **Dual Indications on the Same Channel:** The conflict monitor unit shall detect a dual indication if two or more inputs of a FYA channel pair (RA, YA, FYA, GA) are "on" at the same time.

**Short/Missing Yellow Indication Fault (Clearance Error):** The conflict monitor unit shall monitor the solid Yellow arrow for a clearance fault when terminating both the Protected Turn

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channel (solid Green arrow) interval and the Permissive Turn channel (flashing Yellow arrow) interval.

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 conflict monitor with an Ethernet 10/100 Mbps, RJ-45 port for data communication access to the monitor by a local notebook computer and remotely via a workstation or notebook computer device connected to the signal system local area network. The Ethernet port shall be electrically isolated from the conflict monitor's electronics and shall provide a minimum of 1500 Vrms isolation. Integrate monitor with Ethernet network in cabinet. Provide software to retrieve the time and date from a network server in order to synchronize the on-board times between the conflict monitor and the controller. Furnish and install the following Windows based, graphic user interface software on workstations and notebook computers where the signal system client software is installed: 1) software to view and retrieve all event log information; 2) software that will search and display a list of conflict monitor IP addresses and IDs on the network; and 3) software to change the conflict monitor's network parameters such as IP address and subnet mask.

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**MONITOR BOARD EDGE CONNECTOR**


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<b>Pin #</b>	<b>Function (Back Side)</b>	<b>Pin #</b>	<b>Function (Component Side)</b>
1	Channel 2 Green	A	Channel 2 Yellow
2	Channel 13 Green	B	Channel 6 Green
3	Channel 6 Yellow	C	Channel 15 Green
4	Channel 4 Green	D	Channel 4 Yellow
5	Channel 14 Green	E	Channel 8 Green
6	Channel 8 Yellow	F	Channel 16 Green
7	Channel 5 Green	H	Channel 5 Yellow
8	Channel 13 Yellow	J	Channel 1 Green
9	Channel 1 Yellow	K	Channel 15 Yellow
10	Channel 7 Green	L	Channel 7 Yellow
11	Channel 14 Yellow	M	Channel 3 Green
12	Channel 3 Yellow	N	Channel 16 Yellow
13	Channel 9 Green	P	Channel 17 Yellow
14	Channel 17 Green	R	Channel 10 Green
15	Channel 11 Yellow	S	Channel 11 Green
16	Channel 9 Yellow	T	Channel 18 Yellow
17	Channel 18 Green	U	Channel 10 Yellow
--		--	
18	Channel 12 Yellow	V	Channel 12 Green
19	Channel 17 Red	W	Channel 18 Red
20	Chassis Ground	X	Not Assigned
21	AC-	Y	DC Common
22	Watchdog Timer	Z	External Test Reset
23	+24VDC	AA	+24VDC
24	Tied to Pin 25	BB	Stop Time (Output)
25	Tied to Pin 24	CC	Not Assigned
26	Not Assigned	DD	Not Assigned
27	Relay Output, Side #3, N.O.	EE	Relay Output, Side #2, Common
28	Relay Output, Side #1, N.C.	FF	AC+

-- Slotted for keying between Pins 17/U and 18/V

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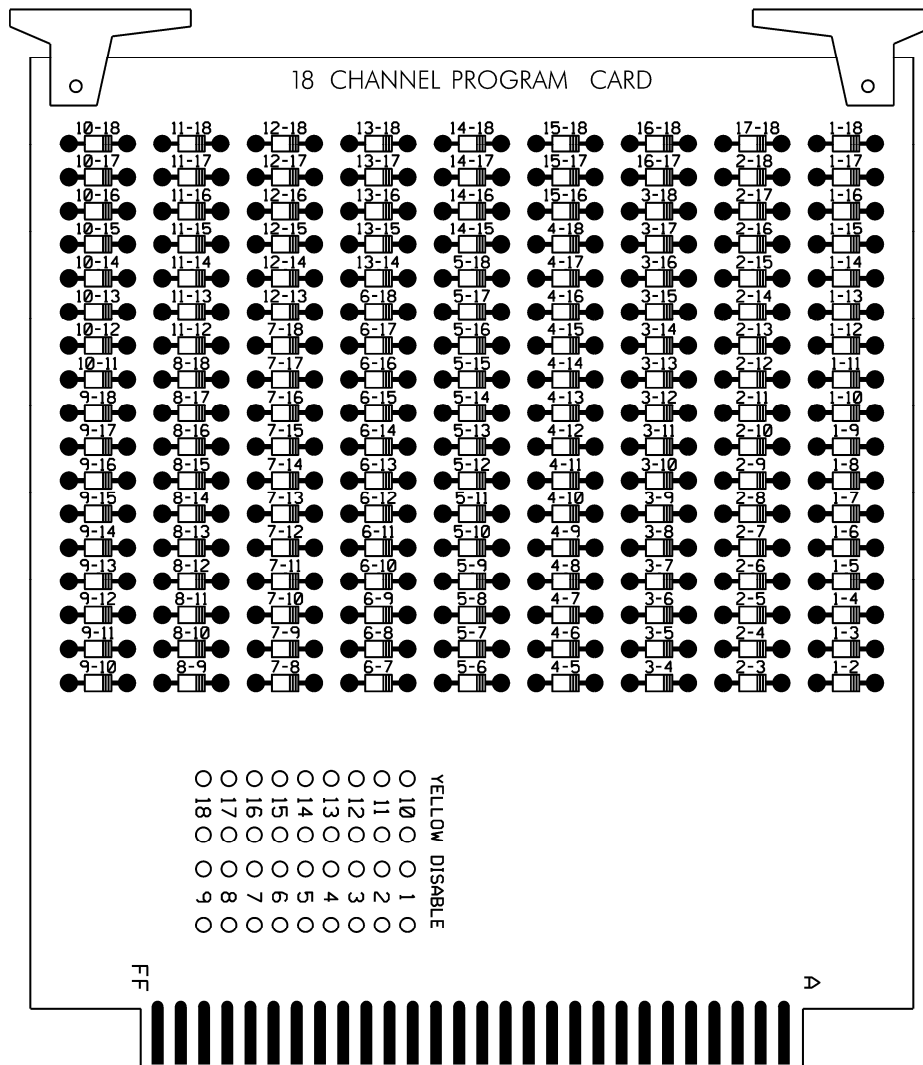
**CONFLICT PROGRAM CARD PIN ASSIGNMENTS**


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<b>Pin #</b>	<b>Function (Back Side)</b>	<b>Pin #</b>	<b>Function (Component Side)</b>
1	Channel 2 Green	A	Channel 1 Green
2	Channel 3 Green	B	Channel 2 Green
3	Channel 4 Green	C	Channel 3 Green
4	Channel 5 Green	D	Channel 4 Green
5	Channel 6 Green	E	Channel 5 Green
6	Channel 7 Green	F	Channel 6 Green
7	Channel 8 Green	H	Channel 7 Green
8	Channel 9 Green	J	Channel 8 Green
9	Channel 10 Green	K	Channel 9 Green
10	Channel 11 Green	L	Channel 10 Green
11	Channel 12 Green	M	Channel 11 Green
12	Channel 13 Green	N	Channel 12 Green
13	Channel 14 Green	P	Channel 13 Green
14	Channel 15 Green	R	Channel 14 Green
15	Channel 16 Green	S	Channel 15 Green
16	N/C	T	PC AJAR
17	Channel 1 Yellow	U	Channel 9 Yellow
18	Channel 2 Yellow	V	Channel 10 Yellow
19	Channel 3 Yellow	W	Channel 11 Yellow
20	Channel 4 Yellow	X	Channel 12 Yellow
21	Channel 5 Yellow	Y	Channel 13 Yellow
22	Channel 6 Yellow	Z	Channel 14 Yellow
23	Channel 7 Yellow	AA	Channel 15 Yellow
24	Channel 8 Yellow	BB	Channel 16 Yellow
--		--	
25	Channel 17 Green	CC	Channel 17 Yellow
26	Channel 18 Green	DD	Channel 18 Yellow
27	Channel 16 Green	EE	PC AJAR (Program Card)
28	Yellow Inhibit Common	FF	Channel 17 Green

-- Slotted for keying between Pins 24/BB and 25/CC





**23.7. MATERIALS – PREEMPTION AND SIGN CONTROL BOX**

Provide preemption and sign control box to operate in a Model 332 and Model 336S cabinet. Provide hardware to mount the box to the cage of the cabinet to ensure the front side is facing the opposite side of the cabinet. Furnish the material of the box from a durable finished metallic or thermoplastic case. Ensure the size of the box is not greater than 7(l) x 5(w) x 5(d) inches. Ensure that no modification is necessary to mount the box on the cabinet cage.

Provide the following components in the preemption and sign control box: relays, fuses, terminal blocks, MOVs, resistor, RC network, lamp, and push button switch.

Provide UL Listed or Recognized relay K1 as a DPDT enclosed relay (120 VAC, 60 Hz coil) with an 8-pin octal-style plug and associated octal base. Provide contact material made of AgCdO with a 10 amp, 240 VAC rating. Ensure the relay has a specified pickup voltage of 102 VAC.

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Provide relay SSR1 as a Triac SPST normally open solid state relay that is rated for 120 VAC input and zero-crossing (resistive load) 25 amp @ 120 VAC output. Ensure the relay turns on at 90 Vrms within 10 ms and turns off at 10 Vrms within 40 ms. Ensure the relay has physical characteristics as shown in the wiring detail in Figure 1. Provide 4 terminal screws with saddle clamps.

Provide fuses F1 and F2 as a UL Listed ¼" x 1-1/4" glass tube rated at 250 volts with a 10kA interrupting rating. Ensure F1 non-delay (fast-acting) and F2 slow-blow (time-delay) fuses have a maximum opening times of 60 minutes and 120 seconds for currents of 135 and 200 percent of the ampere rating, respectively. Ensure F2 slow-blow (time-delay) fuses have a minimum opening times of 12 seconds at 200 percent of the ampere rating. Provide fuse holders that are UL Recognized panel-mounted holders rated 250V, 15 ampere minimum with bayonet-type knobs which accept ¼" x 1-1/4" glass tube fuses.

Provide terminal blocks that are rated for 300V and are made of electrical grade thermoplastic or thermosetting plastic. Ensure each terminal block is of closed back design and has recessed-screw terminals with molded barriers between terminals. Ensure each terminal block is labeled with a block designation. Ensure each terminal is labeled with the function and a number.

Provide 3/4-inch diameter radial lead UL-recognized metal oxide varistors (MOVs) that have electrical performance as outlined below.

<b>PROPERTIES OF MOV SURGE PROTECTOR</b>	
Maximum Continuous Applied Voltage at 185° F	150 VAC (RMS) 200 VDC
Maximum Peak 8x20µs Current at 185° F	6500 A
Maximum Energy Rating at 185° F	80 J
Voltage Range 1 mA DC Test at 77° F	212-268 V
Max. Clamping Voltage 8x20µs, 100A at 77° F	395 V
Typical Capacitance (1 MHz) at 77° F	1600 pF

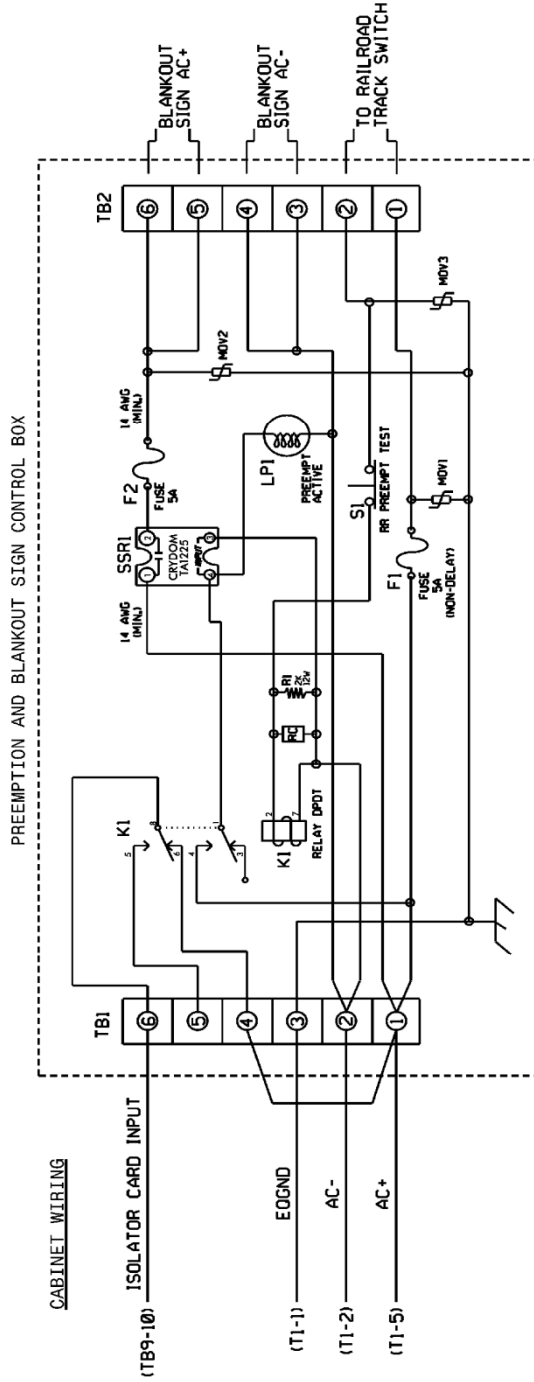
Provide resistor R1 as a 2K ohm, 12 watt, wirewound resistor with tinned terminals and attaching leads. Ensure the resistor is spaced apart from surrounding wires.

Provide a LED or incandescent lamp that has a voltage rating of 120 VAC with a minimum life rating at 50,000 hours.

Wire the preemption and sign control box as shown in Figure 1.

**RAILROAD PREEMPTION WIRING DETAIL**

(wire as shown below)



**NOTES**

1. RELAY K1 IS SHOWN IN THE ENERGIZED (PREEMPT NO1 ACTIVE) NORMAL OPERATION STATE.
2. AC ISOLATOR CARD SHALL ACTIVATE PREEMPTION UPON REMOVAL OF AC+ FROM INPUT (AS SHOWN ABOVE). THIS IS ACCOMPLISHED BY SETTING TYPE 252 AC ISOLATOR CARD TO INVERTED OPERATION.

**FRONT VIEW**

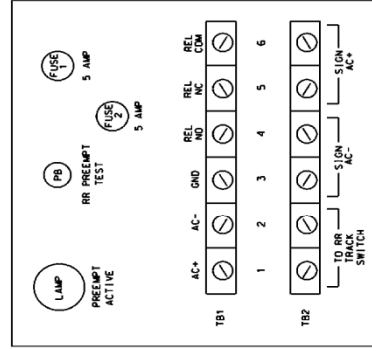


Figure 1

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**23.8. MATERIALS – TYPE 170 DETECTOR SENSOR UNITS**

Furnish detector sensor units (i.e., detector cards) that comply with Chapter 5, Section 1, “General Requirements” and Chapter 5, Section 2, “Model 222 & 224 Loop Detector Sensor Units,” of the CALTRANS *Transportation Electrical Equipment Specifications*, dated March 12, 2009 with Erratum 1.

**23.9. CONSTRUCTION METHODS****(A) General**

Identify and label all field wiring (e.g., signal conductors, pushbutton wires, loop detector lead-ins, etc.) in existing controller cabinets prior to disconnecting any field wiring.

Remove existing controllers and cabinets where required. Remove the maintenance diary from the existing cabinet and place it in the new cabinet. Take existing equipment out of service only at the time directed. Provide a law enforcement officer(s) to direct traffic through the signalized intersection while the signal is inoperable. Complete installation the new controller and cabinet and **restore signal operations within 3 hours** of taking the existing controller and cabinet out of service.

Turn to the next clean page (i.e., next page with no entries) in the diary and make an entry on the new page upon installation of the new controller and cabinet to document the date and time of installation. Maintain the maintenance diary and update it upon each subsequent visit to the cabinet until final acceptance of the project.

If the existing maintenance diary is found to be in poor condition or nearly full, notify the Engineer to have the City provide a new diary. Upon receipt of the new maintenance diary, place the new diary inside the cabinet and give the old diary to the Engineer for return to the City for archiving. Prior to removing the existing maintenance diary, make an entry in the old diary to document the date and time it was removed from the cabinet and turned over to the Engineer. Make the initial entry in the new maintenance diary to document the date and time of installation of the new cabinet and controller and the date the new maintenance diary was placed inside the cabinet. Maintain the maintenance diary and update it upon each subsequent visit to the cabinet until final acceptance of the project.

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

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

Where the Plans call for using existing upstream detection loops for both local intersection and system detection (i.e., shared local/system loops), install new lead-ins and additional new detector units as required to break out the loops onto separate lead-ins and channels. Refer to the “Lead-in Cable” section of these Project Special Provisions for additional requirements concerning the proposed shared system/local detection loops.

For all Department-owned signals, stencil the signal inventory number on both the front and rear doors of the cabinet. For all City-owned signals, stencil the City signal inventory number (i.e., intersection number) on both the front and rear doors of the cabinet. Use 3-inch black characters.

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Provide external electrical service disconnect, mounted independent of the cabinet, at all new cabinet locations and at existing cabinet locations where specified in the Plans.

Do not program controller for late night flashing operation at railroad preemption installations. For all other installations, do not program 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.

When installing a pole mounted cabinet in a new location or in an existing location where new risers and cabling are replacing existing risers and cabling, mount the cabinet so that the height to cabinet middle is 4 feet from the ground below. Avoid mounting cabinets so that they overhang and encroach upon an adjacent sidewalk or pedestrian path. Where a minor overhang of the sidewalk or pedestrian path cannot reasonably be avoided, ensure that a minimum of 4 feet of clear sidewalk width will remain once the cabinet is installed. Do not mount cabinets where one of its doors opens into a street, driveway or other area subject to vehicular traffic or where an existing physical feature such as a pole, sign post, down guy, shrub or tree prevents its doors from being opened at least 90 degrees.

When replacing an existing pole-mounted cabinet with a new pole-mounted cabinet and the existing risers and cabling are being retained, mount the new cabinet so that the cabinet bottom rests upon the existing riser connections even though this causes the cabinet middle to be higher or lower than 4 feet above ground, unless the Plans indicate or the Engineer directs otherwise. Comply with the cabinet layout shown in *Roadway Standard Drawing* No. 1751.01, Sheet 2 of 2.

Do not construct new conduit entry holes into existing metal poles to attain the 4-foot mounting height.

Program and activate controllers with proposed phasing and timing.

Install all updates to the local controller software and OS9 operating system software during the life of the project up through final acceptance of the project, including existing 2070L controllers that will be retained and incorporated into the upgraded and expanded High Point Signal System.

Once all new cables have been installed in and existing cables, where applicable, have been removed from base-mounted cabinets, seal all conduits entering the cabinet base as follows:

- Seal spare conduits with approved conduit plugs.
- Seal conduits containing fiber-optic communications cable with duct and conduit sealer.
- Seal conduits containing signal cable, and loop lead-in wire with duct and conduit sealer.

Seal existing conduits as well as new conduits, regardless of whether cables are being removed from or installed in them. Comply with the requirements for conduit plugs and duct and conduit sealer in the “Underground Conduit” section of these Project Special Provisions.

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Where electrical services do not include an external electrical service disconnect, modify or replace the electrical service as shown in the Plans to add an electrical service disconnect and a new grounding electrode system.

Furnish and install a grounding electrode system at all new electrical services.

Comply with all requirements of the "Electrical Service" section of these Project Special Provisions.

**(C) Edge Switch**

Install and program the Ethernet edge switches in accordance with the "Communications Hardware" section of these Project Special Provisions.

**(D) Emergency Generator Provisions**

Comply with the emergency generator provisions detailed in "Electrical Service" section of these Project Special Provisions for new installations of emergency generator provisions.

**(E) Workshop**

Provide enclosed workshop to store, set up and test new controllers and cabinets before installation. Locate workshop within the City Limits of High Point. Ensure workshop provides protection from weather and sufficient space to house two test observers, all necessary test equipment and material, controllers and cabinets. Provide the workshop until final acceptance of the project.

Configure and test each controller and cabinet to match the proposed signal design. Ensure all equipment furnished and installed or modified by the Contractor at each location operates in full compliance with the Plans and Project Special Provisions. Test each controller and cabinet for proper color sequence, flashing operation, phase timings, preemption, coordination, and conflict monitor programming. Ensure that simultaneous conflicting phase outputs will cause the cabinet to revert to flashing operation. For intersections with any type of preemption, submit a completed Preemption Test Procedure Checklist. The checklist is located on the Department's Website.

Test the cabinet and controller for eight hours minimum. Following this test, and before installation, the Engineer will inspect the equipment in operation. The Engineer may require other tests to ensure proper operation. These tests shall be at no additional cost to the Department.

**(F) GPS Coordinates**

Provide real world coordinates for all junction boxes and equipment cabinets installed or utilized under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet in the horizontal plane and 3.3 feet in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer.

Provide both digital copies and hard copies of all information regarding the location (including to but not limited to manufacturer, model number, City system ID number and

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NCDOT inventory number) in the Microsoft Excel® spreadsheet using the format shown in example below. In addition to Excel format, provide a digital copy of the location information as an ESRI Shapefile (.SHP file format).

City System ID#	NCDOT Inv #	Name	Location	Latitude	Longitude	Manufacturer	Model #
	05-0134	Equipment Cabinet	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5500	35.6873	McCain	Type-332
		Junction Box # 1 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5516	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 2 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5506	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 3 (Near Cabinet)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5501	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 4 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5486	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 5 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5493	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 6 (Phase 4 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5503	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)

### 23.10. MEASUREMENT AND PAYMENT

*Controller with cabinet* (\_\_\_\_) will be measured and paid as the actual number of each type of controllers with cabinets of each type and mounting method that are furnished, installed, and accepted, subject to the following conditions: 90% of the payment will be made upon acceptance of the unit; 10% of the payment will be made following final acceptance of the integrated system (including completion of the 60-day observation period).

No measurement will be made of conflict monitors, grounding systems, modems and workshop as these will be considered incidental to furnishing and installing controllers with cabinets.

New and modified electrical services and electrical service grounding systems will be measured and paid for in accordance with the “Electrical Service” section of these Project Special Provisions.

*Detector card (Model 222)* will be measured and paid as the actual number of Model 222 detector cards furnished, installed, and accepted.

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

Ethernet edge switches will be measured and paid for in accordance with the “Communications Hardware” section of these Project Special Provisions.

Lead-in cable will be measured and paid for in accordance with the “Lead-in Cable” section of these Project Special Provisions.

No measurement or payment will be made of any hardware and fasteners required for mounting controller cabinets to poles and foundations as these items will be considered incidental to installing controllers with cabinets.

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No measurement or payment will be made of conduit nipples, fittings, signal cable, service wire, locknuts and bushings or other materials necessary to mount a new pole-mounted cabinet in the same location as an existing pole-mounted cabinet that is being replaced.

No measurement or payment will be made of sealing conduits with duct plugs, mechanical sealing devices and duct and conduit sealer as such work will be considered incidental to furnishing and installing controllers with cabinets.

No measurement will be made of collecting and recording GPS coordinates for controller cabinets and junction boxes, compiling this data in the prescribed Microsoft Excel<sup>®</sup> spreadsheet and providing an ESRI Shapefile (.SHP file format) as such work will be considered incidental installing controllers with cabinets and installing controllers.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Controller with Cabinet (2070E, 336S, Pole Mounted)	Each
Controller with Cabinet (2070E, 332, Base Mounted)	Each
Detector Card (Model 222)	Each
Auxiliary Output File	Each



## 24. INTEGRATED CABINET BASE ADAPTER

### 24.1. DESCRIPTION

Furnish and install integrated cabinet base adapters equipped with integrated electrical service equipment, electrical service conduit and other items as shown in the Plans for traffic signal cabinets primarily located in downtown High Point.

Furnish and install an integrated cabinet base adapter at locations designated in the Plans that have an existing underground power service where the service wires enter the cabinet directly from this underground service without first passing through service disconnect external to the cabinet (i.e., “unfused” service wires). Use the integrated cabinet base adapter to intercept the existing service wires and reroute them to a new disconnect and meter base prior to entering the base-mounted controller cabinet.

Furnish and install integrated cabinet base adapters with integrated electrical service meter and disconnect at locations in downtown High Point identified in the Plans. The Contractor is encouraged to inspect each location where the Plans require a Model 332A cabinet to be installed on an integrated cabinet base adapter on an existing foundation prior to submitting his/her bid for this contract.

### 24.2. MATERIALS

#### (A) Integrated Cabinet Base Adapter

Fabricate the integrated cabinet base adapter and electrical service equipment as a single, integrated piece of equipment with separation between the electrical service equipment and traffic signal controller cabinet. Ensure that a new Model 332A base-mounted controller cabinet will mount directly to the integrated cabinet base adapter with a cabinet orientation that ensures that both cabinet doors will swing away from, not toward, the meter/disconnect column.

Fabricate integrated cabinet base adapters from the same materials and with the same finish as cabinet housing. Fabricate integrated cabinet base adapters in the same manner as controller cabinets, meeting all applicable specifications called for in Section 7.5 of CALTRANS TEES (11/19/99). Provide integrated cabinet base adapters a minimum height of 12 inches. Provide meter column that is at least 48” tall (measured from the top of the base adapter) and sized to house one (1) 1.25-inch Liquidtight Flexible Nonmetallic Conduit with connectors and one (1) 1-inch Liquidtight Flexible Nonmetallic Conduit with connectors.

Fabricate integrated cabinet base adapters in the four different configurations (i.e., types) as shown in the Plans.

#### (B) Electrical Service

Provide, reuse, revise and/or upgrade all materials necessary to form a complete electrical service assembly as shown in the Plans. Furnish new external electrical service disconnects, meter bases, feeder conductors, electrical service conductors and conduits between the disconnects and the controller cabinets as required. Provide a meter base and disconnect for each integrated cabinet base adapter that comply with the “Materials” subsection of the “Electrical Service” section of these Project Special Provisions.

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For the intersection of College Drive and Centennial Street, provide an external service disconnect only (no meter base required; existing meter base and disconnect across street).

For the intersection of N. Main Street and Lexington Avenue (07-0757) only, provide a generator transfer switch assembly mounted on the meter column in addition to the meter base and disconnect as shown in the Plans. Ensure that the generator transfer switch assembly is mounted such that it does block access panels on the meter column.

**(C) Grounding System**

Provide a new grounding system at each traffic signal cabinet. In addition to NEC requirements, test grounding electrode resistance for a maximum of 20 ohms. Follow test equipment's procedures for measuring grounding electrode resistance. 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:

<https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx>

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

**24.3. CONSTRUCTION METHODS**

**(A) General**

Unless otherwise directed by the Engineer, install integrated cabinet base adapters only at locations indicated in the Plans. Do not install integrated cabinet base adapters where the Plans call for use of a cabinet base extender without the prior approval of the Engineer.

**Comply with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), the NCDOT 2012 *Standard Specifications*, the Project Special Provisions and all local ordinances. All work involving the electrical service shall be coordinated with City of High Point Electric Utilities and City of High Point Electrical Inspector.**

The Contractor shall be responsible for applying and paying for all fees associated with any electrical permits and inspections if required by the local utility or municipality. At locations where new electrical service is to be installed, make an application for a new electrical service with City of High Point Electric Utilities (336-883-3111). Furnish and install a new electrical service as required by the Plans.

Notify the City of High Point Electric Utilities, City of High Point Transportation Department, High Point Police Department and the Engineer at least 5 business days in advance of turning of any the traffic signal to install an integrated cabinet base adapter and associated controller cabinet. Coordinate with City of High Point Electric Utilities for service disconnection and re-connection to limit the time the traffic signal will be out of service. Coordinate all work involving electrical service with the City Electrical Inspector and High Point Electric Utilities.

Do not replace more than one downtown cabinet at a time. Complete all work at each location and have power restored to the traffic signal before beginning work at any other downtown location.

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Provide temporary traffic control for extended periods of time while the traffic signal electrical service and foundation are being modified.

Provide Engineer with a copy of all permits and final inspections if required.

**(B) Grounding**

Field investigate each location for which the Plans call for installation of an integrated cabinet base adapter to determine the condition of the existing grounding system. Where existing cabinet grounding system is not external to cabinet foundation, drill/core drill a new 1” conduit entrance into the existing cabinet foundation as necessary to provide a grounding system that complies with the “Electrical Service” section of these Project Special Provisions. Comply with the “Modify Cabinet Foundation” section of these Project Special Provisions when drilling/core-drilling new conduit entrance for ground wire. Install ground wire and install ground rods, as required, external to the foundation to provide a grounding system that is compliant with these Project Special Provision and the details shown in the Plans.

**(C) Integrated Cabinet Base Adapter**

Install new 332A base-mounted controller cabinet with integrated cabinet base adapter as follows:

- Have the electric power service to the existing controller and cabinet turned off by the electric power company, then disconnect all wires from the existing controller cabinet and remove the existing controller and cabinet from the existing foundation.
- Protect existing conduits and conductors.
- Where the grounding system is in the existing cabinet foundation, cut existing ground rod(s) and anchors flush to existing foundation surface. Provide entrance for a new grounding electrode conductor to ground the electrical service.
  - Option 1 for grounding:

Install a new insulated (green) #4 AWG stranded copper Type THWN grounding electrode conductor into the existing fiber-optic cable conduit to the nearest junction box containing fiber-optic cable located outside the cabinet foundation. Protect the existing fiber-optic cable from damage. Install new ground rods in junction box (use sectional ground rods) and exothermically weld grounding electrode conductor to ground rod(s). Shield, guard and protect the existing fiber-optic cable from the welding process.
  - Option 2 for grounding:

Drill/core drill existing foundation for a new 1” conduit to extend outside the cabinet foundation. Install new ground rods (sectional ground rods may be used) and exothermically weld grounding electrode conductor to ground rod(s) using a #4 AWG solid bare copper wire. Ground the electrical service as shown in the Plans. Where sidewalk, decorative brick pavers, or surface treatments or landscaping treatments are removed or damaged as part of the cabinet grounding or conduit installation, replace and restore the area to pre-construction conditions using the same materials.

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**Wherever sidewalk is to be removed, “Option 2’ shall be used as the preferred method of grounding.**

- Install the integrated cabinet base adapter over the existing conduits on the existing cabinet foundation with the orientation specified in the Plans. Mount the meter base and external service disconnect (breaker box) on the meter/disconnect column of the new integrated cabinet base adapter. Mount the new controller cabinet on the new integrated cabinet base adapter. Ensure that the cabinet doors open fully and open away from the meter/disconnect column.
- For locations where the existing service conductors share a conduit with other cables (see table below), insert existing service conductors provided by the power company into a new 3/4” Liquidtight Flexible Nonmetallic Conduit (LFNC). Slide new 3/4” LFNC into the existing service conduit a minimum of 12”. Run new 3/4” LFNC up into meter column. Secure new 3/4” LFNC to meter/disconnect column, base adapter and cabinet. Identify the grounded conductor in accordance with NEC. Install connectors and bushings as required. If required, splice and extend existing service conductors. Use pre-insulated irreversible compression connectors, appropriately sized to splice or extend existing service conductors. Where required, upsize the LFNC accordingly.

<b>Electrical Service Conductors in Shared Conduit</b>	
<b>Signal Inventory #</b>	<b>Intersection</b>
07-0768	N. Main Street at Westwood Avenue
07-0769	N. Main Street at Church Avenue
07-0994	W. Kivett Drive at Lindsay Street
07-0995	E. Green Drive at S. Centennial Street
HP-0502*	Commerce Avenue at Hamilton Street*
HP-0526	Fred Alexander Place at Wrenn Street
HP-0601	Hamilton Street at Richardson Avenue
HP-0602	Richardson Avenue at Wrenn Street

\* Existing 3” conduit

- For locations where the existing service conductors reside in an exclusive conduit (e.g., do not share the conduit with other cables and conductors; see table below), insert existing service conductors provided by the power company into a new 1.25” Liquidtight Flexible Nonmetallic Conduit (LFNC) Slide new 1.25” LFNC down over top of the 1” service conduit until it comes in contact with the cabinet foundation. Run new 1.25” LFNC up into meter column. Secure new 1.25” LFNC to meter/disconnect column, base adapter and cabinet. Identify the grounded conductor in accordance with NEC. Install connectors and bushings as required. If required, splice and extend existing service conductors. Use pre-insulated irreversible compression connectors, appropriately sized

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to splice or extend existing service conductors. Where required, upsize the LFNC accordingly.

<b>Electrical Service Conductors in Exclusive 1" Service Conduit</b>	
<b>Signal Inventory #</b>	<b>Intersection</b>
07-0288	S. Main Street at Russell Avenue
07-0757	N. Main Street at Lexington Avenue
07-0759	Lexington Avenue at McGuinn Avenue
07-0761	N. Main Street at Farriss Avenue
07-0770	N. Main Street at English Road
07-0772	W. English Road at N. Lindsay Street
07-0780	N. Main Street at Kivett Drive
07-0781	E. Kivett Drive at N. Wrenn Street
07-0782	E. Kivett Drive at N. Hamilton Street
07-0785	S. Main Street at High Avenue
07-0786	S. Main Street at Commerce Avenue
07-0787	S. Main Street at Green Drive
07-0788	E. Green Drive at S. Wrenn Street
07-0789	E. Green Drive at S. Hamilton Street
07-0791	W. Green Drive at S. Elm Street
07-0814	E. Lexington Avenue at Johnson Street
07-0993	W. Kivett Drive at Lindsay Street
07-0996	E. Russell Avenue at S. Centennial Street
07-0997	W. Russell Avenue at S. Elm Street
07-1002	E. English Road at N. Hamilton Street
07-1004	E. English Road at N. Wrenn Street
07-1923	N. College Drive at N. Centennial Street
HP-0211	Elm Street at Grimes Avenue
HP-0212	Elm Street at Taylor Avenue
HP-0311	Prospect Street at Ward Avenue
HP-0501	Centennial Street at Commerce Avenue
HP-0503	High Avenue at Wrenn Street

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<b>Electrical Service Conductors in Exclusive 1" Service Conduit</b>	
<b>Signal Inventory #</b>	<b>Intersection</b>
HP-0509	Commerce Avenue at Wrenn Street
HP-0511	Commerce Avenue at Elm Street
HP-0512	Elm Street at High Avenue
HP-0609	Hamilton Street at Westwood Avenue
HP-0613	Church Avenue at Elm Street

- Install 1" LFNC from new disconnect through the meter/disconnect column to the controller cabinet. Secure 1" LFNC to meter/disconnect column, base adapter and cabinet. Install two (2) # 8 AWG stranded copper Type THWN feeder conductors and one (1) #6 AWG stranded copper Type THWN grounding conductor into 1" LFNC. Identify the grounded conductor in accordance with NEC. Install connectors and bushings as required.
- Seal all conduits using moldable duct seal.
- Reconnect the existing field wiring inside the new controller cabinet. Splice and extend conductors inside the integrated cabinet base adapter or inside the controller cabinet in accordance with the "Extension of Existing Field Wiring at Controller Cabinets" section of these Project Special Provisions as necessary and as approved by the Engineer.
- Using a permanent, flexible waterproof sealing material, seal between the controller cabinet and integrated cabinet base adapter and seal the space between the integrated base adapter and the cabinet foundation.

**(D) Ground Surface Restoration**

Restore the disturbed ground, both paved and unpaved, surrounding the cabinet foundation to its original, preconstruction condition as determined and approved by the Engineer. Comply with all requirements of the "Ground Surface Restoration" subsection of the "Equipment Cabinet Foundation" section of these Project Special Provisions.

**24.4. MEASUREMENT AND PAYMENT**

*Integrated Base Adapter (Type \_\_)* will be measured and paid for as the actual number of integrated cabinet base adapters of each type furnished, installed and accepted. No separate measurement or payment will be made for conduit extensions (including LFNC and associated fittings and clamps), electrical service meters, disconnects, and associated wiring, service conductors, feeder conductors, grounding, grounding electrodes, ground wire, connectors, acquisition of service fees or permits and any remaining hardware or fittings as these items will be considered incidental to furnishing and installing integrated cabinet base adapters.

Generator transfer switch and generator tie-down anchor will be measured and paid for in accordance with the "Electrical Service" section of these Project Special Provisions.

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Restoration of the concrete sidewalk and brick paver sidewalks will be measured and paid for in accordance with the “Equipment Cabinet Foundations” section of these Project Special Provisions.

No measurement will be made of drilling/core drilling 1-inch conduit entrances into existing foundations to upgrade and replace cabinet grounding systems as such work will be considered incidental to furnishing and installing integrated cabinet base adapters.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Integrated Base Adapter (Type 1)	Each
Integrated Base Adapter (Type 2)	Each
Integrated Base Adapter (Type 3)	Each
Integrated Base Adapter (Type 4)	Each

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## 25. CABINET BASE ADAPTER AND BASE EXTENDER

### 25.1. DESCRIPTION

Furnish and install cabinet base adapters and base extenders with all necessary hardware for 170E-family cabinets.

### 25.2. MATERIALS

Fabricate base adapters and extenders from the same materials and with the same finish as cabinet housing. Fabricate base adapter and extender in the same manner as controller cabinets, meeting all applicable specifications called for in Section 7.5 of CALTRANS TEES (11/19/99). Provide base adapters and extenders that have a minimum height of 12". Provide cabinet base adapters that comply with the details shown in the Plans.

### 25.3. CONSTRUCTION METHODS

#### (A) General

Unless otherwise shown in the Plans, install a cabinet base extender at locations requiring a new Model 332 cabinet on an existing/modified or new foundation and where an existing base-mounted Model 332 cabinet that is being retained does not have a cabinet base extender.

Install a cabinet base adapter at locations requiring a new Model 332 cabinet to be installed on an existing/modified foundation where the opening in the bottom of a cabinet base extender will not fit over the existing conduit spread. Unless otherwise directed by the Engineer, install cabinet base adapters only at locations indicated in the Plans. Do not install cabinet base adapters where the plans call for use of a cabinet base extender without the prior approval of the Engineer.

Where the plans require a Model 336 cabinet to be base mounted, install a cabinet base adapter or extender, as required.

Use permanent, flexible waterproof sealing material to:

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

### 25.4. MEASUREMENT AND PAYMENT

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

*Cabinet base adapter* will be measured and paid as actual number of cabinet base adapters furnished, installed, and accepted.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Cabinet Base Extender	Each
Cabinet Base Adapter	Each



## 26. ELECTRICAL SERVICE

### 26.1. DESCRIPTION

At locations called out in the Plans, install a new electrical service, modify an existing electrical service, including an external disconnect and meter base, and install emergency generator provisions.

Comply with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), the *Standard Specifications*, these Project Special Provisions, and all local ordinances. Coordinate all work involving electrical service with the appropriate utility company and the Engineer.

### 26.2. MATERIALS

#### (A) Electrical Service

Provide material, equipment and hardware under this section that is pre-approved on the 2012 ITS and Signals QPL by the date of equipment installation.

Provide, modify and/or upgrade all materials necessary to form a complete electrical service assembly as shown in the Plans. Furnish new external electrical service disconnects, meter bases, and required grounding. Replace electrical service feeder conductors and conduits between the disconnects and the controller cabinets as required.

Provide external electrical service disconnects at all new and existing cabinet locations unless otherwise specified in the Plans. Where electrical services do not include an external electrical service disconnect, modify service to include electrical service disconnect and a new grounding electrode system.

Provide all electrical service disconnects with a space/expansion slots, covered by a knockout or removable blank cover, designed to allow the future installation of at least one additional circuit breaker.

Provide inverse time circuit breaker with at least 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure.

Furnish 3-wire stranded #8 AWG copper service conductors with THWN rating for supplying power to the meter base/disconnects where only one device is being connected (1 signal cabinet or 1 CCTV cabinet). Furnish 3-wire stranded #3 AWG copper service conductors with THWN rating for supplying power to the meter base/disconnect where multiple devices are sharing the service. Provide conductors with black, red, and white insulation that are intended for power circuits at 600 V or less and comply with the following:

- Listed as meeting UL Standard UL-83
- Meets ASTM B-3 and B-8 or B-787 standards.

Furnish 3-wire stranded copper feeder conductors with THWN rating for supplying power to field equipment cabinets. Provide conductors with black, white, and green insulation that are intended for power circuits at 600 V or less and comply with the following:

- Listed as meeting UL Standard UL-83
- Meets ASTM B-3 and B-8 or B-787 standards.

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As indicated below, provide the following:

Traffic Signal Cabinet:

- 1 single-pole 50A breaker
- 1 spare slot/space (minimum)
- 3-wire stranded #8 AWG copper feeder conductors with THWN rating

CCTV Camera Cabinet:

- 1 single-pole 15A breaker
- 1 spare slot/space (minimum)
- 3-wire stranded #12 AWG copper feeder conductors with THWN rating

Traffic Signal Cabinet and CCTV Camera Cabinet:

- 1 single-pole 50A breaker (Signal)
- 1 single-pole 15A breaker (CCTV)
- 1 spare slot/space (minimum)
- 3-wire stranded #8 AWG copper feeder conductors with THWN rating (Signal)
- 3-wire stranded #12 AWG copper feeder conductors with THWN rating (CCTV)

Furnish 1" rigid galvanized conduit between the disconnect and the equipment cabinets as required. For underground runs greater than 10 feet in length, the Contractor may transition from 1" rigid galvanized conduit to 1" PVC conduit for the remainder of the underground run beyond the initial 10 feet. Furnish Schedule 40 PVC female adapters to connect the PVC conduit to the threaded end of the rigid galvanized conduit. The interior surface of one end of the PVC female adapter shall be compatibly threaded to connect it to the threaded end of the rigid metallic riser without the aid of additional fittings, hardware or adhesives. The opposite end of the adapter shall be non-threaded to permit a slip fit, glued connection to the underground PVC conduit.

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. Provide ground bus and neutral bus with a minimum of four terminals with minimum wire capacity range of number 8 through number 2/0 AWG.

Furnish NEMA Type 3R meter base rated 100A minimum for overhead service and 200A minimum for underground service and that meets the requirements of the local utility. Provide meter base with ampere rating of meter sockets based on sockets being wired with insulated wire rated at least 167°. With each meter base, provide a blank meter socket cover made from UV stabilized polycarbonate or metal and that is either clear or gray in color to prevent access to interior of meter base until meter is installed by the local power company.

Furnish 4 terminal, 600 volt, single phase, 3 wire meter base that complies with the following:

- Line, Load, and Neutral Terminals accept #8 to 2/0 AWG copper/aluminum wire;
- Ringed or Ringless Type, with or without bypass;
- Made of galvanized steel;
- Listed as meeting UL Standard UL-414; and
- Overhead or underground service entrance as specified.

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Provide electrical service disconnects, meter bases, combination panel enclosures and pedestals with electrostatically applied dry powder paint finish with minimum thickness of 2.4 mils and that is light gray in color. All exterior surfaces must be powder coated steel.

Furnish 1" watertight hub (i.e., meter socket hub) for threaded rigid galvanized conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure (i.e., combination panel), 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.

Except for locations designated in the "Emergency Generator Provisions" subsection below, provide a combination panel with pedestal extension as shown in the Plans for all new ground-mounted electrical service assemblies for underground electrical service. Do not provide wood posts, steel U-channel posts, square tube sign posts, metal framing channels or any method other than an underground service pedestal to mount meter bases and disconnects for new underground electrical service. Provide combination panels with pedestals of sufficient length to attain a minimum embedment depth of 24 inches below grade when installed per the manufacturer's instructions.

For new electrical service at locations designated in the "Emergency Generator Provisions" subsection below where the controller cabinets will not be installed on an integrated cabinet base adapter, provide a combination panel and a 6" x 6" pressure treated wood post for mounting the new electrical service and emergency generator transfer switch assembly. Furnish a 6" x 6" pressure treated wood post of sufficient length to mount the electrical service assembly and emergency generator equipment at the height required by the special details when the post is embedded into the ground at the required depth. Provide wood posts treated in accordance with the requirements for sign posts in Article 1082-4 of the *Standard Specifications*.

Provide a grounding electrode system at all new electrical services. Provide underground marker tape above ground grounding electrodes and buried ground wire. Provide all grounding electrodes and ground wire necessary to ensure that grounding system, whether existing or new, complies with all grounding requirements of these Project Special Provisions.

Where the Plans call for modifying an existing electrical service for a traffic signal, provide a single-pole 50A inverse time circuit breaker with at least 10,000 RMS symmetrical amperes short circuit current rating to replace an existing circuit breaker in an existing disconnect.

**(B) CCTV Cabinet Disconnect**

Furnish new CCTV cabinet disconnect with a 15A circuit breaker at the locations shown in the Plans. Provide CCTV cabinet disconnects that have spaces (slots) for at least two breakers (one occupied by the 15A breaker + one future breaker) and a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure equipment cabinet disconnects are listed as meeting UL Standard UL-489 and marked as being suitable for use as service disconnects. 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. All exterior surfaces must be powder coated steel. Provide ground bus and neutral

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bus with a minimum of four terminals and a minimum wire capacity range of number 8 through number 2 AWG.

**(C) Grounding Electrodes (Ground Rods)**

Furnish 5/8"x10' copper clad steel grounding electrodes (ground rods), #4 AWG solid bare copper conductors, and exothermic welding kits for grounding system installations. Comply with the NEC, the *Standard Specifications*, these Project Special Provisions and the Plans.

**(D) Emergency Generator Provisions**

Provide all equipment, materials and hardware required to install a fully-functional emergency generator transfer switch assembly as shown in the special details in the Plans at certain traffic signals identified in the Plans. Furnish 6" x 6" pressure treated wood posts for mounting generator transfer switch equipment and new electrical service equipment (where applicable) as shown in the special details in the Plans.

### **26.3. CONSTRUCTION METHODS**

**(A) General**

All work involving electrical service shall be coordinated with the appropriate electric utility company. Coordinate with the utility company to ascertain the feasibility of installing electrical service at each location before performing any work. Obtain all required local permits before beginning work.

Run feeder conductors separately from all other conductors in a 1-inch rigid galvanized conduit. Do not allow feeder conductors to share conduits with any other conductors or cables. Do not route unfused electrical feeder conductors inside of metal poles. Permanently label conductors at all access points using nylon tags labeled with permanent ink. Ensure each conductor has a unique identifier. Label conductors immediately upon installation. Use component name and labeling scheme approved by the Engineer.

Use rigid galvanized conduit for all underground conduit runs 10 feet or less in length. For underground runs greater than 10 feet in length, the Contractor may transition from 1" rigid galvanized conduit to 1" PVC conduit for the remainder of the run beyond the initial 10 feet using an approved PVC female adapter. Apply thread seal tape to the threads of the rigid galvanized conduit before screwing the PVC adapter onto the threaded male end of the conduit. Connect the threaded female end of the PVC adapter to the threaded end of the rigid galvanized conduit, then connect the not threaded end of the adapter to the PVC conduit using a slip fit, glued connection.

Direct bury pedestals that support combination panel at a minimum embedment depth of 24 inches below grade.

Upon completion of electrical service installation and backfilling of all excavations, restore the disturbed ground to its original condition as determined and approved by the Engineer. For paved areas, replace removed or damaged pavement with in kind materials, matching the elevation, color, texture/finish and general appearance of the surrounding pavement in accordance with the "Equipment Cabinet Foundation" section of these Project Special Provisions. Refer to Section 1 of these Project Special Provisions for additional requirements concerning sidewalks and curbs in historic districts. For unpaved areas, backfill excavations

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with removed material, tamp the backfilled material and rake smooth the top 1½ inches. Finish unpaved areas flush with surrounding natural ground and to match the original contour of the ground. Seed with same type of grass as surrounding area and mulch the newly seeded area. If unpaved area was not grassed, replace the original ground cover in kind as directed by the Engineer.

**Complete repairs to and restoration of all ground (paved and unpaved) disturbed for construction within five consecutive calendar days following initial removal.** If the Contractor fails to repair and restore the ground in accordance with these Project Special Provisions within the time frame specified, the Department reserves the right to make the necessary repairs, and all expenses incurred by the Department in making the repairs and restoring the ground will be deducted from payment due the Contractor, plus **\$500 liquidated damages per occasion, per day, or any portion thereof**, until corrected.

Install meter socket covers on new meter bases to block access to the wiring inside until the meter is attached to the meter base by the power company. Use only approved meter socket covers that comply with these Project Special Provisions; do not use cardboard, paper, plywood, sheet plastic, tape, etc. to cover the meter socket opening. Do not leave a meter socket uncovered.

Provide all necessary stainless steel banding hardware and clamps for securely attaching service disconnects, meter bases, combination panels and service conduits and risers to metal poles.

**(B) New Electrical Service for Traffic Signal**

At locations identified in the Plans, install new electrical service for a traffic signal controller cabinet. Comply with *Roadway Standard Drawing* Nos. 1700.01 and 1700.02 as well as the special details entitled “Signal Cabinet Detail, Pole-Mounted” and “Ground Mounted Electrical Service Detail” provided in the Plans. For locations identified in the “Emergency Generator Provisions” subsection below, coordinate the installation of the new electrical service with the installation of emergency generator transfer switch assembly as shown in the special details in the Plans.

Install a new electrical service comprised of an external service disconnect as well as a meter base with meter socket cover, even if the new service is replacing an existing non-metered electrical service. After installation of the meter base with meter socket cover, the local power company will remove the meter socket cover and transfer the existing meter or install a new meter and make any necessary connections to the power lines.

For locations that have existing PVC service risers, replace the existing electrical service with a new electrical service that has a rigid galvanized riser, as described above.

**(C) New Electrical Service for CCTV**

At locations identified in the Plans, install new electrical service for a CCTV cabinet in accordance with the details shown in the Plans. Install a new electrical service comprised of an external service disconnect and a meter base with meter socket cover housed in a combination panel. Mount the combination panel on the CCTV pole. After installation of the meter base with meter socket cover, the local power company will remove the socket cover and transfer the existing meter or install a new meter and make any necessary connections to the power lines.

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Unless the Plans indicate otherwise, have the power company route the service drop underground to combination panel, even where source power lines are overhead.

**(D) New Shared Electrical Service for Traffic Signal and CCTV**

For locations where a single new electrical service is being provided to both a traffic signal controller cabinet and a CCTV cabinet (i.e., two separate circuits from single electrical service), install the new electrical service with two circuit breakers in the disconnect adjacent to the signal controller cabinet in accordance with the "New Electrical Service for Traffic Signal" subsection above. Install new 1" rigid galvanized underground conduits and short risers between the new disconnect and the CCTV cabinet. Route new conductors from the circuit breaker to the cabinets through the new underground rigid conduit and short risers. Permanently label the circuit breakers to identify which circuit serves the signal controller cabinet and which circuit serves the CCTV cabinet.

**(E) Modify Existing Electrical Service**

At locations shown in the Plans, modify an existing electrical service by one of more of the following methods:

- Replace the existing feeder conductors between the existing disconnect and the traffic signal controller cabinet with new feeder conductors.
- For existing roof-top mounted CCTV cameras, replace the existing feeder conductors between the existing disconnect and the new building-mounted CCTV cabinet with new feeder conductors, as required by the Engineer. Provide and install new 1" rigid galvanized conduits and fittings to convey the new conductors between the existing disconnect and the adjacent equipment cabinet as directed by the Engineer;
- Install a new 15A breaker for CCTV cabinet service in a spare slot in the existing disconnect for a traffic signal controller cabinet to enable the CCTV cabinet to share electrical service with the adjacent traffic signal. Extend electrical service to the CCTV cabinet by routing new feeder conductors to the CCTV cabinet through new 1" rigid galvanized conduit and risers as shown in the Plans. Permanently label the circuit breakers to identify which circuit serves the signal controller cabinet and which circuit serves the CCTV cabinet.
- Install a new grounding system.

Test and upgrade grounding system of the modified electrical service as required to ensure that grounding system complies with the grounding requirements for electrical service in these Project Special Provisions.

**(F) Disconnect for CCTV Cabinet**

At locations indicated in the Plans where a CCTV cabinet shares electrical service with a nearby traffic signal controller cabinet but is located 100 feet or more away from the shared electrical service, install an additional disconnect on the CCTV pole. Route the feeder conductors from the shared power service disconnect near the traffic signal to this second disconnect on the CCTV pole through new 1" underground conduit and 1" rigid galvanized short risers as shown in the Plans. Install 1" rigid galvanized conduit housing new feeder conductors between the second disconnect on the CCTV pole and the CCTV cabinet.

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**(G) Grounding of Electrical Services**

In addition to NEC requirements, test grounding electrode resistance for a maximum of 20 ohms. Furnish and install additional ground rods to grounding electrode system as necessary to meet test requirements. Furnish 5/8" x 10' copper clad steel grounding electrode system (ground rods), #4 AWG solid bare copper conductors, and exothermic welding kits for grounding system installations. Comply with NEC, the *Standard Specifications*, these Project Special Provisions and the Plans.

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

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

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

<https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx>

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

For locations in downtown High Point where there is insufficient or no available unpaved areas within the existing right-of-way and grounding electrodes, therefore, must be installed beneath existing sidewalk, replace all sidewalk removed to install the grounding electrodes with in-kind materials in accordance with the requirements for the same in the "Ground Surface Restoration" subsection of the "Equipment Cabinet Foundations" section of these Project Special Provisions.

**(H) Emergency Generator Provisions**

At locations shown in the Plans and listed in the table below, implement and install new emergency generator provisions including lockable power inlet box and manual transfer switch.

<b>Signal Inventory #</b>	<b>Intersection</b>
07-0493	Eastchester Drive at Wendover Avenue/Skeet Club Road
07-0707	Surrett Drive at Eden Terrace/Corporation Drive
07-0734	S. Main Street at Fairfield Road

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<b>Signal Inventory #</b>	<b>Intersection</b>
07-0737	Eastchester Drive at Johnson Street
07-0738	Fairfield Road at Surrett Drive
07-0753	N. Main Street at Eastchester Drive/Westchester Drive
07-0754	Eastchester Drive at Centennial Street
07-0756	Westchester Drive at Lexington Avenue
07-0757	N. Main Street at Lexington Avenue
07-0774	Westchester Drive at Chestnut Drive
07-0892	Wendover Avenue at Penny Road
07-0894	N. Main Street at Old Winston Road/Belle Avenue
07-0915	S. College Drive at Kivett Drive
07-0916	N. College Drive at Lexington Avenue
07-1217	Guilford College Road at Piedmont Parkway/Hilltop Road
07-1268	Main Street at Dillon Road (in Jamestown)
07-1455	N. Main Street at Hartley Drive
07-1525	Wendover Avenue at Penny Road
07-1527	Eastchester Drive at Penny Road
07-1623	Eastchester Drive at I-74/US 311 North
07-1624	Eastchester Drive at I-74/US 311 South
07-1747	Eastchester Drive at Hartley Drive/N. College Drive
07-1980	Eastchester Drive at Lassiter Drive
07-2171	Surrett Drive at Fraley Road
HP-0708	Hoskins Street at Gordon Street/Washington Street

Comply with all requirements shown in the detail drawings in the Plans for emergency generator provisions. For intersections with integrated cabinet base adapter, mount the transfer panel and power inlet on the integral meter pedestal in such a way as not to block pedestal access panels or interfere with the meter base and disconnect. For locations with new electrical service, install a 6" x 6" treated wood post a minimum of 3 feet into the ground and mount both the electrical service equipment and the generator transfer switch assembly on the wood post. For retrofit locations where the existing electrical service is being retained, install the transfer switch assembly on the wood pole adjacent to the existing meter base and disconnect, on the existing rigid galvanized pipe to which the electrical service is mounted at the Wendover Avenue/Piedmont Parkway intersection, and on a new 6" x 6" wood post installed beside the existing pedestal at the Eden Terrace/Corporation Parkway intersection.



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Install an eye bolt in the side of the cabinet foundation to serve as an anchor for emergency generators being used by the City. Provide a forged machinery eye bolt with shoulder with a minimum 7/8" diameter that is a hot dipped galvanized steel material to prevent corrosion. Install the eye bolt a minimum of 4" below grade on any side of the existing foundation. Extract surrounding soil if necessary. Drill a new hole into the existing foundation and epoxy anchor in hole. For the intersection of N. Main Street and Lexington Avenue only where the existing foundation is surrounded by concrete sidewalk, install the anchor on top of the existing foundation instead of in the side of the foundation and locate the anchor immediately next to the integrated base adapter on the side either adjacent to the meter column or adjacent to the street so as not to pose a tripping hazard.

#### **26.4. MEASUREMENT AND PAYMENT**

*New electrical service* will be measured and paid for as the actual number of complete, functional electrical service locations furnished, installed and tested, regardless of type (i.e., traffic signal only; CCTV cabinet only; shared service for signal and CCTV).

No measurement will be made of risers with weatherheads for electrical service as they will be considered incidental to furnishing and installing a new electrical service.

No measurement will be made of short risers (i.e., from disconnect to underground conduit and from underground conduit to bottom of cabinet), meter bases, meter socket covers, service disconnects, additional circuit breakers in new service disconnects where required, underground conduit between service risers and disconnects/meters, conduit for feeder conductors between the service disconnect and the equipment cabinet, PVC female adapters, acquisition of service fees, service entrance conductors, feeder conductors, ground wire, and any remaining hardware and conduit to connect the electrical service to the cabinet as they will be considered incidental to furnishing and installing new electrical service.

*Modify existing electrical service* will be measured and paid for as the actual number of existing electrical service locations that have been modified by replacing the existing feeder conductors with new conductors between the disconnect and the controller cabinet as shown in the Plans, by installing an additional 15A breaker for shared electrical service to a CCTV cabinet or by installing a new grounding system. No measurement will be made of electrical service feeder conductors and ground wire as such work is considered incidental to modifying an existing electrical service.

*CCTV cabinet disconnect* will be measured and paid as the actual number of complete and functional CCTV cabinet disconnects furnished, installed and accepted. No measurement will be made of breakers, feeder conductors, ground wire and any remaining hardware as they will be considered incidental to furnishing and installing the CCTV cabinet disconnect. No measurement will be made of short risers, underground conduit, PVC female adapters and junction boxes from the existing service point to the CCTV cabinet as such work is considered incidental to furnishing and installing the CCTV cabinet disconnect.

*5/8" X 10' grounding electrode* (ground rod) will be measured and paid as the actual number of 5/8" copper clad steel ground rods furnished, installed and accepted as part of grounding systems only for existing electrical services that are being retained and not being modified. No measurement and payment will be made for grounding electrodes installed for modified existing or new electrical services as they will be considered incidental to modifying the existing

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electrical service and installing the new electrical service. No separate payment will be made for #4 AWG solid bare copper grounding conductors or exothermic welding kits as they will be considered incidental to furnishing and installing the ground rod. No measurement and payment for grounding electrodes furnished and installed for any other purposes.

Restoration of sidewalk that is removed to install grounding systems and to install underground conduit between a new electrical service and an equipment cabinet will be measured and paid for in accordance with the "Equipment Cabinet Foundations" section of these Project Special Provisions.

*Emergency generator transfer switch* will be measured and paid as the actual number of complete emergency generator transfer switch assemblies furnished, installed and accepted. There will be no separate measurement and payment for conduits, conduit fittings, NEMA enclosures, wiring, mounting hardware, liquidtight flexible metal conduit, and generator anchor required to install a complete and functional transfer switch assembly as shown on the details in the Plans.

No measurement will be made of 6" x 6" wood post installed at emergency generator transfer switch locations for mounting emergency generator transfer switch assemblies and electrical service as the wood posts will be considered incidental to furnishing and installing the emergency generator transfer switch and incidental to furnishing and installing a new electrical service.

No measurement will be made of restoration of unpaved ground surfaces with like materials, including but not limited to backfill, graded stone, seeding and mulching, as this work will be considered incidental to installation of a new electrical service.

The Department will make no payment for a given new electrical service until all repairs to paved and unpaved surfaces damaged/disturbed during the installation the electrical service have been completed and accepted.

Repair and replacement of existing sidewalk will be measured and paid for in accordance with the "Equipment Cabinet Foundations" section of these Project Special Provisions.

No separate measurement and payment will be made for new electrical service installed for traffic signal controller cabinets mounted on integrated base adapters as such work will be measured and paid for as part of the integrated base adapters in accordance with the "Integrated Cabinet Base Adapters" section of these Project Special Provisions.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
New Electrical Service	Each
Modify Existing Electrical Service	Each
CCTV Cabinet Disconnect	Each
5/8" x 10' Grounding Electrode	Each
Emergency Generator Transfer Switch	Each

## 27. ETHERNET CABLE

### 27.1. DESCRIPTION

Furnish and install copper Ethernet cable, as shown in the Plans, for interconnecting various hardware in an Ethernet network located between the traffic signal cabinets, CCTV cabinets, the TOC, and the Signal Shop.

### 27.2. MATERIALS

#### (A) Ethernet Cable

Provide shielded Category 5 Enhanced (5e) Ethernet cable that complies with ANSI/TIA-568-A-5 standards for four-pair shielded twisted copper for Ethernet communications. The cable shall meet all of the mechanical requirements of ANSI/ICEA S-80-576 applicable to four-pair inside wiring cable for plenum or general cabling.

Furnish Ethernet cable meeting the following minimum performance requirements:

- Specified frequency range: 1-100 MHz
- Attenuation: 24 dB
- NEXT: 37.1 dB
- ACR: 3.1 dB
- ELFEXT: 17 dB
- Power-sum ELFEXT: 14.4 dB
- Return loss: 8 dB
- Propagation delay: 548 nsec
- Delay skew: 50 nsec

Furnish Ethernet cable meeting the following physical requirements:

- Jacket: PVC, UV resistant
- Insulation: Polyolefin
- Core: Gel-filled or flooded core
- Binder: Clear mylar with 100% coverage
- Shield: Aluminum/mylar with 100% coverage
- Drain Wire: 24 AWG, seven stranded tinned copper
- Conductors: Annealed bare copper
- Conductor size: 24 AWG

For Ethernet cable installed in outdoors on aerial messenger cable and in underground conduits, provide the cable rated for such conditions (i.e., UV-resistant, wet conditions, etc.).

Furnish color coded cables to denote the type of connection between devices. The colors shall be:

- TOC or Signal Shop:
  - ITS Servers and firewall - Blue
  - Video Servers and Video Processor Units – Yellow
  - Workstations and UPS – Gray

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- Video encoders and decoders – Green
- Test Cabinets - Orange
- Exterior Cable - Black
- Field Device Cabinets:
  - Traffic Signal Controllers – Blue
  - Conflict Monitors - Red
  - CCTV Cameras – Black
  - Video Encoders – Green
  - Laptop - Gray

**(B) Connectors**

Provide RJ-45 connectors with gold wire conductors terminated according EIA/TIA-568-A/568-B standards. Provide connectors with eight contacts. Furnish connectors appropriately rated for the cable being installed. Provide cables with factory-installed connectors for interior cables.

**(C) Ethernet Patch Cords**

Furnish Fast Ethernet patch cords meeting the following physical requirements:

- Minimum of five (5)-foot length,
- Category 5e,
- Factory pre-installed RJ-45 connectors on both ends,
- Molded anti-snag hoods over connectors, and
- Gold plated connectors.

Furnish Ethernet patch cords meeting the following minimum performance requirements:

- TIA/EIA-568-A-5, Additional Transmission Performance Specifications for 4-pair 100  $\Omega$  Enhanced Category 5e Cabling.
- Frequency Range: 1-100 MHz.
- Near-End Crosstalk (NEXT): 30.1 dB.
- Power-sum NEXT: 27.1 dB.
- Attenuation to Crosstalk Ratio (ACR): 6.1 dB.
- Power-sum ACR: 3.1 dB.
- Return Loss: 10 dB. and
- Propagation Delay: 548 nsec.

**(D) Environmental Requirements****(1) Outdoor Cable**

Provide 4-pair twisted copper Ethernet cable and connectors rated for an ambient operating temperature range of -30° to 165° F. The cable shall be shielded, outdoor-rated and have a UV resistant jacket. The void between the insulated copper pairs and the polyethylene outer jacket shall be injected with a water resistant flooding compound.

**(2) Indoor Cable**

Provide 4-pair twisted copper Ethernet cable and connectors rated for an ambient operating temperature range of -30° to 165° F. Furnish factory pre-terminated/pre-connectorized Ethernet

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cables whenever possible. Provide factory pre-connectorized Ethernet cables for all cables that are less than or equal to 12 feet in length.

**27.3. CONSTRUCTION METHODS****(A) General**

Install color-coded Category 5e Ethernet cable for traffic signal controller and CCTV cabinets, on traffic signal and utility poles, and in conduits or on messenger cable to bring the cable between traffic signal controller and CCTV cabinets. Use color-coded cable as described in these Project Special Provisions above.

Furnish all tools, equipment, materials, supplies, and hardware necessary to install a fully operational Ethernet cable system as depicted in the Plans. Install the Ethernet cable according to the latest version of the manufacturer's cable installation procedures and the industry-accepted installation standards, codes, and practices, or as directed by the Engineer.

Take all precautions necessary to ensure the Ethernet cable is not damaged during storage and installation. Do not step on the cable nor run over the cable with vehicles or equipment. Do not pull the cable over or around obstructions or along the ground.

Immediately cease work and notify the Engineer and the affected owner should damage to existing cables or equipment occur. Make the required repairs at no additional cost to the Department.

Provide the Engineer with three copies of the Ethernet cable manufacturer's recommended and maximum pulling tensions for each Ethernet cable size before the installation of Ethernet cable.

Install Ethernet cable in continuous lengths with no splices outside cabinets.

Cut cables to length to minimize coils of spare cable. Cut outer jacket and trim conductors per manufacturer's recommendations. Ensure all conductors extend to the end of the channel and make solid electrical contact with the gold connectors. Crimp the RJ-45 connector body to lock conductors in channels.

**(B) Aerial Installation**

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

Maintain tension during the pulling process for aerial run Ethernet cable by using a mechanical clutch (dynamometer) device with breakaway swivel approved by the Engineer. Do not exceed 80 percent of the manufacturer's maximum allowable pulling tension. Do not allow the Ethernet cable to contact the ground or other obstructions between the poles during installation. Do not use a motorized vehicle to generate cable-pulling forces.

**(C) Messenger Cable Installation**

Double lash the Ethernet cable to the messenger cable where the messenger cable is used solely to support the communications cable.

Wrap the communications cable to the messenger cable using aluminum ribbon wraps where the messenger cable supports other cables (i.e., traffic signal cable, lead-in cable, etc.).

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Install underground Ethernet cable as shown in the Plans using cable-pulling lubricants approved by the Ethernet cable manufacturer and the Engineer. Obtain the Engineer's approval of the cable lubricant and method of pulling before the installation of underground Ethernet cable.

Do not exceed 80 percent of the manufacturer's maximum pulling tension when installing underground Ethernet cable.

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

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

Set cable reels up on the same side of the junction box as the conduit section in which the cable is to be installed. Place the reel level and align the reel with the conduit section such that the cable will pass from the top of the reel in a smooth bend into the conduit without twisting. Do not pull the cable from the bottom of the reel. Manually feed the cable by rotating the reel. Do not pull the cable through intermediate junction boxes, pull boxes, handholes, or openings in conduit unless otherwise approved by the Engineer.

Crimp the RJ-45 connector body to lock conductors in channels. Test each connector from end to end.

**(E) Underfloor Installation**

Install underfloor Ethernet cable in the TOC as shown in the Plans using the above described pulling methods.

**(F) Ethernet Patch Cords**

Install Ethernet patch cords between Ethernet patch panels and devices and network interface box and devices.

**27.4. MEASUREMENT AND PAYMENT**

*Ethernet cable* will be measured and paid as the actual linear feet of Ethernet cable furnished, installed, and accepted regardless of the color of the outer jacket. 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. No measurement will be made of connectors as such work is considered incidental to installing the Ethernet cable.

No measurement will be made for Ethernet patch cables that connect adjacent devices/equipment (e.g., between an Ethernet edge switch and a controller housed in the same cabinet) as they will be considered incidental to furnishing and installing the equipment that they connect.

Payment will be made under:

**Pay Item**

Ethernet Cable

**Pay Unit**

Linear Foot

## 28. CCTV FIELD EQUIPMENT

### 28.1. DESCRIPTION

Furnish and install CCTV field equipment, cabinets and local camera control software described in this Section. Remove and deliver existing CCTV field equipment and cabinets that will not be used per Section 1 of these Project Special Provisions and as shown in the Plans.

Furnish and install new electrical service for CCTV where shown in the Plans.

Provide a system to protect field devices and electronic equipment from lightning and surge protection using UL<sup>®</sup> listed surge protection devices.

Modify existing NCDOT Triad Region CCTV camera locations along US 311 Bypass/I-74 as shown in the Plans for operation on an Ethernet communications network as described in these Project Special Provisions and as shown in the Plans.

### 28.2. MATERIALS

#### (A) General

Provide new CCTV camera assemblies and cabinets and all wiring as shown in the Plans. Each CCTV camera assembly shall consist of the following:

- NEMA environmental dome enclosure,
- CCTV color digital signal processing camera unit with zoom lens, filter, control circuit, and accessories,
- Motorized pan, tilt, and zoom,
- Power supplies,
- Pole-mount camera attachment hardware,
- Built-in video encoder cable of H.64/MPEG-4 compression for video-over IP transmission,
- All necessary cable, connectors and incidental hardware to make a complete and operable system,
- NEMA Type 4, IP 66 enclosure constructed of aluminum with a clear acrylic dome or approved equal camera unit housing,
- Composite cable for power supply and Ethernet communications, and
- Surge protection devices.

CCTV cabinets shall be either Type 336A cabinets or small NEMA Type 4 cabinets as shown in the Plans. Provide a Type 336A cabinet at those locations shown in the Plans where there will be fiber-optic communications directly to the CCTV cabinet. Provide a NEMA Type 4 cabinet where Ethernet communications and 24VAC power originates at a nearby traffic signal controller cabinet.

Furnish all tools, equipment, materials, supplies and hardware necessary to install a fully operational CCTV camera system as depicted in the Plans and described in these Project Special Provisions.

Provide all hardware and mounting brackets required to mount CCTV camera assemblies and CCTV cabinets to metal and wood poles as required by the Plans. Attach camera mounting brackets and CCTV cabinets to poles using Engineer-approved stainless steel banding hardware

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and clamps. Submit catalog cuts/manufacturer's literature for banding hardware and clamps to the Engineer for approval.

For the intersection of College Drive and Lexington Avenue, furnish a side-of-pole, two-way signal mounting bracket and all hardware needed to mount the NEMA 4 CCTV cabinet back-to-back with the existing pedestrian signal to the side of the metal signal pole as shown in the Plans. Provide a mounting bracket with hub plates that is on the NCDOT QPL. Provide threaded metallic pipes and hub plates for connecting the NEMA 4 cabinet to the upper and lower arm assemblies of the mounting bracket. Ensure that the entire assembly, including nipples, pipes and hub plates, has a black painted or powder-coated finish factory-applied by the manufacturer. Provide stainless steel banding hardware to band the hub plates to the side of the metal signal pole.

**(B) Standards**

- ANSI,
- ASTM,
- CE, Class B,
- EIA Standards 170, 232, 422, 250C and 485,
- FCC Rules Part 15, Sub-part J,
- FCC Class A,
- FCC, Class B,
- IEEE,
- ICEA,
- IMSA,
- ISO 9001,
- NEC,
- NEMA 4X, IP 66,
- NEMA Type 1,
- NTSC, and
- UL Listed.

Provide UL listed surge protection devices according to the UL 1449, 2nd edition standard that comply with the NEMA requirements as detailed in the NEMA LS 1 (1992) standard.

Provide a means to ground all equipment as called for in the Standard Specifications, these Project Special Provisions, and the Plans.

**(C) Camera Assembly**

Furnish new CCTV camera assemblies at locations shown on the Plans. Each assembly consists of one dome CCTV camera that contains, in a single enclosed unit, the following functionality and accessories:

**(1) Cameras**

Provide new 1/3-inch charged-coupled device (CCD) color day/night cameras. The sensors shall use Complementary Metal-Oxide-Semiconductor (CMOS) technology. The camera must meet the following minimum requirements:



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- Video signal format: NTSC compatible resolution, user selectable up to a maximum of 1920 x 1080 (1080p)
- White balance: Automatic through the lens with manual override,
- Electronic-shutter: DIP-switch selectable NTSC electronic shutter with speed range from 1/2 of a second (off) to 1/30,000 of a second (NTSC),
- Overexposure protection: Built-in circuitry or a protection device to prevent any damage to the camera when pointed at strong light sources, including the sun,
- Gain control: Automatic and manual,
- Sensitivity: 0.6 lux at 90% scene reflectance, with f/1.6 and 28 dB gain,
- Input/Output Connection: Single 10BASE-T/100BASE-T compatible outdoor-rated Cat5e cable for video and control, and IP66-rated RJ45 connector
- Security: Min. 20 users in unicast mode, unlimited in multicast
- Open Application Programming Interface (API): ONVIF Profile S
- Primary supply voltage: 120 VAC,
- Camera voltage: 24 VAC or 24 VDC, and
- Camera power: 73 VA with heater at 24 VAC or 3 amps at 24 VDC.

**(2) Lens**

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

- Automatic focus: Automatic with manual override, Electronic Image Stabilizations (EIS)
- Horizontal angle of view: 59 degrees at 4.3 mm wide zoom and 2.1 degrees at 129 mm telephoto zoom,
- Focal length: 4.3 mm to 129 mm, 30X optical zoom, 12X electronic zoom,
- Zoom Speed: 2.9, 4.2 and 5.8 seconds,
- Lens aperture: Minimum of f/1.6 to f/4.7,
- Maximum Sensitivity at 35 IRE: .025 lux at 1/2 second color, .1 lux at 1/60 second black and white, .004 lux at 1/2 second black and white,
- Preset positioning: Minimum of 128 presets.

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

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Provide new dome style enclosure for assemblies with a high performance integrated dome system or approved equal. Provide the dome housing with a 1½” NPT threaded cable entry. Except for cameras that will be mounted to existing roof-top mounting assemblies, equip each camera housing with a mounting assembly for attachment to the CCTV camera pole. Furnish all necessary hardware for mounting camera housings on existing roof-top camera mounting assemblies. The enclosures must be equipped with a strip heater. Provide a sunshield fabricated from corrosion resistant aluminum and finished in a neutral color of weather resistant enamel. The viewing area of the enclosure must be tempered glass.

Provide surge protectors for all ungrounded conductors that will enter the CCTV enclosure as described below. House the surge protectors within the CCTV housing in a manner approved by the Engineer.

A dome-type environmental housing shall have a sustained ambient operating temperature of -50 degrees F to 122 degrees F, with 100 percent non-condensing relative humidity as defined within the NEMA TS-2 (1998) standard.

The enclosure shall have a NEMA 4X/IP-66 rating.

**(4) Pan and Tilt Unit**

Equip each new dome style assembly with a pan and tilt unit. The pan and tilt unit must be integral to dome system. The pan and tilt unit must be rated for outdoor operation, provide dynamic braking for instantaneous stopping, prevent drift, and have minimum backlash. The dome must have an auto flip dome rotation to rotate and reposition camera for viewing objects passing below camera. Provide electronic image stabilization. The pan and tilt units must meet or exceed the following specifications:

- Pan: Continuous 360 degrees,
- Tilt: +2 to -92 degrees minimum,
- Presets: Minimum of 128 presets,
- Preset accuracy: 0.1 degree,
- Preset pan speed: 0.1 degrees/second to 200 degrees/second,
- Preset tilt speed: 0.1 degrees/second to 400 degrees/second,
- Privacy zones: Minimum of eight user configurable shapes,
- Input voltage: 24 VDC or 24 VAC, and
- Motors: Two-phase induction type, continuous duty, instantaneous reversing.

**(5) Ethernet Cable**

Furnish copper Ethernet cable for interconnecting various hardware between the CCTV cabinets and the CCTVs as described in the “Ethernet Cable” section of these *Project Special Provisions*, except the Ethernet cable must be rated for medium-power, network-powered broadband communications circuits and must be Type BMU network-powered broadband communications medium-power cable.

**(6) Power Supplies**

Furnish a camera power supply recommended by the manufacturer for use with the camera. Furnish a power supply that is rated for outdoor use, is compatible with the AC electric service

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source (e.g., traffic signal cabinet), and provides power within the input range of the camera. Furnish camera power cable from the camera manufacturer as follows:

- Three wire consisting of power conductors and bond wire,
- 8 AWG power conductors,
- 6 AWG bond wire, and
- THWN stranded.

**(D) Camera Mounting Bracket**

Provide a pole attachment assembly for the CCTV camera unit to mount on wood poles, metal poles, and metal poles with mast arms. The attachment assembly shall use stainless steel banding around the pole approved by the Engineer. Provide black stainless steel banding for attaching the assembly to existing metal poles that have a black finish/coating.

For CCTV 01, CCTV 03, CCTV 05, CCTV 07, and CCTV 08 mounted on building roofs, reuse the existing rooftop mounting bracket to mount the new camera unit. Provide all hardware necessary to mount the new camera to the existing mounts.

Submit shop drawings of the attachment assembly for review and approval by the Engineer prior to delivery.

Provide the CCTV attachment assembly 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.

Provide CCTV camera attachment assembly that is able to withstand wind loading at the maximum wind speed and gust factor called for in the interim revision of the 5<sup>th</sup> Edition *AASHTO Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals* and can support a minimum camera unit dead load of 45 pounds.

**(E) Video Encoder**

All video encoders must have the following minimum features:

- Network Interface: Ethernet 10/100Base-T (RJ-45 connector)
- Protocols: IPv4, IPv6, HTTP, HTTPS, SSL, QoS, FTP, SMTP, UPnP, SNMP v2c/v3, DNS, NTP, RTSP, RTP, TCP, UDP, IGMP, DHCP
- Security: SSL, SSH, 802.1x, HTTPS encryption with password controlled browser interface
- Video Streams: 2 simultaneous streams, user configurable
- Compression: H.264 (MPEG-4 Part 10/AVC)
- Resolution: Scalable; NTSC-compatible 320x176 to 1920x1080 (HDTV 1080p, 16:9 Aspect Ratio)
- Frame Rate: 1-30 FPS programmable (full motion)
- Bandwidth: 30 kbps – 6 Mbps, configurable depending on resolution
- Edge Storage: SD/SDHC/SDXC slot supporting up to 64GB memory card

For the NCDOT Triad Region camera cabinets along US 311/I-74, as shown in the Plans, provide shelf mounted video encoders. For all other CCTV locations, furnish cameras with a built-in digital video Ethernet encoder to allow video-over-IP transmission. The encoder units

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must be built into the camera housing and require no additional equipment to transmit encoded video over IP networks.

**(F) Type 336A Camera Cabinet**

**(1) General**

Provide Type 336A CCTV cabinets that provide for and meet the following minimum requirements:

- Ethernet edge switch (paid for separately),
- Termination of the composite cable to the camera,
- Local interface panel with maintenance access points for data and video connections to observe camera images and program/monitor camera status,
- Fiber-optic interconnect center (paid for separately),
- Grounding bus bar,
- 19-inch rack system for mounting of all devices in the cabinet,
- Pull-out shelf for laptop and maintenance use,
- Stationary shelf for shelf-mounting the Ethernet edge switch,
- Fluorescent lighting,
- Ventilation fan,
- Thermostats,
- 120 VAC power supply,
- 120 VAC GFCI-protected duplex outlets for tools,
- 120 VAC surge protected duplex outlets for equipment,
- Surge protection on incoming and outgoing electrical lines (power and data),
- Transformers/power supplies, and
- Power strip along vertical rail.

Provide cabinets complete with a prefabricated cabinet shell, and all internal components and equipment, back and side panels, front and back doors, terminal strips, cabling and harnesses, surge protection for power and communication circuits, power distribution blocks or assemblies, shelves, connectors and all mounting hardware necessary for installation of equipment.

Provide the cabinets using unpainted sheet aluminum with a minimum thickness of 0.125 inch.

Provide the rack assembly with a removable, standard 19-inch EIA compliant rack. Equip each cabinet with an aluminum storage compartment mounted in the rack assembly with the following dimensions ( $\pm 0.5$  inch): 16 inches wide, 14 inches long and 1.75 inches deep. Provide the compartment with ball bearing telescoping drawer guides to allow full extension from the rack assembly. The storage compartment shall open to provide a full-depth storage space for cabinet documentation and other miscellaneous items. The storage compartment shall be of adequate construction to support a weight of 20 pounds without sagging when extended. The top of the storage compartment shall be hinged aluminum. Provide at least one removable metal full-depth shelf with each cabinet.

Provide all cabinets and exterior door seams with continuously welded seams and with smooth exterior welds. Provide all cabinets with two (2) full-size doors (one front, one back). Provide the doors with three hinges, or a full-length stainless steel piano hinge, with stainless

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steel pins spot-welded at the top. The hinges shall utilize stainless steel hinge pins. Mount the hinges so that they cannot be removed from the door or cabinet without first opening the door. Brace the door and hinges to withstand a 100-pound per vertical foot of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed. Provide the cabinet door with a #2 Corbin lock. Provide two keys for each cabinet. Provide the cabinet doors so they can be padlocked. Provide door openings with double flanges on all four sides.

Doorstops shall be included at 90° and 180° positions. Provide both the door and the doorstop mechanism of sufficient strength to withstand a simulated wind load of five pounds per square foot of door area applied to the both inside and outside surfaces without failure, permanent deformation, or compromising of door position and normal operation. Provide the cabinets without auxiliary police doors.

Ensure that cabinet doors include a gasket to provide a dust and weather-resistant seal when closed. Provide the gasket material with closed-cell neoprene and shall maintain its resiliency after exposure to the outdoor environment. The gasket shall show no sign of rolling or sagging, and shall ensure a uniform dust and weather-resistant seal around the entire door facing.

Provide both pole-mounted and base-mounted (i.e., open bottom) versions of the 336A CCTV cabinet as required by the Plans. Provide base adapters for the base-mounted 336A CCTV cabinets that comply with the "Cabinet Base Adapter and Base Extender" section of these Project Special Provisions.

### **(2) Ventilation**

Provide a cooling fan in all cabinets with a minimum capacity of 100 CFM. Provide a thermostat to control the ventilation system.

Provide the cabinets with vent openings in the door to allow convection cooling of electronic components. Locate the vent opening on the lower portion of the cabinet door and cover fully on the inside with a commercially available disposable three layer graded type filter.

Provide cabinets with a serial number unique to the manufacturer. Engrave the entire identification code on a metallic plate that is epoxied to the cabinet on the upper right hand sidewall.

### **(3) Electrical**

Provide a power distribution assembly that consists of power filters, transient voltage suppression, equipment grounding, main and branch circuit breakers for equipment, electrical outlets, lighting and ventilation.

Provide AC isolation within the cabinet. Configure all cabinets to accept 120 VAC from the utility company.

Provide UL listed circuit breakers with an interrupt capacity of 5,000 amperes and insulation resistance of 100 MΩ at 500 VDC. Provide power distributions blocks for use as power feed and junction points for two and three wire circuits. The line side of each shall be capable of handling up to 2/0 AWG conductors. Isolate the AC neutral and equipment ground wiring and terminal blocks from the line wiring by an insulation resistance of at least 10 MΩ when measured at the AC neutral.

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For components that are furnished by the Contractor that are mounted on cabinet side panels, fasten with hex-head or Phillips-head machine screws. Install the screws into tapped and threaded holes in the panels. The components include, but are not limited to, terminal blocks; bus bars, and DC power supply chassis.

Tag and identify all cabinet wiring installed by the Contractor by the use of insulated pre-printed sleeves. The wire markers shall identify in plain words with sufficient details without abbreviations or codes.

Neatly arrange all wiring in the cabinet, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling so as to avoid sharp edges and to avoid conflicts with other equipment or cabling. Terminate all wiring on a terminal block, strip, bus bar, device clamp, lug; or connector, do not splice any wiring. Label all wiring, cables, terminal strips, and distribution blocks provided by the Contractor. Provide strain relief for all cabling with connectors, all cabling entering knockouts or ports at the equipment, and where appropriate.

#### **(4) Cable Terminations**

Terminate the Ethernet field cabling on the Ethernet surge protection device for the Ethernet communications. Terminate Ethernet data cables in RJ-45 connector plug receptacles. Terminate power conductors on the surge protection devices. Clearly and permanently factory label all input and output cable sides.

#### **(G) NEMA Type 4 CCTV Cabinet**

At locations shown in the Plans, provide NEMA Type 4 cabinet fabricated of sheet steel or sheet aluminum with continuous weld construction and with a drip shield top. Steel enclosures shall be stainless steel. Aluminum enclosures shall have a standard mill finish.

For the cabinet at the intersection of College Drive and Lexington Avenue (CCTV 29) where the NEMA Type 4 cabinet will be attached to a metal pole with a black coating, provide a NEMA Type 4 cabinet that has a factory-applied, black powder-coated finish on its exterior.

Provide a cabinet that is compact but of sufficient size to accommodate entrances for a minimum of two 2-inch galvanized rigid metal conduits in the bottom of the enclosure. The dimensions of the enclosure shall not be less than 12" wide x 12" high x 6" deep and shall not exceed 18" wide x 18" high x 8" deep. The enclosure shall have a continuously hinged front door which opens to the side and which is secured by a Corbin No. 2 lock and latch. A door handle is not required.

These cabinets shall be pole mounted and equipped with following items:

- Ethernet surge protection device described below,
- Low voltage power surge protection device described below,
- Double pole convenience switch to disconnect CCTV power,
- DIN rail to mount the surge protection devices and convenience switch, and
- Ground bus bar.

Mount the DIN on the back wall of the enclosure in such a manner that no mounting screws, nuts, etc., protrude through the enclosure. Center the DIN rail both horizontally and vertically on the back wall of the enclosure.

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Provide a means to ground the cabinet to the pole ground.

Except for the cabinet at the intersection of College Drive and Lexington Avenue, provide conduit entrances in the bottom of the cabinet only which are of the size and number required for the specific location where cabinet will be installed; conduit entrances in the top or sides of the cabinet are prohibited. For the cabinet at the College Drive/Lexington Avenue intersection, provide one cable entry hole approximately 1" in diameter centered on both the top and bottom of the cabinet to facilitate mounting in a 2-way side-of-pole signal mounting bracket. Conduit and cable entrances may be either pre-drilled or field-drilled, but shall not exceed the number required for the location. Extra or spare entrances, capped or otherwise, are not acceptable. Field-verify the required number, size and position of entrances prior to drilling.

Provide all necessary hardware and mounting brackets for attaching the NEMA Type 4 CCTV cabinet on the pole. Such hardware shall provide for mounting the cabinet to metal or wood signal poles using at least two stainless steel bands (straps) of the size recommended by the manufacturer, one near the top of cabinet and one near the bottom, and for mounting the cabinet at the College Drive/Lexington Avenue intersection in a 2-way side-of-pole signal mounting bracket.

**(H) Composite Cable**

Provide a composite cable for carrying the CCTV power and Ethernet communications between the camera and CCTV cabinet. The composite cable shall consist of:

- Outer jacket composed of UV resistant PVC,
- Ethernet cable (refer to "Ethernet Cable" section of these Project Special Provisions)
- Power Cable,
  - 8 AWG, 2 conductors
  - 6 AWG, green bond wire
  - Three wire, and
  - THWN stranded.

**(I) Surge Suppression**

Provide surge protection both ahead of and behind the ITS device electronics for the cameras. All surge protection devices shall have an ambient operating temperature of -40 degrees F to 165 degrees F with 95 percent non-condensing relative humidity. All surge protection devices shall comply with the following standards:

- UL 1449 version 3 for electrical power,
- UL 497B for paired data communications, and

For those CCTV cabinets with Ethernet communications over twisted-pair copper cable, provide surge protection devices meeting UL 1449A.

Provide surge protection for all four pairs of the Ethernet cable. Data voltage shall be 48 VDC. Surge protector will function with a Maximum Continuous Operating Voltage (MCOV) of 64VDC, and will clamp (on 1000VDC, 1mA, 10/1000  $\mu$ s waveform) at 72VDC +/- 5V. The maximum continuous current on data lines under normal conditions will be 1.5 A. The peak surge current that can be passed on any pair of data lines can be no more than 30A. Response time on data lines shall be no more than 1 pico-seconds.

**C-5558****ITS-216****Guilford County****(1) Line Side CCTV Power**

Each cabinet must be provided with a hybrid-type, power line surge protection device mounted inside the power distribution assembly. The protector must be installed between the applied line voltage and earth ground. The surge protector must be capable of reducing the effect of lightning transient voltages applied to the AC line. The protector must be mounted inside the power distribution assembly housing facing the rear of the cabinet. The protector must include the following features and functions:

- Maximum AC line voltage: 140 VAC,
- Twenty pulses of peak current, each of which must rise in 8 microseconds and fall in 20 microseconds to ½ the peak: 20,000 Amperes,
- The protector must be provided with the following terminals:
  - Main line (AC line first stage terminal),
  - Main neutral (AC neutral input terminal),
  - Equipment line out (AC line second state output terminal, 19 amps),
  - Equipment neutral out (neutral terminal to protected equipment),
  - Ground (earth connection),
- The main AC line in and the equipment line out terminals must be separated by a 200 Microhenry (minimum) inductor rated to handle the 10 Amp AC service,
- The first stage clamp must be between main line and ground terminals,
- The second stage clamp must be between equipment line out and equipment neutral,
- The protector for the first and second stage clamp must have an MOV or similar solid-state device rated at 20 KA and must be of a completely solid-state design (i.e., no gas discharge tubes allowed),
- The main neutral and equipment neutral out must be connected together internally and must have an MOV similar solid-state device or gas discharge tube rated at 20 KA between main neutral and ground terminals,
- Peak clamp voltage: 350 volts at 20 KA (voltage measured between equipment line out and equipment neutral out terminals. Current applied between main line and ground terminals with ground and main neutral terminals externally tied together),
- Voltage must never exceed 350 volts, and
- The protector must be epoxy-encapsulated in a flame-retardant material.
- Continuous service current: 10 Amps at 120 VAC RMS.
- The equipment line out must provide power to cabinet CCTV and communications equipment and to the 24V power supply.

**(2) Load Side CCTV Power**

Load side protection is designed to restrict surge current transients from entering the power source from the CCTV device and/or site. The surge protection for the CCTV power source shall have an operating voltage of 120 volts single phase and a maximum continuous operating voltage of 150 volts single phase.

The device's surge protection shall be rated at a minimum of 90,000 amps per phase and have maximum clamping voltage ratings of 330 volts at 500 amps, 395 volts at 3,000 amps, and 533 volts at 10,000 amps. The surge protection shall also be UL listed for a minimum



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suppressed voltage of 330 volts per line to the neutral/ground. The suppression device shall be of the metal oxide varistor (MOV) type.

**(3) Load Side CCTV Data**

Provide specialized surge protection devices at the supply and load sides of all low voltage connections to the CCTV device and its operating subsystems. For the building mount CCTV, provide a means to bond the cabinets and cameras to the building ground. Provide specialized surge protection devices at the supply and load sides of all low voltage Ethernet data connections between a CCTV and traffic signal cabinet.

The surge protection shall have an operating voltage to match the characteristics of the CCTV, such as 24 volts of direct current (VDC) or 24 volts of alternating current and less than 5 VDC for data functions. These specialized surge protection units shall be UL listed according to the UL 497B (paired-data cable) standards. The minimum surge current rating for the surge protection shall be 2,000 amps for data and telecommunications, 2,000 amps for twisted pair video.

**(J) Grounding**

Provide a cabinet grounding system for the Type 336A cabinets as shown in the Plans. Incorporate a means to bond (i.e., connect) all metal components of the camera and cabinets to the grounding system with a grounding cable that uses a mechanical connection on the equipment side and an exothermic welded connection at the down cable.

Provide a minimum of four grounding electrodes with a minimum length of 10 feet each and listed according to UL requirements as detailed in the *UL 467J* standard. Provide copper clad or solid copper electrodes.

**(K) Software**

Provide Vendor-supplied GUI-based software to setup, configure and operate the cameras in the field. This software shall include features to set communications addresses and protocols, define camera ID lens control, digital signal processing (DSP) settings, azimuth configuration, presets, tours, and privacy zones. The software shall allow the user to control all functions of the camera locally from the CCTV cabinet at the base of the pole with a serial or USB cable.

**28.3. CONSTRUCTION METHODS****(A) Electrical and Mechanical Requirements**

Ground all equipment as called for in the *Standard Specifications*, these Project Special Provisions, and the Plans.

The air terminal ground wire must not pass through any equipment cabinet or enclosure.

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) Requirements for Working on Rooftops of Privately-Owned Buildings**

Five existing CCTV cameras and their cabinets are mounted on the rooftops of the following three privately owned buildings in downtown High Point:

1. IHFC Building, 210 E. Commerce Avenue (CCTVs 01, 03 & 05)
2. C&D Building, 201 W. Commerce Avenue (CCTV 08)

**C-5558****ITS-218****Guilford County****3. Showplace West Building, 101 S. Main Street (CCTV 07)**

Review each work site in advance to ascertain site conditions and requirements for performing the required construction work at each location. Contact James Baker at the City of High Point at (336) 883-8540 to make arrangements with the property owner/manager for building access. Contact the City at least 10 business days in advance of proposed rooftop work to make arrangements for building and rooftop access and confirm permissible work days and times.

Comply with all rules, policies and procedures of each building owner/property manager. Comply with all OSHA safety regulations when working on the rooftops of buildings. Take necessary steps to protect rooftop from damage as directed by the building owner/property manager, including but not limited to providing protective mats, plywood, etc. The Contractor will be held responsible for repair of any damage to the building and its rooftop caused by the Contractor.

**(C) CCTV Cabinet**

Where the Plans call for a pole-mounted CCTV cabinet, either Type 336A or NEMA Type 4 CCTV, mount the CCTV cabinet on the pole supporting the CCTV camera it controls using approved hardware and attachment brackets. Mount the cabinet 4 ft from the ground to the center of the cabinet. Avoid mounting cabinets where they will overhang and encroach upon an adjacent sidewalk or pedestrian path. Where a minor overhang of the sidewalk or pedestrian path cannot be reasonably avoided, ensure that a minimum of four feet of clear sidewalk width will remain once the cabinet is installed. Do not mount cabinets above pedestrian pushbuttons or where they will hinder access to pedestrian pushbuttons. Have the Engineer approve the proposed mounting position prior to attaching the CCTV cabinet to the pole.

Where the Plans call for a base-mounted Type 336A CCTV cabinet, mount the CCTV cabinet on a base extender and concrete foundation as shown in the Plans.

Where the Plans call for a building mounted Type 336A CCTV cabinet, remove the existing cabinet and install a new Type 336A CCTV cabinet in its place using the existing mounting bolt holes in the building. Bond the building mounted cabinets to the building ground.

Ground all CCTV cabinets in accordance with the requirements of these Project Special Provisions. Keep the ground wire from the cabinet ground bus bar to the ground rod assembly or array as short as possible. Ensure the ground wire is not in contact with any other part of the cabinet.

Tag and identify all cabinet wiring installed by the Contractor by the use of insulated pre-printed sleeves. The wire markers shall identify in plain words with sufficient details without abbreviations or codes.

Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling to avoid sharp edges and to avoid conflicts with other equipment or cabling. Terminate all wiring on a terminal block, strip, bus bar, device clamp, lug, or connector, do not splice any wiring. Label all wiring, cables, terminal strips, and distribution blocks installed by the Contractor. Provide strain relief for all cabling with connectors, all cabling entering knockouts or ports at the equipment, and where appropriate.

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Fasten all components installed by the Contractor to be mounted on cabinet side panels with hex-head or Phillips-head machine screws. Install the screws into tapped and threaded holes in the panels. The components include, but are not limited to, terminal blocks; bus bars, and DC power supply chassis.

For all CCTV locations, stencil the CCTV camera number on both the front and rear doors of the Type 336A CCTV cabinet and on the front door of the NEMA Type 4 CCTV cabinet. Use 3-inch black characters.

**(1) Type 336A Cabinets**

Install new Type 336A CCTV camera cabinets as shown in the Plans. For cabinets mounted on building roofs, reuse the existing mounting bolts. Connect the cabinet to the CCTV camera assembly with an Ethernet cable and low voltage power conductors. Mount the fiber-optic interconnect center in accordance with the "Fiber-Optic Communications Cable" section of these Project Special Provisions. Install the Ethernet edge switch inside the cabinet in accordance with the "Communications Hardware" section of these Project Special Provisions. Connect the appropriate connectors on the interconnect center with those on the Ethernet edge switch using SMFO jumpers.

For the building mounted CCTV cabinets, reuse or replace the existing fiber-optic drop cables as shown in the Plans. Pull the existing fiber-optic drop cable out of the existing cabinets and install the new cabinets. Reinstall the fiber-optic drop cables and splice the cables to pigtails and terminate in new interconnect centers inside the new CCTV cabinets as shown in the Plans for Ethernet communications. Mount and connect the Ethernet edge switch using SMFO jumpers as described above.

Where the Plans call for a base-mounted CCTV cabinet (e.g., Hamilton Street at Commerce Avenue), install a new cabinet base extender on a new CCTV cabinet foundation and mount the new CCTV cabinet on the base extender. Install the cabinet base extender and CCTV cabinet foundation in accordance with the "Cabinet Base Extender and Adapter" and "Equipment Cabinet Foundations" sections of these Project Special Provisions.

**(2) NEMA Type 4 CCTV Cabinets**

Install new NEMA Type 4 CCTV camera cabinets as shown in the Plans.

At the intersection of Lexington Avenue and College Drive, mount the NEMA Type 4 cabinet and the existing pedestrian signal head in a two-way, side of pole signal bracket as shown in the Plans and as described below:

1. Disconnect the existing pedestrian signal and remove it from the existing side-of-pole mounting bracket, taking care not to damage the existing signal conductors nor damage the existing pedestrian signal.
2. Remove the existing side-of-pole mounting bracket from the pole, once again protecting the existing signal conductors from damage.
3. Route CCTV cables in and out of the signal pole to the NEMA Type 4 cabinet via the existing cable entry hole in the pole used to pass the existing signal conductors to the signal head via the side-of-pole mounting bracket.
4. Route the CCTV cables and signal cables through the hub plate and arm assembly of the new two-way side of pole signal mounting bracket. Mount the existing pedestrian and

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the new NEMA 4 cabinet in the new 2-way mounting bracket and attach the mounting assembly to the side of the metal pole at the height of the previous mounting bracket using stainless steel bands.

5. Terminate the existing signal conductors inside the pedestrian signal and terminate all CCTV cables inside the NEMA Type 4 cabinet.

Touch up any damage to the black finish of the existing pedestrian signal, the NEMA Type 4 cabinet, the side-of-pole mounting bracket and the signal pole that occurred during removal of the existing pedestrian signal and mounting bracket and installation of the new mounting bracket, NEMA Type 4 cabinet and pedestrian signal.

Connect the line side power conductors to the convenience switch, connect the bond wire to the busbar, and connect the line side Ethernet communications to the Ethernet surge protection device. Connect the cabinet to the CCTV camera assembly with an Ethernet cable and the power conductors.

In the adjacent signal cabinet, install CCTV power supply and connect the line side power conductors to the power surge protection device. Connect the power conductors to the CCTV cabinet to the surge protection device. Connect the bond wire between the CCTV cabinet and the signal cabinet to the bus bar in the signal cabinet. Connect an Ethernet communications cable between the Ethernet edge switch and the Ethernet surge protection device. Connect the Ethernet cable to the CCTV cabinet to the Ethernet surge protection device.

**(D) Power Service**

For Type 336A CCTV cabinets, provide 120 VAC power from the existing or proposed electrical service or from an existing traffic signal controller cabinets as shown on the Plans. For locations where a power service is shared with CCTV and signal cabinets, modify the existing electrical service or provide a new electrical service to provide separate breakers in the service disconnect. For all other Type 336A CCTV cabinets, install new power service under separate pay item as shown in the Plans. Comply with the "Electrical Service" section of these Project Special Provisions and the details shown in the Plans.

At all other CCTV locations obtain 24VAC power from the adjacent traffic signal cabinet.

**(E) Grounding**

Ground the CCTV pole and subsystems in accordance with the special details in the Plans.

**(F) Surge Protection**

**(1) Device Line Side Power**

Connect the surge protection devices on the CCTV power source on the line side. This device shall provide protection between line-to-neutral, line-to-ground, line-to-line and neutral-to-ground.

**(2) Device Load Side Power**

Connect the surge protection devices in the power line side ahead of all CCTV electronic equipment. This installation technique is designed to restrict earth current transients induced within the ground or directly from the power source from entering the ITS device through the incoming 120/240-volt power circuit. This device shall provide protection between line-to-neutral, line-to-ground, line-to-line and neutral to ground. For 24VAC power connections

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between a traffic signal cabinet and a NEMA 4 CCTV Cabinet, install surge protection devices in both cabinets in accordance with the special details in the Plans.

**(3) Device Data**

Connect the specialized surge protection devices at the supply and line sides of all Ethernet communications to the CCTV device and its operating subsystems. For 24VAC power connections between a traffic signal cabinet and a NEMA 4 CCTV Cabinet, install surge protection devices in both cabinets in accordance with the special details in the Plans.

**(G) CCTV Camera Attachments**

Install the camera attachment assembly to the mounting bracket in a manner 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.

Install CCTV camera attachment assembly that is able to withstand wind loading at the maximum wind speed and gust factor called for in the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, 4th Edition, 2006 Interim, and can support a minimum camera unit dead load of 45 pounds.

**(1) Poles and Mast Arms**

Mount CCTV camera units at a height sufficient to adequately see traffic in all direction and as approved by the Engineer. Mount cameras on poles at the attachment heights shown in the Plans.

Mount CCTV camera on the side of pole that is nearest to the intended field of view, to avoid occlusion of the view by the pole or utility lines. Obtain approval of camera orientation from the Engineer. Comply with the "CCTV Wood Poles" section of these Project Special Provisions.

Have the Engineer approve the pole location prior to installing the camera on an existing pole and prior to setting a new pole. At locations shown in the Plans, assemble the camera attachment hardware for the CCTV camera unit and attach to the pole using stainless steel banding approved by the Engineer. Submit shop drawings for review and approval by the Engineer prior to installation.

**(2) CCTV Camera Attachment to Buildings**

At locations shown in the Plans, assemble the camera attachment hardware for the CCTV camera unit and attach the camera to the existing building mounting hardware. Install the camera attachment assembly to the existing brackets in a manner that allows for the removal and replacement of the CCTV camera enclosure as well as providing a weatherproof, weather-tight seal that does not allow moisture to enter the enclosure. Install new composite CCTV cabling to the CCTV camera from its respective cabinet. The locations where CCTV cameras are located on the buildings are:

- CCTV 01: NE corner of IHFC Building
- CCTV 03: NW corner of IHFC Building
- CCTV 05: SW corner of IHFC Building
- CCTV 07: NW Corner of Showplace West Building
- CCTV 08: NE Corner of C&D Building

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Existing CCTV equipment is located in the following eight NCDOT Type 336A CCTV cabinets. Perform the following work at these locations:

- CCTV 43, US 311 Bypass at Business 85:
- CCTV 44, US 311 Bypass at East Green Drive/Triangle Lake Road
- CCTV 45, US 311 Bypass at East Kivett Street
- CCTV 46, US 311 Bypass at Greensboro Road
- CCTV 48, US 311 Bypass at Johnson Street
- CCTV 83, US 311 Bypass at Jackson Lake Road:
- CCTV 89, US 311 Bypass at I-85 North
- CCTV 90, US 311 Bypass at I-85 South

Retain and reuse the existing fiber-optic drop cable and interconnect center. Modify the fiber-optic splices to terminate four strands as shown in the Plans. Remove existing serial video-data transceiver. Install a shelf-mounted digital video encoder and install an Ethernet edge switch in accordance with the "Communications Hardware" section of these Project Special Provisions. Install cables to connect the camera to the encoder and then the encoder to the Ethernet edge switch. Install SMFO jumpers to connect the Ethernet edge switch with the appropriate connectors on the connector panel of the existing interconnect center.

**(I) Mast Arm Pole Locations**

For CCTV 06 at the intersection of Commerce Avenue and Wrenn Street and CCTV 09 at the intersection of Hamilton Street and English Road, replace the existing cameras mounted on the metal pole just below the mast arm attachment point. Replace the existing composite video cable for PTZ, coax and power between the traffic signal controller cabinet and the CCTV camera with a new composite CCTV cable for Ethernet communications and power conductors.

For CCTV 29 at the intersection of College Drive and Lexington Avenue, install a new camera mounted on the upright portion of a vertical extension of the existing metal pole that is being furnished and installed by the City. Mount the camera near the top of the pole extension as directed by the City. Install CAT-5 cable and 24V power cables by routing the cable between the traffic signal controller cabinet and the pole-mounted NEMA Type 4 CCTV cabinet via existing underground conduits and the interior of the existing metal pole. Route the cables between the interior of the pole and the cabinet via the new 2-way side of pole mounting bracket. Route the composite cable from the pole-mounted NEMA Type 4 CCTV cabinet to CCTV camera mounted above via the new 2-way side of pole mounting bracket and the interior of the metal pole. Mount the CCTV power supply in the traffic signal controller cabinet at the intersection. Mount surge protection devices for the CCTV and power conductors in the traffic signal controller cabinet.

Connect the power conductors to the CCTV to the surge protection devices. Connect an Ethernet communications cable between the Ethernet edge switch and the Ethernet surge protection device. Connect the Ethernet cable to the Ethernet surge and power protection devices in the CCTV cabinet.

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If Vendor software is provided to program and operate the cameras, install the Vendor-supplied GUI-based software to setup, configure and operate the cameras on each laptop supplied with the project.

**(K) GPS Coordinates**

Provide real world coordinates for all junction boxes and equipment cabinets installed or utilized under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet in the horizontal plane and 3.3 feet in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer.

Provide both digital copies and hard copies of all information regarding the location (including to but not limited to manufacturer, model number, City system ID number and NCDOT inventory number) in the Microsoft Excel spreadsheet using the format shown in example below. In addition to Excel format, provide a digital copy of the location information as an ESRI Shapefile (.SHP file format).

City System ID#	NCDOT Inv #	Name	Location	Latitude	Longitude	Manufacturer	Model #
	05-0134	Equipment Cabinet	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5500	35.6873	McCain	Type-332
		Junction Box # 1 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5516	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 2 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5506	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 3 (Near Cabinet)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5501	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 4 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5486	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 5 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5493	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
		Junction Box # 6 (Phase 4 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	-78.5503	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)

**28.4. MEASUREMENT AND PAYMENT**

*CCTV camera assembly* will be measured and paid as the actual number of CCTV camera assemblies furnished, installed, and accepted according to following conditions: 90% of the payment will be made upon acceptance of the installed CCTV camera assembly and the remaining 10% of the payment will be made following final acceptance (including completion of the 60-day observation period).

No separate measurement will be made for composite cabling, connectors, CCTV camera attachment assemblies, software, grounding equipment, surge protector devices, other cabling, and conduit, or any other equipment or labor required to install the CCTV assembly and integrate

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it with the fiber-optic communications equipment as they are considered incidental to furnishing and installing the CCTV camera assembly and the CCTV cabinet.

*CCTV cabinet* (\_\_\_\_, \_\_\_\_ ) will be measured and paid as the actual number of CCTV cabinets of each type and mounting method furnished, installed, and accepted, according to following conditions: 90% of the payment will be made upon acceptance of the installed CCTV cabinet and the remaining 10% of the payment will be made following final acceptance (including completion of the 60-day observation period).

No separate measurement and payment will be made for hardware, fasteners, stainless steel bands and brackets required to mount CCTV cabinets to a pole, a foundation, or a building rooftop as shown in the Plans as such work will be considered incidental to furnishing and installing the CCTV cabinets. No separate measurement and payment will be made for protective measures and materials required by building owners/property managers to protect the roofs of buildings while removing existing rooftop CCTV cameras and cabinets and installing new rooftop CCTV cameras and cabinets, including any liability/property damage insurance required by building owner/property manager as such work will be considered incidental to furnishing and installing the CCTV camera assemblies and CCTV cabinets.

No separate measurement and payment will be made for providing a black powder coated finish on the NEMA Type 4 CCTV cabinet at the intersection of College Drive and Lexington Avenue as the finish will be considered incidental to furnishing and installing the CCTV cabinet. In addition, no measurement and payment will be made of removing the existing pedestrian signal head and existing side-of-pole mounting bracket, furnishing and installing a new 2-way side-of-pole mounting bracket, reinstalling the pedestrian signal in the new 2-way mounting bracket, installing the NEMA Type 4 cabinet in the 2-way mounting bracket, rerouting and re-terminating the existing signal cable in the reinstalled pedestrian signal, providing all mounting hardware necessary, and touching up the black finish of the existing mounting bracket and existing pedestrian signal mounted therein, as such work will be considered incidental to furnishing and installing the NEMA Type 4 CCTV cabinet in a two-way, side-of-pole mount.

No measurement will be made of collecting and recording GPS coordinates for junction boxes and CCTV cabinets and compiling this data in the prescribed Microsoft Excel spreadsheet as such work will be considered incidental to furnishing and installing junction boxes and CCTV cabinets.

No measurement and payment will be made for removing existing CCTV equipment (e.g., cameras and their mounting brackets, cabling, cabinets, fiber-optic transceivers, etc.) that will not be retained and used as part of the new CCTV system, nor for delivery of removed CCTV cameras to City's Signal Shop, delivery of removed CCTV cameras and all equipment housed inside to the Division 7 Traffic Services office, and disposal of all other removed CCTV related hardware, as such work will be considered incidental to furnishing and installing CCTV camera assemblies and CCTV cabinets.

Cabinet base extenders for base-mounted CCTV cabinets will be measured and paid for in accordance with the "Cabinet Base Adapter and Base Extender" section of these Project Special Provisions.



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Foundations for base-mounted CCTV cabinets will be measured and paid for in accordance with the “Equipment Cabinet Foundations” section of these Project Special Provisions.

Installation of Ethernet edge switches and digital video encoders will be measured and paid for in accordance with the “Communications Hardware” and “Digital Video Equipment” sections of these Project Special Provisions.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
CCTV Camera Assembly	Each
CCTV Cabinet (336A, Pole Mount)	Each
CCTV Cabinet (336A, Base Mount)	Each
CCTV Cabinet (336A, Building Mount)	Each
CCTV Cabinet (NEMA 4, Pole Mount)	Each
CCTV Cabinet (NEMA 4, 2-Way Side-of-Pole Mount)	Each

## 29. CCTV INTEGRATION AND SOFTWARE MODIFICATION

### 29.1. DESCRIPTION

Reinstall the City's existing VideoPro CCTV system software package on the new video server and update the configuration to add the additional cameras, network video recorders, and video devices provided in this Project.

### 29.2. CONSTRUCTION METHODS

Protronix's VideoPro is the existing regional video sharing and distribution system that controls the existing video matrix switches at the TRTMC and the TOC. The software utilizes a client-server architecture. Modify the Protronix CCTV central software configuration at the TRTMC and TOC to display and map the CCTV devices from both networks so that the CCTV video can be displayed on the existing monitors and display devices in the TOC.

#### (A) CCTV Control Software

Update the existing VideoPro servers in the TOC and TRTMC and edit the existing device databases to assign 16 outputs for center-to-center (C2C) video sharing. All additions and edits to the databases must be viewable by all current users of the system. Note: the City only desires to view the NCDOT CCTV on US 311/I-74.

Update the existing VideoPro server in the TOC for the new monitor wall devices, IP cameras and network video recorders, and PTZ joysticks.

Configure administrative and user VLANs for the VideoPro servers in the TRTMC Layer 3 Ethernet switch and TOC Ethernet core switch to enable video sharing. The existing TRTMC Layer 3 switch is a Cisco Catalyst 6506-E.

Integrate the VideoPro software to allow for:

- Remote users to view and control CCTV devices that terminate on the TRTMC analog video matrix switch and digital CCTV devices connected to the TOC through the Ethernet network connection between the two centers and the CCTV Control GUI furnished as part of this software such that a user in a facility (TOC or TRTMC) can switch, view, and control cameras in the other facility
- City staff to control the network video recorders to record, playback and write to DVD video streams. Playback could be on a workstation monitor or wall monitor.
- City staff to display signal system software graphics on the wall monitors.
- Users on the VideoPro software shall be able to access and control CCTV devices that reside on the Remote Users' Ethernet network via the LAN connection between the TRTMC and the TOC. This shall be accomplished through modification of the existing VideoPro software to permit the control of remote user CCTV unit via the VPE GUI and the transmission of CCTV video over the center-to-center Ethernet connection called for under this project.

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**29.3. MEASUREMENT AND PAYMENT**

*Modify CCTV Software* shall be measured and paid as a lump sum. This shall include furnishing, installing, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to modify the existing software, complete system integration, and provide a complete operating system.

Payment will be made under:

**Pay Item**

Modify CCTV Software

**Pay Unit**

Lump Sum

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### 30. SIGNAL SYSTEM SOFTWARE

#### 30.1. DESCRIPTION

Furnish and install traffic control system software for the following applications

- Distributed Processing System Software
- System Support Software

Install the following software as furnished by the Engineer.

- Local Controller Software (latest IP version of NCDOT's OASIS<sup>®</sup> software package)

**The Contractor shall be responsible for the development of and integration of all system graphics (and associated system devices) described in the following specifications.**

#### 30.2. 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<sup>®</sup> 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 the "Computer Hardware and Peripherals" section of these Project Special Provisions. Windowing graphical user interfaces (GUI) using object-oriented design and geographically coded database components shall be an integral part of the system design. These elements shall form the basis of all user interactions with the system.

The software shall be portable, as a minimum, across multiple PC hardware platforms and shall be designed to integrate with off-the-shelf PC software. For example, the system shall provide the ability to exchange files with common Geographic Information Systems (GIS), databases, and the latest version of Microsoft<sup>®</sup> Office.

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.

##### (1) Local Area Network Requirements

A 10/100/1000 Base-T Ethernet, local area network (LAN) shall support the distributed client/server architecture. The requirements for the LAN are in "Communications Hardware" section of these Project Special Provisions.

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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.

**(2) Software License**

Provide a perpetual, irrevocable software license to the Department and the City of High Point that gives them the right to copy and use the distributed processing software furnished with this project at any facility within the signal system limits.

Furnish software modifications necessary for system operation as per this Project Special Provision to the agency at no additional cost during the warranty period.

Furnish software that may be used at TOC/City of High Point Municipal Building, City of High Point Signal Shop, NCDOT Division 7, or at any other offices in the State of North Carolina that the City and State, or their authorized agent, may establish for the purpose of traffic signal monitoring and control of the High Point 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 (minimum of 3 years) programmer/developer in the language(s) that the software is written may interpret, modify, and debug the code. The required software compilers shall be specifically and clearly identified and include the operator system platform, the version number, release number and date, and brand.

For copyrighted commercial off-the-shelf (COTS) software, a copy of the source code (both hardcopy and un-compiled digital commented as described in the preceding paragraph) shall be held in an escrow account by an independent agent agreed to prior to final acceptance of the system by the Department. The version of the source code in the escrow account shall be updated as modifications, fixes, enhancements, and improvements are made to the software and implemented on the software products used by the Department. In the event the provider of COTS software product(s) defaults, discontinues support of the software product(s) furnished under this project, goes out of business, or otherwise is unavailable to support the software product(s), the software source code contained in the escrow account shall immediately become the property of the Department.

Provide any third party software licenses to the Department and the City of High Point for software that may be used. Example: report-configuring, diagnostic, or monitoring software.

**(3) Operating System**

The operating system for all server software provided under this project shall be Microsoft Windows Server<sup>®</sup> 2008, Microsoft SQL Server 2008 Release 2 standard edition. The operating system software for all workstations and laptops shall be Microsoft Windows<sup>®</sup> 7 Professional Edition. The release used shall be the latest revision with service packs available as recommended by the supplier of the system software.

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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 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****(1) General**

The signal system software shall not be a prototype or software custom-developed for this project. The software shall have been successfully integrated, tested, and accepted in at least two cities of comparable size (a minimum of 100 intersections). This deployment shall be with 2070 controllers utilizing the local controller software to be deployed under this project.

The system software shall communicate directly with the local intersection 2070 controllers installed under this project. The use of remote communication units (RCUs) is not permitted. The signal system software shall interface with the latest IP version of NCDOT's OASIS® local controller software package. The system shall use a client-server design based on hybrid centralized/distributed intersection control.

The Contractor shall demonstrate to the Department that the system software is capable of communicating with 2070E controllers produced by at least three different manufacturers on at least three channels.

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 500 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 or transceivers 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 and 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.

**(2) Start-Up and Shut-Down**

The traffic control system shall provide for the initial start-up of the system by initializing all operational and failure arrays within the software. The initialization routines shall be used not only at the true initial start-up of the system, but whenever it is desired to reinitialize the system without prior status information.

The traffic control system shall accommodate a planned shutdown of the monitoring functions of the traffic control software.

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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.

**(4) Backup Intersection Operation**

The system shall provide for backup intersection operation in case of failure of the ITS Application Server, ITS 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.

**(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.

**(6) Remote Access**

The system shall allow full access to the system for a multiple user by means of Ethernet access through a secured firewall, using VPN or other means approved by the Department. 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.

**(7) Paging**

The system shall be capable of automatically sending alphanumeric messages (SMS – text messaging) to cellular telephones and email addresses upon detecting problems with the system or from any device. Malfunctions notifications shall also appear as a pop-up alarm, or similar notification approved by the department, on each workstation logged into the system. An audible alert shall be associated with a pop-up alarm, and configurable by the user.

The visual pop-ups and audible alerts shall be configurable to stay up for a specified time period or to stay up indefinitely until closed by the user. Malfunction notifications shall consist of at least three (3), user configurable, priority levels, to include low priority, medium priority and high priority alerts. Acknowledgements of incoming malfunction alarms shall be required for all medium and high priority on-screen notifications. Low priority alarm notifications shall not require acknowledgements.

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Malfunction alerts shall be sent via text (SMS) or email notifications and shall be configurable by TOD/DOW, allowing recipients to be selected based upon severity or priority of event and to issue text/email messages sent to multiple devices or addresses.

Notifications shall allow a confirmation to assure that the malfunction has been acknowledged. If no acknowledgement is received upon expiration of a user programmable time-out period, subsequent notifications shall be configurable to be sent to alternate devices.

The system shall log all malfunction notifications, retries, and acknowledgements with time and date stamps. The first acknowledgement shall be recorded; all others shall be ignored.

**(8) Field Communications**

Within the High Point computerized signal system, traffic signal controllers will be integrated with field Ethernet edge switches that are arranged in a multi-drop communications channels capable of supporting a minimum twenty (20) traffic signal controllers on a dedicated communications channel. The software shall operate with a fully redundant communications network. Each controller is connected to the system via a pair of optical fibers and field Ethernet switch. A channel consists of two fibers: one transmitting and the other receiving.

Each channel with its boundaries and the controllers and CCTV cameras contained within it are depicted on the cable schematic diagram shown in the Plans.

**(9) Database Preparation**

Complete all data entry necessary to implement the operation of the system software.

The Engineer will furnish intersection timing information and coordination parameters (cycle, split, offset). Any custom intersection displays will also be provided by the Department or City. Otherwise, default intersection timing data and standard intersection maps will be utilized when configuring intersections onto the system. Program all system detectors shown in the plans. Coordinate with the City to provide setup, naming/labeling, logging and any features required for the operation of all system detectors.

TOD/DOW plans, alarms and other information for the operation of the signal system shall be entered by the Contractor.

**(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.

**(11) Database Backup and Restoration**

The system shall have a simple means of copying the database files from the hard disk to a removable storage device or archive server. All files required to restore the system to operation without the need to manually re-enter data shall be included on removable storage device.

Files containing records of logged events and detector data shall be saved on a RAID array disk storage as described in the "Computer Hardware and Peripherals" section of these Project Special Provisions. The system shall enable an operator to copy all logged events, within a user-specified date range, to the removable storage device or archive server. The system shall enable an operator to copy all selected detector data to the removable storage device.



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The software shall provide simple, straightforward means for restoring system operation from the backup database files.

**(12) Graphical User Interface**

An object-oriented, graphical user interface (GUI) shall be provided to control and access all systems displays, reports, and dialogue boxes. The GUI shall provide access to all signal system monitoring and control options from a single screen.

Graphical icons shall be used on the displays to represent system devices. The icons shall provide easy access to traffic control data (signal timing, geometric, etc.), real-time data (intersection, link status, etc.), the database, and graphical image files.

The GUI shall include an intersection/link base map with windowed table reports and management input windows. The GUI shall provide interactive mechanisms to assist in creating, editing, and modifying editable dynamic graphic screens that are linked to system dynamic elements. As a result, all operator actions shall be immediately visible as a change in the system graphic.

The workspace session window shall display a toolbar near one of the window borders. The toolbar shall contain buttons and other controls specific for actions relating to a selected window. Actions supported by and pertaining to an active window shall be invoked through the toolbar, action bars, menu selection, popup menu or controls internal to the window itself.

Menu and dialogue box options that are not appropriate in a particular context or not available to a given user shall be "grayed-out" and unavailable for selection.

Traffic engineering terminology shall be used throughout the programming displays. Display organization and data entry approach shall allow system operators to operate the distributed signal system software without using reference cards or manuals.

The user interface shall include an object library that contains dynamic icon objects for system control and monitoring devices. The basic system shall include, at a minimum, objects for traffic signals (OASIS<sup>®</sup>).

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.

*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

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with common GIS packages such as ARCGIS. 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.**

#### *System Map*

The ESRI-based system-wide map or approved equivalent shall provide a dynamic display of the entire surveillance area and any layers the agency requires, including but not limited to interstate highways, major arterial roads, railroads, jurisdiction boundaries, and bodies of water. It shall be possible to “zoom in” and “drill down” to any specific area of the map using the pointing device to select one corner of an area to view, and then select the opposite corner of the area to view. (Zoom out capability shall also be provided). The window containing the system-wide map shall be capable of being dynamically sized by a workstation user.

It shall be possible to display intersection icons in different formats, using the menu bar. The system map shall provide a dynamic display of the signal system signalized intersections in the following two modes:

- Intersection phasing
- Intersection plan

The graphic shall also dynamically display the status of the controllers (e.g., coordination, emergency vehicle preemption, railroad preemption, transition, free operation, flashing, failure, intersection phase status). Intersection status and roadway links shall change color dynamically based on user definable color selection.

Intersection phase status (green, yellow and red) shall be displayed in real-time on the intersection phasing icon. The intersection control status shall be displayed as the background color on the intersection plan icon. Intersection plan information shall be displayed as a number on the intersection plan icon.

Link status shall be shown as different (user defined) colors for differing traffic flow conditions.

The system display shall be capable of being dynamically sized by a workstation user. Resizing the window shall not reduce the amount of data displayed on a workstation monitor and the same aspect ratio shall be monitored as before the resizing.

#### *Control Section Map*

Create default subsection maps/zones or areas to provide a display. The default displays will be called control section maps, and shall provide a more detailed display of selected zones or areas of the system. A control section shall be able to be called from the system map display via a double mouse click or from a drop down menu. A minimum of fifteen (15) control section displays shall be capable of being simultaneously displayed while the system map is open and

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the maximum number intersection display windows are open. The control section map interface shall be an integrated portion of the distributed processing system software and shall not be a stand-alone package.

The control section map shall provide a dynamic display of the signal system, including landmarks, streets, signalized intersections, interstate highways (if applicable), railroads (if applicable), system detectors, system detector actuation. Labels for these items shall also be displayed. All labeling shall be approved by the Engineer. The graphic shall also dynamically display the status of the controllers in the sub-area (e.g., coordination, emergency vehicle preemption, railroad preemption transition, free operation, flashing, failed, intersection phase status). Volume and occupancy levels shall be displayed as color bars on the map. Intersection phase status (green, yellow, and red) shall be displayed in real-time using arrow icons. Link status shall be shown as green for free flow or near free flow conditions. Yellow shall be shown for moderate congestion or transition conditions. Red shall be shown for congested conditions, and flashing red shall be used to indicate severe congestion or major delays. The control section display shall be capable of being dynamically sized by a workstation user. Resizing the window shall not reduce the amount of data displayed on a workstation monitor, and the same aspect ratio shall be monitored as before the resizing. The control section map graphic shall include a user-definable control section map title. North shall either be at the top or right side of the monitor when displaying a control sub-area. Vertical and horizontal scroll bars may be provided if the size of the sub-area is such that it cannot be displayed on a monitor at a scale (as determined by the Engineer) that is adequate for viewing by the operator. Refer to the System Detector Schematic in the Plans for control section boundaries and numbering. There will be a maximum of 30 control section Map displays. Submit a sample of a control section display or map for review by the Engineer.

#### *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 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.)

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- Status mode (transition, free operation, flash, preemption (railroad or emergency vehicle))
- Control mode (manual control, local control, failed, etc.)

The intersection display shall accommodate all OASIS<sup>®</sup> 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.

### (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:

#### *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.

#### *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.

#### *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.

#### *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.).

**C-5558****ITS-237****Guilford County***Implemented Local Manual Control*

Local manual control shall be initiated and controlled by hardware at the intersection. The software shall identify any intersection that is in local manual control by means of a status message. 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.

*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.

*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<sup>®</sup> 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.

*Phase Movements*

The system shall monitor each independent movement of up to sixteen (16) phases, for the quad-ring OASIS<sup>®</sup> controller. This monitoring shall include force off points, and permissive periods for each phase.

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Following each update of the clock on the communications server, the system shall update the clocks in each local controller and the distributed system server.

The system shall be able to receive clock updates from an external time synchronization source. Clock updates shall be demonstrated and approved by the Engineer. The system shall broadcast, unicast, or use a combination of both to send time updates to controllers on a user-configurable schedule. The user shall be able to configure how often the broadcast is performed, the hour at which the broadcast begins, the number of times the broadcast is repeated, and the time period between repeated broadcasts.

The system shall provide a means of monitoring the time drift of clocks on controllers, provided the controller supports this functionality.

For each controller that supports this functionality, the system shall allow checking controller clock times on a user-specified interval.

The system shall display the time the controller's clock was last checked and the difference between that controller clock and the system time reference.

The system shall also provide the ability to automatically synchronize a controller's clock if the time drift exceeds a user-specified threshold.

The system shall provide a means to synchronize controller clocks with the system time reference upon user command.

This functionality shall be provided in addition to the scheduled time broadcasts previously specified.

**(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.

*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 controllers. The set of schedulable events shall include:

- Coordination Plans
- Software Flash
- Free Operation
- Local TOD

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- 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.

#### *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.

#### *Coordination Plan and Scheduler Resolution*

Events in the scheduler (both turn-on and turn-off) shall be adjustable in minimum increments of one minute.

#### *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.

#### *Traffic-Responsive Operation*

In traffic-responsive operation (TRO), the system software implements 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.

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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.

#### **(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



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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.

#### *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).

#### *Upload/Download of Database*

Any workstation shall provide for uploading (copying) the database, and logical segments thereof, from any OASIS<sup>®</sup> local controller. The software shall similarly provide for downloading (copying) the database, and logical segments thereof, to a 2070 controller using OASIS<sup>®</sup> 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.

#### *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. Provide a means to view/locate stored data on file server.

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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 produce pre-configured reports. System report information shall be able to be exported to a XML file with report data, CSV (comma delimited), PDF file, TIFF file or a Microsoft Word file. All reports should show asset ID number, main street, cross street, asset type and prevalent information to the asset.

**The formats (samples) of all pre-configured reports shall be submitted to the Engineer for approval.**

The list of pre-configured reports shall include, but not be limited to, the following:

- System Errors/Alerts
- Communications Status Online/Offline
- System and Local Detector VOS Data
- Device Communications Configuration
- Device Configuration
- Events Log
- Control Section/Links Data
- Scheduler
- Signal Changes
- Signal Detector Events
- Split Monitor
- System Activity
- System Events
- Time Drift
- Upload and Compare
- User Login
- Detector VOS
- Daily
- Hourly
- Multi-date / Hourly
- Multi-date / Daily

Use of third party software for the development of custom reports shall be provided by the Contractor. The software shall interface with the signal system software and its data base to allow the user to create custom reports. The user shall be able to define the format of those

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reports. The system shall also provide a means by which user-specific reports can be created and added to the Reports menu item without the requirement of additional software or custom development work by the software provider.

Training shall be provided on the editing, creation, exporting and general use of pre-configured and custom reports.

**(17) Security**

In addition to the network security features provided by the operating system, the software shall provide customizable levels of access security. Each user must enter a login name and 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:

- ITS Communications Server Setup
- Detectors
- Sections
- ICM Port Configuration
- Scheduler

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- 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

**(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-5558****ITS-245****Guilford County****(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) System Support Software and Devices****(1) Devices**

Furnish one (1) Garmin eTrex Legend GPS Receivers, or approved equivalent, with Cigarette Lighter Adapters (#010-10203-00).

**(2) Productivity Software**

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

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.

**(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. Provide a copy of the utility software on all notebook computers furnished under this project. In addition, provide a copy of the utility software to the Engineer prior to Final Acceptance.

**30.3. INSTALLATION AND INTEGRATION****(A) General**

Install and fully integrate distributed processing signal system software on ITS Application Server called for in "Computer Hardware and Peripherals" section of these Project Special Provisions. Install and fully integrate distributed processing signal system software on each workstation and notebook computers in the High Point traffic signal system.

Install and fully integrate distributed processing signal system software with the ITS Communications Server called for in "Computer Hardware and Peripherals" section of these Project Special Provisions as required.

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

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

Register all software products furnished with this project with the software supplier. The City of High Point and NCDOT shall be identified as the registered owner of all software.

**C-5558****ITS-246****Guilford County****(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.

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. Submit all graphics to the Engineer for approval prior to the System Operational Test and prior to integration in the 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. Integrate system detector locations (based on the actual installation in the field) on all associated system graphics.

Submit specific landmarks and features to be displayed in the section and intersection displays to the Engineer for approval. Develop each screen upon approval of the areas to be displayed by each screen and make revisions as required from review.

Provide training to City and Department personnel relative to the creation and editing of the sub-area and intersection displays as required in these Project Special Provisions.

**(C) Local Controller Software**

Install NCDOT-furnished local controller software on all new controllers. Use the latest version available at the time of installation as directed by the Engineer. Request local controller software from Engineer a minimum of one (1) week prior to use of software during burn-in period.

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

**(D) System Support Software and Devices**

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

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Provide the following tests and demonstration of the system software:

- System Demonstration Test, if required (see below)
- System Operational Test (as called for in “Testing and Acceptance” section)
- 60-Day Observation Period (as called for in the “Testing and Acceptance” section)

**(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 High Point System. All transportation, lodging and per diem costs for NCDOT and City personnel to witness the system demonstration will be borne by NCDOT or the City.

**30.5. 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, 3<sup>rd</sup> party software for reporting, equipment, labor, tools, storage, shipping, and incidentals necessary to install the software, complete system integration, and provide a complete operational system. Partial payment for this item will be made as follows: 50% of the lump sum price upon delivery and installation of the software and 50% of the lump sum price upon successful completion of the Observation Period. No payment will be made for providing software license and source code as required in these Project Special Provisions.

*System support software and devices* shall be measured and paid as a lump sum. This shall include the furnishing, installation, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to install and configure the software and provide a complete operating system. Payment for this item will be made as follows: 100% of the lump sum price upon delivery, installation and testing of the software into the appropriate hardware. GPS receivers

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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 these 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:

<b>Pay Item</b>	<b>Pay Unit</b>
Signal System Software	Lump Sum
System Support Software and Devices	Lump Sum



**C-5558****ITS-249****Guilford County****31. COMPUTER HARDWARE AND PERIPHERALS****31.1. DESCRIPTION**

Furnish and install all materials with the most recently developed and approved product versions that meet or exceed all applicable standards, specifications, and requirements before the system is considered for acceptance. Ensure that all equipment features, functions, and performance measures are met.

Furnish, assemble, fabricate and install new products obtained from the manufacturer or reseller. Provide commercial off-the-shelf materials, equipment, and components.

Furnish and install ITS servers and three computer workstations in the TOC, one in the City Transportation Department conference room, and one workstation in the Signal Shop. Install two laptops in the TOC and two laptops in the Signal Shop for diagnostic work on the signals system. Ensure that all workstation and laptop computers can access the ITS LAN and can be used to monitor, interact, and control all critical input and output parameters of the traffic signal system and ITS devices.

**(A) ITS Servers**

Furnish and install ITS servers in the TOC as described in the Plans and these Project Special Provisions. Furnish and install application servers (one for the signal system and one for the CCTV system) and one communications server in the TOC, install a redundant signal system application server in the Signal Shop. Connect the ITS servers in the TOC to the Ethernet core switch and to a UPS protected outlet. Connect the redundant signal system application server in the Signal Shop to the proposed Ethernet distribution switch and to its UPS.

**(B) Computer Workstations**

Furnish and install computer workstations consisting of a CPU, monitor(s), keyboard, UPS (Conference Room and Signal Shop only) and mouse in the TOC, City Transportation Conference Room, and the Signal Shop.

**(C) Laptop Computers**

Furnish and install laptop computers consisting of the computer, power supply, carrying bag, and mouse for use by City staff in the TOC and the Signal Shop.

**(D) KVM Switch**

Furnish and install a rack-mounted KVM switch assembly consisting of a monitor, keyboard, and mouse with switching hardware to control and access the servers supplied with this project.

**(E) UPS**

Furnish and install uninterruptible power supply (UPS) units for the Ethernet distribution switch in the Signal Shop. Each UPS shall also include any ancillary equipment or incidental items, such as required mounting hardware and cabling.

**(F) Existing Equipment**

Remove existing computer equipment from the TOC, City Transportation Department conference room, and the Signal Shop noted to be removed in the Plans.

**C-5558****ITS-250****Guilford County****31.2. MATERIALS****(A) ITS Servers****(1) Functional**

The ITS servers shall integrate the workstations with other ITS systems and shall enable video and data accessibility and exchange between various systems. The servers shall function in automated fashion in unmanned mode supporting clients' control functions via ASN.1 and/or XML-defined protocols over TCP/IP. Provide the servers capable of operating in the following configurations:

- Single server configuration (environments with n\*10 controlled objects).
- Multiple server configuration (environments with n\*100 controlled objects).
- Thin server configuration (active control of local part in case of larger system).

Provide ITS servers meeting the following functional requirements:

- Handle commands from system clients via ASN.1 and/or XML defined protocol over standard TCP/IP connection.
- Command underlying nodes (devices such as encoders, video servers).
- Report status of system nodes and alarms.
- Monitor system nodes connections.
- Store recent alarms in internal database.
- Receive Simple Network Management Protocol (SNMP) traps generated by network infrastructure, translate SNMP traps as system alarms, and send alarms as SNMP traps.
- Support remote configuration and diagnostics.
- Restore video and connections in case of system component restarts.
- Support protocols: TCP, UDP, NTP and IP Multicast IGMP.

**(2) Performance**

Provide ITS application and backup servers meeting the following minimum requirements:

- Processor: Dual quad core Intel Xeon E5-2640 or better at 2.5 GHz or greater, 15 MB cache processor, Turbo, L2 cache at 1333 MHz,
- Memory: Minimum 8 GB dual-ranked UDIMMS for two processors at 1333 MHz,
- Backplane: 1x6 backplane for 3.5 inch drives, expandable to eight drives,
- Power Supply: Dual, hot plug, redundant power supplies with separate cords,
- Riser: Riser with four PICE x 8 and two PICE x16 slots
- Drive Controller: PERC H710 Integrated RAID with PCIe 512 MB NV cache,
- Hard Drives: RAID 5 with 4 x 300 GB, 15k RPM serial SCSI drives, 6 Gbps, 3.5 inch, Hotplug,
- CD-ROM: DVD +/-RW SATA Drive, internal,
- Video Card: Integrated video chipset controller 8 MB SD RAM with 480 MB/s memory bandwidth and DirectX 5.0,
- Video Adaptor: SGVA,

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- Mounting: Slide ready rails and cable management
- Network: Dual-port Gigabit Network Adaptor with TOE, PCIe-4, and
- Embedded Controller: out of band management,
- Operating System: Microsoft Server 2008, Standard Edition with 5 CALs, and
- Support Software: Microsoft SQL 2008 Release 2 with 10 CALs, Standard Edition.

Provide one ITS communications server meeting the following minimum requirements:

- Processor: Dual quad core Intel Xeon E5-2640 or better at 2.8 GHz or greater, 12 MB cache processor, Turbo, L2 cache at 1333 MHz,
- Memory: Minimum 4 GB, dual ranked UDIMMS for two processors at 1333 MHz,
- Power Supply: Redundant power supplies with separate cords,
- Riser: Riser with two PCIe x 8 and two PCIe x slots
- Drive Controller: Internal PERC H310 RAID with RAID 1 OS, 2x4 connectors, PCIe, 256 MB cache, expandable to eight drives,
- Hard Drives: Raid 5 with 4 x 73 GB, 15k RPM serial attached SCSI drives, 3 Gbps 3.5 inch, Hotplug,
- CD-ROM: DVD +/-RW SATA Drive, internal,
- Video Card: Integrated video chipset controller 8 MB SD RAM including 3D 60 MHz memory, 480 MB/s memory bandwidth and DirectX 5.0,
- Video Adaptor: SGVA,
- Mounting: Slide ready rails and cable management
- Network: Dual-port Gigabit Network Adaptor with TOE, PCIe-4, and
- Embedded Controller: out of band management,
- Operating System: Microsoft Server 2008, Standard Edition and 5 CALs.

**(3) Physical Features**

Provide rack-mounted ITS servers for proposed enclosed 19-inch communications rack located in the TOC and Signal Shop. Provide servers with a maximum size of 2 RUs.

Provide servers meeting the minimum following power requirements:

- Power supply: 110-130 VAC.
- Power consumption: Typical 750W per power supply.

Provide servers meeting the following data port requirements:

- Serial: One standard serial port,
- Audio: Three jacks – channel out, line in, and microphone.
- Ethernet: Dual 1000 Base T Ethernet with RJ-45 connectors as described above and
- USB port: Four USB 2.0 ports.

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Provide servers with at least one direct 10/100 Base T Ethernet LAN interface. The network connector shall be RJ-45 for Category 5e UTP for interfacing with the signal system's Gigabit Ethernet core switch.

**(B) Computer Workstations****(1) Functional**

Provide computer workstations that can operate the signal system software and the video control software over an Ethernet network in the TOC, City Transportation Conference Room, and the Signal Shop.

**(2) Performance**

Provide computer workstations meeting the following requirements:

- Processor: Quad core Intel Xeon E5-2609 v2 processor at 2.5 GHz or greater, 8 MB cache, L2 cache at 1333 MHz,
- Memory: 4 GB RDIMM, 2 x 2 GB DIMMs at 1866 MHz,
- Network: 10/100/1000 Base T Ethernet PCI Express with RJ-45 connector,
- Hard Drive Controller: C1, All SATA drives, non-RAID, six ports (2 -6 Gbps, 2 3 Gbps and 2 optical),
- Hard Drive: 250 GB SATA, 6 Gbp/s, operating at 7200 RPM, 8 MB data burst cache,
- CD-ROM: 16X DVD and 16x DVD+/- RW,
- Keyboard: USB 104-key model,
- Mouse: USB 3-button optical mouse with center scroll,
- Sound: 16-bit integrated high definition audio with external speakers,
- Speakers: Sound bar for use with flat panel monitor,
- Video Card: 1 Gb DDR3 memory, PCIe 2.1 compliant with dual DVI video outputs, maximum digital resolution 2580 x 1600, maximum analog resolution 1920 x 1200, with breakout cables for dual displays,
- Video Output: RGB and DVI connector,
- Desktop Monitor Color: 16.7 million colors,
- Operating System: Windows® 7 Professional, latest version,
- Application software: Enterprise version of Norton antivirus software compatible with City requirements, and DVD burning software, and
- Desktop Monitors: LED, dual 23-inch, digital flat panel display, DVI-D, HDCP Display ports,
  - USB Ports: One USB upstream port and three downstream ports,
  - Resolution: 1,920 x 1,080 dpi,
  - Pixel Pitch: 0.265 mm
  - Viewing Angle: 178 degrees vertically and horizontally
  - Contrast Ratio: 1,000:1 (typical) and 10,000:1 (dynamic)
  - Brightness: 300 cd/m<sup>2</sup>
  - Colors: 16.7 million colors.

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For the workstation in the Signal Shop, use dual video output card to drive the workstation monitor and the existing wall monitor.

### **(3) Physical Features**

Provide computer workstations meeting the minimum power requirements:

- Input voltage: 90-135 V at 50/60 Hz, and
- Output wattage: 825 W.

Provide computer workstations meeting the minimum port requirements:

- Keyboard: One USB connection,
- Mouse: One USB connection,
- Audio: Miniature phono jacks – line out, line in, and microphone,
- Ethernet: 10/100 Base T Ethernet with RJ-45 connector, and
- USB Port: At least 4 rear and 2 front USB 2.0 ports (min. 6 total)

Equip all computer workstations with at least one direct 10/100 Base T Ethernet LAN interface. The network connector shall be RJ-45 for Category 5e or 6 UTP for interfacing with the Ethernet core switch.

## **(C) Laptop Computers**

### **(1) Functional**

Provide laptop computers that can operate the signal system software and the video control software over an Ethernet network in the TOC, the Signal Shop, in a field cabinet and remotely.

### **(2) Performance**

Ensure that the laptop computers meet the following requirements. Ensure that the laptops have the capability to be networked with ITS LAN via an Ethernet cable connection through the Gigabit Ethernet core switch located in the TOC and over the Internet. Configure the laptop computers for connection anywhere in the network to facilitate maintenance and troubleshooting activities.

- Processor: Intel dual core i7 at 2.4 GHz or greater, 2x6MB cache processor, 3M L2 cache at 1066 MHz,
- Memory: 4 GB DDR2-800 SDRAM,
- Network: Integrated 10/100/1000 Base T Ethernet with RJ-45 connector, 802.11g wireless LAN card,
- WiFi Adaptor: 802.11 a/g/n 2X2 mini card
- Hard Drive Controller: C1, All SATA drives, non-RAID,
- Hard Drive: 250 GB SATA operating at 7200 RPM,
- CD-ROM: 8X DVD+/-RW combo drive,
- Keyboard: 104 key model,
- Mouse: USB, 2 three-button optical mice,
- Audio: Miniature phono jacks – line out, line in, and microphone
- Sound: Integrated audio with internal speakers,
- Video Adaptor: 4X AGP with 1 GB GDDR3 memory, 128-bit, 25.6 Gbps memory bandwidth,

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- Internal Monitor: 16.5-inch HD, LED, 1366 x 768,
- Operating System: Windows® 7 Professional, latest version,
- Application software: Enterprise version of Norton antivirus software compatible with City requirements, and DVD burning software, and
- Other Accessories: Two AC adaptors per laptop, spare battery and nylon travel bag.

**(3) Physical Features**

Ensure that the laptop computer operates on an input voltage of 90 to 135 VAC at 50/60 Hz. Provide laptop computers meeting the following minimum port requirements:

- Audio: Three jacks – channel out, line in, and microphone,
- Ethernet: 10/100 Base T Ethernet with RJ-45 connector, and
- USB Port: Two USB 2.0 ports.
- Monitor: LED, anti-glare screen (for outdoor use in sunlight)

Equip the laptop computer with at least one direct 10/100 Base T Ethernet LAN interface. Ensure that the network connector is an RJ-45 for Category 5e UTP to interface with the Ethernet core switch.

**(D) KVM Switch****(1) Functional**

Provide keyboard-video-mouse (KVM) assembly that can access and provide operator interface for at least 10 servers. The KVM switch may have either an integral tilt-up screen or a separate screen.

**(2) Performance**

Provide KVM meeting the following requirements:

- Meets EIA-310C & IEC-3 specifications,
- The KVM assembly shall include KVM switch, keyboard, flat screen display, and associated cabling,
- Port selection by pushbuttons, on-screen display, or hot keys,
- Remotely accessible over the network,
- Active port status LEDs,
- Administrative and user assignable rights,
- IP addressable,
- Compatible with Windows® 7 Professional and Windows® Server 2008,
- Support video resolution up to 1,600 x 1,200 at 75 Hz, and
- Servers: Minimum of six.

**C-5558****ITS-255****Guilford County****(3) Physical Features**

Furnish a KVM switch meeting the following material requirements:

- Monitor: Integrated or separate 17-inch, TFT 1,280 x 1,024, 27 dpi, SGVA, LED, folding rack-mounted, contrast ratio of 350:1, frame rate of 60Hz (typ.), 75Hz (Max),
- Keyboard: 104 key model,
- Mouse: Touch pad,
- KVM switch: Rack-mounted, maximum 2 RU size,
- Cabling: All power, keyboard, mouse and display cabling between each server and the KVM assembly; and mounting brackets, and
- Power Supply: 120 VAC.

**(E) UPS****(1) Functional**

Provide UPS units that produce uninterruptible power and power conditioning for the computer workstations in the City Transportation Conference Room and in the Signal Shop as well as the ITS Server and Ethernet distribution switch in the Signal Shop.

Each UPS shall provide adequate capacity to run its respective workstation and monitor(s) without commercial power for twenty minutes. Provide load calculations for each configuration of equipment connecting to a UPS.

**(2) Performance**

Provide UPS meeting the following performance requirements:

- Output voltage distortion: less than 5 percent,
- Nominal input voltage: 120V,
- Nominal output voltage: 120V,
- Input frequency: 50/60 Hz  $\pm$ 3Hz, auto-sensing,
- Output frequency (sync to mains): 57-63 Hz for 60 Hz nominal frequency,
- Waveform type: Sine wave, and
- Noise filtering: Full time multi-pole noise filtering shall meet 0.3% IEEE surge let-through; zero clamping response time shall meet UL 1449.

Verify that the UPS meets all specifications and is capable of performing all of its functions during and after being subjected to:

- Operating temperature: 0-104° F,
- Operating relative humidity: 95%,
- Storage temperature: 5-113° F, and
- Storage relative humidity: 95%.

**C-5558****ITS-256****Guilford County****(3) Physical Features**

Supply each UPS unit with twenty-five (25) percent spare outlets. Ensure that the UPS meets the following material requirements:

- Floor mounted for all workstations and laptops at all locations
- Sealed AGM type, maintenance free batteries,
- USB interface port,
- Status Lights: power on, power source and overload,
- Alarms: audible and remote notification, and
- Manual power on/off switch.

Supply UPS unit with multi-pole noise filtering. Ensure that the UPS remote monitoring software performs the following functions:

- Data logging,
- Event logging,
- Fault notification,
- Unattended system shutdown,
- Hibernation,
- Operating system shutdown, and
- Power event summary.

**(F) Ethernet Patch Panel**

Furnish a rack-mountable 48-port Ethernet patch panel for installation in the enclosed 19-inch communications rack inside the TOC. Furnish a rack-mountable 12-port Ethernet patch panel for installation in the enclosed 19-inch communications rack in the Signal Shop. Provide patch panels designed for Category 5e cable and that meets TIA/EIA-568-A-5 Category 5e and ISO 11801 Class D standards. All ports shall be RJ-45 eight-wire jacks. Provide all mounting screws and mounting hardware needed to mount the patch panel in a 19-inch equipment rack.

**31.3. CONSTRUCTION REQUIREMENTS****(A) General**

Receive approval for the System Design Report described in these Project Special Provisions before submitting products submittal data, purchasing, installing and configuring the computer and communications hardware at each facility. Implement the plan upon approval.

Integrate all servers, workstations, laptops, and printers on the ITS LAN so all applications will be fully functional. Install the operating system, software and antivirus software to the City of High Point Information Technology (IT) standards.

Furnish all tools, equipment, materials, supplies, and manufactured hardware, and perform all operations and equipment integration necessary to provide a complete, fully operational network. Mount all TOC server equipment as shown in the Plans in enclosed 19" communications racks. Mount all Signal Shop server equipment as shown in the Plans in the 19" communications rack.



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All cabling shall be:

- Neatly tagged with permanent labels at both ends of every cable,
- Secured with wire ties and cable management hardware in the communications racks, and
- Grounded to rack grounding hardware.

Ensure that all project IP addresses are assigned as defined in the System Design Report. Ensure the as-built documentation includes the identification of all IP addresses and VLANs, and associated hardware devices and device locations.

**(B) ITS Servers**

Install the TOC ITS servers in the proposed enclosed 19-inch communications racks located in the TOC as shown in the Plans. Install the Signal Shop ITS server in the 19" communications rack located in the Signal Shop. Install the software packages described in these Project Special Provisions.

Install all software necessary to support the signal system software and to meet all of the data communications requirements described in these Project Special Provisions, including once-per-second polling of all traffic signal controllers.

Connect proposed ITS servers to the respective Ethernet switches. Install Ethernet patch cords between the Ethernet patch panel and the managed Ethernet switch in the TOC. Plug power supplies into outlets on separate circuits. Connect servers to KVM switch. Power up and run diagnostics.

Configure the ITS LAN for remote access through the firewall with remote access software for up to four laptop licenses.

**(C) Computer Workstation**

Install the computer workstations in locations as shown in the Plans. Install the client software packages described in these Project Special Provisions.

Connect the workstations to the ITS LAN by installing Ethernet patch cords between the Ethernet patch panel and the Ethernet core switch in the TOC. Perform the following operational tests for each computer component in accordance with the test plans. After the equipment has been installed, perform the following:

- Connect all components (monitors, mice, keyboards, existing printers, network cables, power supplies),
- Install all software required in these Project Special Provisions,
- Configure network communications,
- Map network drives and existing printers,
- Run diagnostic utilities on the hardware, and
- Print test pages for each workstation on each existing printer to verify printer configuration.

**(D) Laptop Computers**

Install the laptop computers with supporting hardware in the TOC and Signal Shop. Connect the laptops to the ITS LAN through the respective Ethernet switches in those facilities.

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Perform the following operational tests for each computer component in accordance with the test plans. After the equipment has been installed, perform the following:

- Connect all components (monitors, mice, keyboards, existing printers, network cables, power supplies),
- Install all software required in these Project Special Provisions,
- Configure network communications,
- Map network drives and existing printers,
- Run diagnostic utilities on the hardware, and
- Print test pages for each laptop on the existing printers to verify printer configuration.

**(E) KVM Switch**

Install the KVM assembly in the enclosed 19-inch communications rack with the ITS servers in the TOC. After the KVM assembly has been installed, perform the following operational tests on the KVM assembly in accordance with the test plans:

- Connect all existing and proposed servers, monitors, keyboards, mice, and power supplies,
- Program the on-screen display to assign ports and bank numbers and to enter the names of each server in the menu,
- Program the KVM switch for scan features and access privileges, and
- Select each server and ensure the mouse and keyboard work the selected server and the monitor displays the appropriate server.

**(F) UPS**

Install UPS units in the Transportation Conference Room and the Signal Shop as close as possible to their respective equipment. Connect the UPS unit to a power outlet. Connect the UPS monitoring port to a USB port on its respective workstation.

Install the UPS monitoring software on the workstations in the Transportation Conference Room and the Signal Shop for remote monitoring of the respective UPS units. Configure the remote monitoring to send email alerts. Run the UPS diagnostics.

**(G) Ethernet Patch Panel**

Mount the 48-port Ethernet patch panel in the enclosed communications rack inside the TOC and the 12-port Ethernet patch panel in the enclosed communications rack in the Signal Shop as shown in the Plans. Terminate the Ethernet cables from the respective racks on the punch down block. Follow manufacturer's installation instructions for cable termination and panel assembly. Install Ethernet patch cables between the patch panel and the respective Ethernet switches.

**(H) Existing Equipment**

Reuse the existing printers in the TOC and Signal Shop. Remove all existing servers, computers, monitors, and associated support equipment designated to be removed in the Plans and these Project Special Provisions. Deliver all servers, workstations and flat screen monitors to the City. Dispose of all other equipment.

**C-5558****ITS-259****Guilford County****31.4. DOCUMENTATION**

Furnish the Department and the City two copies of the following materials prior to acceptance: installation, operation, training and troubleshooting manuals, wiring diagrams, including cable pinouts, parts lists, warranty materials, and serial and model numbers of all equipment furnished. Furnish all software and operating system on CD or DVD with original license information registered to the City of High Point.

**31.5. WARRANTY**

Provide a minimum of three-year manufacturer's warranty to guarantee the materials supplied are free of defects and workmanship. The manufacturer's warranty period starts upon the date of final acceptance.

**31.6. MEASUREMENT AND PAYMENT**

*ITS server* will be measured and paid as the actual number of ITS servers furnished, installed, and accepted.

*Computer workstation* will be measured and paid as the actual number of computer workstations with monitor(s), keyboard, UPS, mouse, operating system, and software furnished, installed, and accepted.

*Laptop computer* will be measured and paid as the actual number of laptop computers with external monitors, keyboard, mouse, AC adaptors, spare battery, nylon travel bag, operating system, and software furnished, installed, and accepted.

*KVM switch* will be measured and paid as the actual number of KVM switches furnished, installed, and accepted. If a separate LED monitor is provided, then no separate measurement and payment will be made for the monitor.

No separate measurement will be made for coaxial cables, communication cables, electrical cables, mounting hardware, nuts, bolts, brackets, connectors, risers, grounding equipment, or surge suppression, as these will be considered incidental to the pay items for ITS server, laptop and workstation computer, and KVM switch.

No separate measurement will be made for the Ethernet patch panels as these will be considered incidental to the pay items Ethernet cable.

No separate measurement will be made for UPS units supplied with each workstation. The UPS units for workstation computers will be considered incidental to the pay items for workstation and laptop computers.

No measurement and payment will be made for removal of existing computer hardware and peripherals and existing communications hardware in the TOC and the Signal Shop as such work will be considered incidental to furnishing and installing computer hardware and peripherals and communications hardware at those locations.

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Payment will be made under:

**Pay Item**

ITS Server

Computer Workstation

Laptop Computer

KVM Switch

**Pay Unit**

Each

Each

Each

Each

## 32. COMMUNICATIONS HARDWARE

### 32.1. DESCRIPTION

Furnish and install all equipment described below for a fully functional Gigabit Ethernet network for communication to the signal system and CCTV.

#### (A) Ethernet Core Switch

Furnish and install a central Layer 3 managed Gigabit Ethernet core switch along with a Category 5e/6 patch panel for the TOC. Ensure that the managed Ethernet core switch provides Gigabit Ethernet connectivity at transmission rates of 1000 megabits per second (Mbps), and is expandable to 10 Gigabits per second (Gbps).

#### (B) Ethernet Distribution Switch

Furnish and install a Layer 3 Ethernet distribution switch for use in the Signal Shop. Ensure that the Ethernet distribution switch provides wire-speed, Ethernet connectivity at transmission rates of 1000 megabits per second to/from each device on the switch to the Ethernet core switch, and is expandable to 10 Gigabits per second (Gbps).

#### (C) Ethernet Edge Switch

Furnish and install a hardened, field Ethernet edge switch (hereafter “edge switch”) for field devices. Ensure that the edge switch provides wire-speed, Ethernet connectivity at each ITS device location to the Ethernet core switch.

#### (D) Firewall

Furnish and install firewall appliances in the TOC to provide network security from Internet-based traffic, as well as to provide an IPsec Virtual Private Network (VPN) connectivity.

#### (E) Network Management Software

For the communications network, utilize network management software (NMS) for configuration, troubleshooting, security, and system monitoring. The software shall be furnished and installed by the Contractor from the same manufacturer as the Ethernet core, Ethernet distribution, and Ethernet edge switches. The Contractor shall perform the initial system integration of all core and edge switches installed on the project.

Install the network management software on all relevant communications hardware, including workstations, laptops and servers, as recommended by the manufacturer’s instructions. Ensure that the network management software is compatible with all elements of the network, including the Ethernet switches, workstations, laptops, and servers. Ensure the system meets the minimum technical requirements and is capable of handling expansion within the ITS network. Ensure that the software manages third party switches and hardware via Simple Network Management Protocol (SNMP) v1 or v3.

Provide system that has a graphical user interface (GUI) for the operator and shall graphically depict the equipment and maintenance/operational status using a graphical map of the system. Include setup and diagnostic utility software for both the server and client computers (licenses to be provided by the Contractor). Ensure that the system is interoperable with all end-to-end communications elements (video encoder, Ethernet switches, and video decoder) that connect each CCTV camera to analog and digital video monitors.

**C-5558****ITS-262****Guilford County****(F) Uninterruptible Power Supply (UPS)**

The Ethernet switches, servers and selected workstations and laptops in the TOC will utilize the existing UPS. Furnish and install a new rack mounted UPS in the Signal Shop to serve the Ethernet distribution switch in the Signal Shop and ITS server.

Each UPS shall also include any ancillary equipment or incidental items, such as required mounting hardware and cabling. Furnish and install monitoring software to provide email alerts.

Furnish all materials with the most recently developed and approved product versions that meet or exceed all applicable standards, specifications, and requirements before the system is considered for acceptance. Size the UPS to provide at least 20 minutes of UPS power. Provide the UPS a 25% reserve of receptacles. Provide load calculations for each configuration of equipment connecting to a UPS.

**32.2. MATERIALS****(A) General**

Ensure that the Ethernet switches are fully compatible and interoperable with the trunk Ethernet network interface and that the Ethernet switches support half and full duplex Ethernet communications.

Furnish Ethernet switches that provide 99.999% error-free operation, and that comply with the Electronic Industries Alliance (EIA) Ethernet data communication requirements using single-mode fiber-optic transmission medium and copper transmission medium. Ensure that the Ethernet switches have a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

Provide all SMFO jumpers required to connect the Ethernet core switch, Ethernet distribution switch, and Ethernet edge switches with the connector panels of fiber-optic splice centers. Except for traffic signals on Skeet Club Road installed under STIP Project U-3615B, provide SMFO jumpers with factory-assembled LC connectors on one end (i.e., the fiber-optic interconnect center/connector housing end) and, on the other end, factory-assembled connectors of the same type provided on the managed Ethernet core switch, Ethernet distribution switch and Ethernet edge switch. For the existing U-3615B traffic signals along Skeet Club Road where the existing interconnect centers with ST connectors are being retained, provide SMFO jumpers with factory-assembled ST connectors one end (i.e., the fiber-optic interconnect center end) and, on the other end, factory-assembled connectors of the same type provided on the Ethernet edge switch.

Provide SMFO jumpers that are a minimum of 3 feet in length for Ethernet switches inside controller cabinets, CCTV cabinets, the TOC and the Signal Shop. Furnish SMFO jumpers that are a minimum of 6 feet in length for the communications racks inside the TOC. Ensure SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

**C-5558****ITS-263****Guilford County****(B) Ethernet Core Switch****(1) Standards**

Provide an Ethernet core switch that complies with the following IEEE networking standards for Ethernet communications:

- IEEE 802.1D Spanning Tree Protocol (STP),
- IEEE 802.1P Quality of Service (QoS),
- IEEE 802.1Q Virtual Local Area Networks (VLAN Tagging),
- IEEE 802.1S Multiple Spanning Tree Protocol (MSTP),
- IEEE 802.1X Port-Based Network Access Control,
- IEEE 802.1W Rapid Spanning Tree Protocol (RSTP),
- IEEE 802.3X Flow Control,
- IEEE 802.3Z Standards Compliant 1000 Base-SX and 1000 Base-LX optics,
- IEEE 802.3ad Link Aggregation,
- RFC 821 – Simple Mail Transfer Protocol (SMTP),
- RFC 854 – Telnet Protocol Specification,
- RFC 1112 – IGMP v1,
- RFC 2131 – Dynamic Host Configuration Protocol for IPv4,
- RFC 2236 – IGMP v2,
- RFC 3315 – Dynamic Host Configuration Protocol for IPv6 (DHCPv6),
- RFC 3376 – IGMP v3,
- RFC 2362 – Protocol Independent Multicast Sparse Mode (PIM-SM),
- RFC 3973 – Protocol Independent Multicast Dense Mode (PIM-DM),
- RFC 2328 – Open Shortest Path First (OSPF) v2,
- RFC 2338 – Virtual Router Redundancy Protocol (VRRP),
- RFC 2570:2575 – SNMP v3,
- RFC 2030 – Simple Network Time Protocol (SNTP), and
- RFC 2267 – Denial of Service (DoS).

Ensure that the Ethernet core switch has a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

Ensure that the Ethernet core switch has a limited lifetime hardware warranty.

**(2) Functional**

Provide an Ethernet core switch that is comprised of multiple stackable switches that form a single virtual chassis. The virtual chassis shall be managed as a single network device. The Ethernet core switch shall have a minimum of **five (5)** switches in the initial virtual chassis, however additional switches may be required to meet the port requirements indicated in the Plans. The Ethernet core switch shall have a minimum of two dedicated virtual chassis (stacking) ports providing a minimum 128 Gbps switching capacity across the virtual backplane. Ensure the Ethernet core switch complies with the EIA's Ethernet data communication requirements using a single-mode fiber-optic transmission media; and Category 5e copper transmission media.

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Provide a stackable-type design with the capability to expand the stack to a minimum of eight (8) units in a single logical device (virtual chassis) that meets the following minimum requirements:

*Power:*

- Redundant power supplies, either on a per-switch basis or as a shared resource for each switch in the stack,
- Hot swappable while running without opening the chassis without interrupting the operation,
- Autosensing and autoswitching, and
- 110 VAC single phase power source.

*I/O:*

- A minimum of five (5) switches shall be provided in a full stacking configuration with additional switches provided as needed to meet the required number of optical and copper ports indicated in the plans.
- Each virtual chassis shall contain:
  - A minimum of twenty-four (24) ports per switch,
  - A minimum of three (3) switches with a total of sixty (60) fiber-optic 100/1000 Base-X optical ports at full wire speed.
  - A minimum of two switches each with twenty-four (24) 10/100/1000 Base-T ports at full wire speed.
- Ethernet single mode fiber-optic ports shall support Standard (10 km) and Long Haul (70+ km) optics.

*High Availability (HA) Features:*

- Redundant, hot swappable power supplies
- Ability for each switch in the stack to serve as the master (1:N availability)
- Cross module link aggregation

*Security Features:*

- IEEE 802.1X – RADIUS Authentication,
- TACACS+,
- Secure Shell (SSH v2),
- Access Control List (ACL), and
- Denial of Service (DoS) Protection.

**Optical Ports:** Ensure that all single mode fiber-optic link ports operate at 1310 or 1550 nanometers. Provide fully-functional ports with Type LC connectors and the optics for the optical ports as specified in the Plans or by the Engineer. Do not use mechanical transfer registered jack (MTRJ) or ST type connectors. At a minimum, the core Ethernet switch shall be equipped with sixty (60) fully functional single mode 1 Gbps fiber-optic SFP transceivers, but additional SFPs may be required to meet the total port requirements in the Plans. Provide small form-factor plug-able (SFP) optics with 10 km, 20 km, 40km, 70 km, or 120 km optics as required to meet the distance requirement as indicated in the Plans.



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Provide 1 Gbps optical transceivers as specified in the Plans or by the Engineer. Each transceiver consists of fiber pairs; one fiber will transmit (TX) data and one fiber will receive (RX) data. Provide optical transceivers that meet the following minimum requirements:

- Optical receiver sensitivity: -20 dBm,
- Optical transmitter power: 9.5 to -3 dBm,
- Estimated transmission distance: 20 km,
- Operating wavelength: 1310 nm, and
- Operating temperature: -40 to 185 degrees F.

*Copper Ports:* Provide 48 fully functional copper ports installed in the Ethernet core switch virtual chassis. Provide copper ports that are Type RJ-45 and that auto-negotiate speed (i.e., 10/100/1000 Base) and duplex (i.e., full or half). Ensure that all 10/100/1000 Base TX ports meet the specifications detailed in this section and are compliant with the IEEE 802.3 standard pinouts. Ensure that all Category 5e unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-A standard.

Ensure that the Ethernet core switch (10/100/1000 Mbps ports) supports jumbo frames and full Layer 3 routing. Ensure that the switch includes support for dynamic unicast routing protocols such as RIPv1/v2 and OSPF, and support for multicast routing protocols, including PIM-SM, PIM-DM, and DVMRP.

*Port Security:* Supply an Ethernet core switch that supports/complies with the following (remotely) minimum requirements:

- Ability to configure static MAC addresses,
- Ability to disable automatic address learning per port, known hereafter as Secure Port. Secure Ports only forward data for pre-defined / learned MAC addresses, and
- Trap and alarm upon any unauthorized MAC address and shutdown for programmable duration. Port shutdown requires administrator to manually reset the port before communications are allowed.

### **(3) Physical Features**

*Physical:* Provide an Ethernet core switch that is rack mountable into a standard 19-inch EIA rack and not exceed 10 RU in height. Provide all mounting kits, brackets, and hardware for mounting into a standard 19-inch rack.

*Chassis Fan Assembly:* Equip the managed Ethernet core switch with at least one cooling fan assembly per power supply to cool the CPU, main memory, and voltage regulators. Ensure that the fan has sufficient capacity and airflow to cool the switch.

### **(4) Electrical Specifications**

Ensure that the Ethernet core switch operates and power is supplied with 115 volts of alternating current (VAC) at 60 Hz input frequency. Ensure that the Ethernet core switch has a minimum operating input of 110 VAC and a maximum operating input of 130 VAC. Ensure that if the device requires operating voltages other than 120 VAC, supply the required voltage converter. Ensure that the maximum power consumption does not exceed 350 watts per switch for the Ethernet core switch. Ensure that the managed Ethernet core switch and GBICs have diagnostic light emitting diodes (LEDs), including link, TX, RX, speed (for Category 5e ports only), and power LEDs.

**C-5558****ITS-266****Guilford County****(5) Performance Requirements**

Ensure that the Ethernet core switch includes management capabilities, as defined in the following:

- Have a non-blocking architecture,
- Route and switch unicast and multicast traffic simultaneously at wire speed,
- Support fully redundant load sharing and hot swappable power supplies (N+1 support),
- Minimum 88 Gbps switching capacity per switch
- Minimum throughput: 65 Mbps per switch
- Minimum 128 Gbps switching capacity via stacking port
- Minimum 10k unicast routes in hardware
- Minimum 2k multicast routes in hardware

**(6) Management Capabilities**

Ensure that the Ethernet core switch includes management capabilities, as defined in the following:

- Incorporate an internal temperature sensor capable of sending system log and/or SNMP traps should the switch exceed a specified warning level,
- Support automatic powering off should the temperature exceed a specified level to prevent damage to the switch,
- Support port mirroring and monitoring to aid in troubleshooting,
- Be capable of utilizing the following standard protocols:
  - Support VLAN (IEEE 802.1Q),
  - Support Multiple Spanning Tree Protocol (IEEE 802.1Q-2005),
  - Support Rapid Spanning Tree Protocol (IEEE 802.1W),
  - Support IGMP Versions 1 and 2 (RFC 1112 and 2236),
  - Support RIP Versions 1 and 2 (RFC 1058 and 1723),
  - Support OSPF Version 2 (RFC 1583 and 2328),
  - Support PIM (SM & DM),
  - Support IGMP Version 1 and 2 (RFC 1112 and 2236),
  - Support DVMRP,
  - Support VRRP (RFC 2338),
  - Support ToS/DSCP mapping to priority queue,
  - Support QoS queue management using weighted round robin (WRR) and strict priority (SP),
  - Support 10/100/1000 BaseTX ports (RJ-45),
  - Support a minimum of (2) 10-Gigabit Ethernet ports per switch,
  - Support Flow Control (IEEE 802.3x),
  - Support Gigabit Ethernet (IEEE 802.3z),
  - Support SNMP Version 1 and 3,
  - Support 4 groups of RMON-I (Groups 1-3, 9),
  - Be managed through console (RS-232), telnet, and Web interface, and

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- Support download and upload of images and configurations via Trivial File Transfer Protocol (TFTP).

Ensure that the Ethernet core switch fully supports all Layer 2 and Layer 3 management features related to multicast data transmission and routing, including, but not be limited to:

- An STP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1 D standards.
- An RSTP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1w standard.
- A core switch that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard.
- A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second.
- Support of Traffic Class Expediting and Dynamic Multicast Filtering.
- Support of, at a minimum, Version 2 of the Internet Group Management Protocol (IGMP).
- Support of remote and local setup and management via telnet, Secure Shell (SSHv2) or secure Web-based GUI and command line interfaces.
- Support of the SNMP protocol.
- Verify that the Ethernet core switch can be accessed using the resident EIA-232 management port, a telecommunication network, or the TFTP.
- Port security through controlling access by the users. Ensure that the Ethernet core switch has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network.
- Support of the TFTP and the SNMP. Ensure that the Ethernet core switch supports port mirroring for troubleshooting purposes when combined with a network analyzer.

#### **(7) Environmental Specifications**

Supply an Ethernet core switch that adheres to the following environmental constraints:

- Operating Temperature Range: 32° F to 104° F,
- Storage Temperature Range: 14° F to 158° F, and
- Operating Relative Humidity Range: 10% to 95%, noncondensing.

### **(C) Ethernet Distribution Switch**

#### **(1) Standards**

Ensure that the Ethernet distribution switch complies with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

- IEEE 802.1D Spanning Tree Protocol (STP),
- IEEE 802.1P Quality of Service (QoS),
- IEEE 802.1Q Virtual Local Area Networks (VLAN Tagging),
- IEEE 802.1Q-2005 Multiple Spanning Tree Protocol (MSTP),
- IEEE 802.1X Port-Based Network Access Control,
- IEEE 802.1W Rapid Spanning Tree Protocol (RSTP),
- IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX,

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- IEEE 802.3X Flow Control,
- IEEE 802.3Z Standards Compliant 1000 Base-SX and 1000 Base-LX optics,
- IEEE 802.3ad Link Aggregation,
- RFC 821 – Simple Mail Transfer Protocol (SMTP),
- RFC 854 – Telnet Protocol Specification,
- RFC 1112 – IGMP v1,
- RFC 2131 – Dynamic Host Configuration Protocol for IPv4,
- RFC 2236 – IGMP v2,
- RFC 3315 – Dynamic Host Configuration Protocol for IPv6 (DHCPv6),
- RFC 3376 – IGMP v3,
- RFC 2362 – Protocol Independent Multicast Sparse Mode (PIM-SM),
- RFC 3973 – Protocol Independent Multicast Dense Mode (PIM-DM),
- RFC 2328 – Open Shortest Path First (OSPF) v2,
- RFC 2338 – Virtual Router Redundancy Protocol (VRRP),
- RFC 2570:2575 – SNMP v3,
- RFC 2030 – Simple Network Time Protocol (SNTP), and
- RFC 2267 – Denial of Service (DoS).

Ensure that the Ethernet distribution switch has a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

Ensure that the Ethernet distribution switch has a limited lifetime hardware warranty.

## (2) Functional

Provide an Ethernet distribution switch that is from the same vendor and product line as the Ethernet core switch. The Ethernet distribution switch will not require a virtual chassis configuration during initial deployment, but will require the virtual chassis capability for future expansion. The Ethernet distribution switch shall have a **minimum of two (2)** dedicated virtual chassis (stacking) ports providing a minimum 128 Gbps switching capacity across the virtual backplane. Ensure the Ethernet distribution switch complies with the EIA's Ethernet data communication requirements using a single-mode fiber-optic transmission media; and Category 5e copper transmission media.

Provide a stackable-type design with the capability to expand the stack to a minimum of four (4) units in a single logical device (virtual chassis) that meets the following minimum requirements:

### *Power:*

- Redundant power supplies, either on a per-switch basis or as a shared resource for each switch in the stack,
- Hot swappable while running without opening the chassis without interrupting the operation,
- Autosensing and autoswitching, and
- 110 VAC single phase power source.

### *I/O:*

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- A minimum of twenty-four (24) 100/1000 Base-X optical ports at full wire speed,
- A minimum of four (4) 100/1000 Base-X optical ports at full wire speed,
- Expansion capability to support a minimum of two (2) 10 Gbps uplink ports,
- Ethernet single mode fiber-optic ports shall support Standard (10 km) and Long Haul (70+ km) optics.

*Network Security:* Provide Ethernet distribution switches that support/comply with the following (remotely) minimum network security requirements:

- Multi-level user passwords,
- RADIUS centralized password management (IEEE 802.1X),
- TACACS+,
- Secure Shell (SSH v2),
- Access Control List (ACL),
- Denial of Service (DoS) Protection
- SNMPv3 encrypted authentication and access security,
- Port security through controlling access by the users: ensure that the Ethernet distribution switch has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network,
- Support of remote monitoring (RMON) of the Ethernet agent, and
- Support of the TFTP and SNTP. Ensure that the Ethernet distribution switch supports port mirroring for troubleshooting purposes when combined with a network analyzer.

*Optical Ports:* Ensure that all single mode fiber-optic link ports operate at 1310 or 1550 nanometers. Provide fully-functional ports with Type LC connectors and the optics for the optical ports as specified in the Plans or by the Engineer. Do not use mechanical transfer registered jack (MTRJ) or ST type connectors. At a minimum, the Ethernet distribution switch shall be equipped with two fully functional single mode 1 Gbps fiber-optic SFP transceivers, but additional SFPs may be required to meet the port requirements in the Plans. Provide small form-factor plug-able (SFP) optics with 10 km, 20 km, 40 km, 70km, or 120 km optics.

Provide 1 Gbps optical transceivers as specified in the Plans or by the Engineer. Each transceiver consists of fiber pairs; one fiber will transmit (TX) data and one fiber will receive (RX) data. Provide optical transceivers that meet the following minimum requirements:

- Optical receiver sensitivity: -20 dBm,
- Optical transmitter power: 9.5 to -3 dBm,
- Estimated transmission distance: 20 km,
- Operating wavelength: 1310 nm, and
- Operating temperature: -40 to 185 degrees F.

*Copper Ports:* Provide 20 fully functional copper ports installed in the Ethernet distribution switch. Provide copper ports that are Type RJ-45 and that auto-negotiate speed (i.e., 10/100/1000 Base) and duplex (i.e., full or half). Ensure that all 10/100/1000 Base T ports meet the specifications detailed in this section and are compliant with the IEEE 802.3 standard pinouts. Ensure that all Category 5e unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-A standard.

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Ensure that the Ethernet distribution switch (10/100/1000 Mbps ports) supports jumbo frames and full Layer 3 routing. Ensure that the switch includes support for dynamic unicast routing protocols such as RIPv1/v2 and OSPF, and support for multicast routing protocols, including PIM-SM, PIM-DM, and DVMRP.

*Port Security:* Supply an Ethernet distribution switch that supports/complies with the following (remotely) minimum requirements:

- Ability to configure static MAC addresses,
- Ability to disable automatic address learning per port, known hereafter as Secure Port. Secure Ports only forward data for pre-defined / learned MAC addresses, and
- Trap and alarm upon any unauthorized MAC address and shutdown for programmable duration. Port shutdown requires administrator to manually reset the port before communications are allowed.

### **(3) Physical Features**

*Mounting:* Provide a 19” rack mount Ethernet distribution switch that does not exceed a height of 2 RU. Provide all mounting kits, brackets, and hardware for mounting into a standard 19-inch rack.

*Chassis Fan Assembly:* Equip the managed Ethernet distribution switch with at least one cooling fan assembly per power supply to cool the CPU, main memory, and voltage regulators. Ensure that the fan has sufficient capacity and airflow to cool the switch.

### **(4) Electrical Specifications**

Ensure that the Ethernet distribution switches have redundant power supplies and operate and power is supplied with 115 VAC. Ensure that the edge switch has a minimum operating input of 110 AC and a maximum operating input of 130 VAC. Ensure that if the device requires operating voltages other than 120 VAC, supply the required voltage converter. Ensure that the maximum power consumption does not exceed 350 watts.

Ensure that the Ethernet distribution switch has diagnostic light emitting diodes (LEDs), including link, port activity, duplex mode, speed (for Category 5e ports only), and power LEDs.

### **(5) Performance Requirements**

Ensure that the Ethernet distribution switch meets or exceeds the following performance requirements:

- Have a non-blocking architecture,
- Route and switch unicast and multicast traffic simultaneously at wire speed,
- Support fully redundant load sharing and hot swappable power supplies (N+1 support),
- Minimum 88 Gbps switching capacity per switch
- Minimum throughput: 65 Mbps per switch
- Minimum 128 Gbps switching capacity via stacking port
- Minimum 10k unicast routes in hardware
- Minimum 2k multicast routes in hardware

**(6) Management Capabilities**

Ensure that the Ethernet distribution switch includes management capabilities, as defined in the following:

- Incorporate an internal temperature sensor capable of sending system log and/or SNMP traps should the switch exceed a specified warning level,
- Support automatic powering off should the temperature exceed a specified level to prevent damage to the switch,
- Support port mirroring and monitoring to aid in troubleshooting,
- Be capable of utilizing the following standard protocols:
  - Support VLAN (IEEE 802.1Q),
  - Support Multiple Spanning Tree Protocol (IEEE 802.1Q-2005)
  - Support Rapid Spanning Tree Protocol (IEEE 802.1W),
  - Support IGMP Versions 1 and 2 (RFC 1112 and 2236),
  - Support RIP Versions 1 and 2 (RFC 1058 and 1723),
  - Support OSPF Version 2 (RFC 1583 and 2328),
  - Support PIM (SM & DM),
  - Support IGMP Version 1 and 2 (RFC 1112 and 2236),
  - Support DVMRP,
  - Support VRRP (RFC 2338),
  - Support ToS/DSCP mapping to priority queue,
  - Support QoS queue management using weighted round robin (WRR) and strict priority (SP),
  - Support 10/100/1000 BaseTX ports (RJ-45),
  - Support a minimum of (2) 10-Gigabit Ethernet ports per switch,
  - Support Flow Control (IEEE 802.3x),
  - Support Gigabit Ethernet (IEEE 802.3z),
  - Support SNMP Version 1 and 3,
  - Support 4 groups of RMON-I (Groups 1-3, 9),
  - Be managed through console (RS-232), telnet, and Web interface, and
  - Support download and upload of images and configurations via Trivial File Transfer Protocol (TFTP).

Ensure that the Ethernet distribution switch fully supports all Layer 2 and Layer 3 management features related to multicast data transmission and routing, including, but not be limited to:

- An STP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1 D standards.
- An RSTP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1w standard.
- An Ethernet distribution switch that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard.

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- A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second.
- Support of Traffic Class Expediting and Dynamic Multicast Filtering.
- Support of, at a minimum, Version 2 of the Internet Group Management Protocol (IGMP).
- Support of remote and local setup and management via telnet, Secure Shell (SSHv2), or secure Web-based GUI and command line interfaces.
- Support of the SNMP protocol.
- Verify that the Ethernet distribution switch can be accessed using the resident EIA-232 management port, a telecommunication network, or the TFTP.
- Port security through controlling access by the users. Ensure that the Ethernet distribution switch has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network.
- Support of the TFTP and the SNMP. Ensure that the Ethernet distribution switch supports port mirroring for troubleshooting purposes when combined with a network analyzer.

### **(7) Environmental Specifications**

Provide managed Ethernet switches that adhere to the following environmental constraints if located within a climate-controlled environment:

- Operating temperature range: -40°F to 130°F,
- Storage temperature range: -40°F to 185°F, and
- Operating relative humidity range: 5% to 90%, non-condensing.

### **(D) Ethernet Edge Switch**

#### **(1) Standards**

Ensure that the Ethernet edge switches comply with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

- IEEE 802.1D standard for media access control (MAC) bridges used with the Spanning Tree Protocol (STP),
- IEEE 802.1P standard for Quality of Service (QoS),
- IEEE 802.1Q standard for port-based virtual local area networks (VLANs),
- IEEE 802.1Q-2005 standard for MAC bridges used with the Multiple Spanning Tree Protocol,
- IEEE 802.1w standard for MAC bridges used with the Rapid Spanning Tree Protocol (RSTP),
- IEEE 802.1x standard for port based network access control, including RADIUS,
- IEEE 802.3 standard for local area network (LAN) and metropolitan area network (MAN) access and physical layer specifications,
- IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX,
- IEEE 802.3x standard regarding flow control with full duplex operation, and
- RFC 783 – TFTP
- RFC 854 – Telnet Protocol Specification,
- RFC 1112 – IGMP v1,



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- RFC 1541 – Dynamic Host Configuration Protocol for IPv4,
- RFC 2030 – SNMP
- RFC 2068 – HTTP
- RFC 2236 – IGMP v2,
- RFC 2865 – RADIUS
- RFC 3414 – SNMPv3-USM
- RFC 3415 – SNMPv3-VACM.

Ensure that the Ethernet edge switches have a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

**(2) Functional**

Ensure that the Ethernet edge switches support all Layer 2 management features and certain Layer 3 features related to multicast data transmission. These features shall include, but not be limited to:

- An STP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1D standard,
- An RSTP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1w standard,
- An Ethernet edge switch that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard, and has a minimum 4-kilobit VLAN address table (254 simultaneous),
- A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second,
- A minimum 4-kilobit MAC address table,
- Support of Traffic Class Expediting and Dynamic Multicast Filtering,
- Support of, at a minimum, snooping of Version 2 of the Internet Group Management Protocol (IGMP),
- Support of remote and local setup and management via telnet or secure Web-based GUI and command line interfaces,
- Support of the Simple Network Management Protocol version 3 (SNMPv3). Verify that the Ethernet edge switch can be accessed using the resident EIA-232 management port, a telecommunication network, or the Trivial File Transfer Protocol (TFTP),
- Port security through controlling access by the users. Ensure that the Ethernet edge switch has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network,
- Support of the TFTP and SNMP. Ensure that the Ethernet edge switch supports port mirroring for troubleshooting purposes when combined with a network analyzer.

**(3) Physical Features**

*Mounting:* Provide mounting kit to attach the Ethernet edge switch to a DIN rail in the cabinet. Supply the DIN rail with the Ethernet edge switch.

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*Ports:* Provide 10/100 Mbps auto-negotiating ports (RJ-45) copper Ethernet ports for all Ethernet edge switches. Provide auto-negotiation circuitry that will automatically negotiate the highest possible data rate and duplex operation possible with attached devices supporting the IEEE 802.3 Clause 28 auto-negotiation standard.

*Optical Ports:* Ensure that all fiber-optic link ports operate at 1310 or 1550 nanometers in single mode. Provide fully-functional ports with Type LC connectors and the optics for the optical ports. Do not use mechanical transfer registered jack (MTRJ) or ST type connectors.

Provide Ethernet edge switches having a minimum of two optical 100 Base FX ports capable of transmitting data at 100 megabits per second. Ensure that each optical port consists of a pair of fibers, one fiber will transmit (TX) data and one fiber will receive (RX) data.

Provide 10/100 Mbps optical ports that consist of fiber pairs, one fiber will transmit (TX) data and one fiber will receive (RX) data. Provide optical ports that meet the following minimum requirements:

- Optical receiver sensitivity: -32 dBm,
- Optical transmitter power: -15.5 dBm,
- Typical transmission distance: 20 km, and
- Operating wavelength: 1310 nm.

*Copper Ports:* Provide Ethernet edge switches that include a minimum of six copper ports. Provide Type RJ-45 copper ports and that auto-negotiate speed (i.e., 10/100 Base) and duplex (i.e., full or half). Ensure that all 10/100 Base TX ports meet the specifications detailed in this section and are compliant with the IEEE 802.3 standard pinouts. Ensure that all Category 5e unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-B standard.

*Port Security:* Ensure that the Ethernet edge switches support/comply with the following (remotely) minimum requirements:

- Ability to configure static MAC addresses,
- Ability to disable automatic address learning per ports, known hereafter as Secure Port. Secure Ports only forward, and
- Trap and alarm upon any unauthorized MAC address and shutdown for programmable duration. Port shutdown requires administrator to manually reset the port before communications are allowed.

*Network Capabilities:* Provide Ethernet edge switches that support/comply with the following minimum requirements:

- Provide full implementation of IGMPv2 snooping (RFC 2236),
- Provide full implementation of SNMPv1, SNMPv2c, and/or SNMPv3,
- Capable of mirroring any port to any other port within the switch,
- Meet the IEEE 802.1Q (VLAN) standard per port for up to four VLANs,
- Meet the IEEE 802.3ad (Port Trunking) standard for a minimum of two groups of four ports,
- Telnet/CLI,
- HTTP (Embedded Web Server) with Secure Sockets Layer (SSL), and
- Full implementation of RFC 783 (TFTP) to allow remote firmware upgrades.

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*Network Security:* Provide Ethernet edge switches that support/comply with the following (remotely) minimum network security requirements:

- Multi-level user passwords,
- RADIUS centralized password management (IEEE 802.1X),
- SNMPv3 encrypted authentication and access security,
- Port security through controlling access by the users: ensure that the Ethernet edge switch has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network,
- Support of remote monitoring (RMON) of the Ethernet agent, and
- Support of the TFTP and SNTP. Ensure that the Ethernet edge switch supports port mirroring for troubleshooting purposes when combined with a network analyzer.

#### **(4) Electrical Specifications**

Ensure that the Ethernet edge switches operate and power is supplied with 115 current VAC. Ensure that the Ethernet edge switches have a minimum operating input of 110 VAC and a maximum operating input of 130 VAC. Ensure that if the device requires operating voltages other than 120 VAC, supply the required voltage converter. Ensure that the maximum power consumption does not exceed 50 watts. Ensure that the Ethernet edge switches have diagnostic light emitting diodes (LEDs), including link, TX, RX, speed (for Category 5e ports only), and power LEDs.

#### **(5) Environmental Specifications**

Provide Ethernet edge switches that adhere to the following environmental constraints as defined in the environmental requirements section of the NEMA TS 2 standard if located within a climate-controlled environment:

- Operating temperature range: -30°F to 165°F,
- Storage temperature range: 14°F to 158°F, and
- Operating relative humidity range: 10% to 90%, non-condensing.

Verify that the Ethernet edge switch manufacturer certifies their device has successfully completed environmental testing as defined in the environmental requirements section of the NEMA TS 2 standard. Verify that vibration and shock resistance meet the requirements of Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard. Ensure that the Ethernet edge switch is protected from rain, dust, corrosive elements, and typical conditions found in a roadside environment.

The Ethernet edge switches shall meet or exceed the following environmental standards:

- IEEE 1613 (electric utility substations),
- IEC 6185003 (electric utility substations),
- IEEE 61800-3 (variable speed drive systems), and
- IEC 61000-6-2 (generic industrial).

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Ensure that the firewall appliances comply with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

- RFC 854: Telnet Protocol Specification.
- RFC 4271: Border Gateway Protocol (BGP).
- RFC 2328: Open Shortest Path First (OSPF).
- RFC 2338: Virtual Router Redundancy Protocol (VRRP).
- RFC 2453: Routing Information Protocol (RIP) version 2.
- RFC 2362: Protocol Independent Multicast Sparse Mode (PIM-SM).
- RFC 2236: Internet Group Management Protocol (IGMP) version 2. and
- IEEE 802.1X: Port-Based Network Access Control.

Ensure that the firewall appliances have a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

**(2) Performance Requirements**

Ensure that the firewall appliances meet the following minimum performance requirements:

- Firewall Throughput: 350+ Mbps.
- Advanced Encryption Standard (AES) VPN Throughput: 100 Mbps.
- 3DES Encryption VPN Throughput: 100 Mbps.
- Maximum Concurrent Sessions: 48,000.
- Virtual Routers: 6, and
- Security Zones: 40.

Provide sufficient memory to enable optional features such as Intrusion Prevention System (IPS), antivirus, and anti-spam with no additional hardware upgrades.

**(3) Functional Requirements**

Ensure that the firewall appliances support the following features which shall include, but not be limited to:

- IPsec VPN Capabilities:
  - 500 Concurrent VPN Tunnels.
  - DES, 3DES, and AES.
  - MD-5 and SHA-1 Authentication.
  - Manual Key, Internet Key Exchange (IKE), IKEv2, and EAP Public Key Infrastructure (PKI) (X.509).
  - Remote Access VPN.
- Authentication:
  - Web-based Authentication.
  - RADIUS.
  - 802.1X.
  - RSA SecureID.

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- Modes of Operation:
  - Layer 2 Mode.
  - Layer 3 Mode.
- Address Translation:
  - Network Address translation (NAT).
  - Port Address Translation (PAT).
  - Mapped IP (MIP) (L3 Mode).
  - Virtual IP (VIP) (L3 Mode).
- High Availability (HA):
  - Active/active – L3 mode.
  - Active/passive – Transparent & L3 mode.
  - Configuration Synchronization.
  - VRRP.
- Quality of Service / Traffic Management:
  - Guaranteed Bandwidth.
  - Maximum Bandwidth.
  - Priority Bandwidth Utilization.
- Support for optional Intrusion Prevention System (IPS) (Deep Inspection) subscription.
- Support for optional Antivirus, antispam, and web filtering subscription.
- Network Attack Detection.
- DoS and DDos Protection.
- TCP Reassembly for Fragmented Packet Protection.
- Brute Force Attack Mitigation.
- SYN Cookie Protection.
- Zone-based IP Spoofing, and
- Malformed Packet Protection.

#### **(4) Physical Features**

*Copper Ports:* Provide a firewall appliance that includes a minimum of six (6) Ethernet 10/100 Base-T copper ports and two (2) Ethernet 10/100/1000 Base-T copper ports. Provide Type RJ-45 copper ports that auto-negotiate speed (i.e., 10/100/1000 Base) and duplex (i.e., full or half). Ensure that all ports meet the specifications detailed in this section and are compliant with the IEEE 802.3 standard pinouts. Ensure that all Category 5e unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-B standard. Provide auto-negotiation circuitry that will automatically negotiate the highest possible data rate and duplex operation possible with attached devices supporting the IEEE 802.3 Clause 28 auto-negotiation standard.

#### **(5) Electrical Specifications**

Ensure the firewall appliance meets the following electrical requirements:

- Input voltage range: 110 VAC to 130 VAC, auto ranging, and
- Input frequency: 60 Hz.

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Ensure that if the firewall appliances require operating voltages other than 120 VAC, supply the required voltage converter. Ensure that the maximum power consumption does not exceed 200 watts.

### **(6) Management Capabilities**

Ensure that the firewall appliance supports all Layer 2 management features and certain Layer 3 features related to multicast data transmission and routing. These features shall include, but not be limited to:

- Support of remote and local setup and management via telnet, Secure Shell (SSHv2) or secure Web-based GUI and command line interfaces, and
- Support of the Simple Network Management Protocol (SNMP).
- Verify that the firewall can be accessed using the resident EIA-232 management port, a telecommunication network, or the Trivial File Transfer Protocol (TFTP).

*Network Capabilities:* Provide a firewall appliance that supports/complies with the following minimum requirements:

- Provide full implementation of IGMP v2,
- Provide full implementation of SNMPv3,
- Password manageable,
- Telnet/SSHv2,
- HTTP (Embedded Web Server) with Secure Sockets Layer (SSL), and
- Full implementation of RFC 783 (TFTP) to allow remote firmware upgrades.

*Network Security:* Provide a firewall appliance that supports/complies with the following (remotely) minimum network security requirements:

- Multi-level user passwords,
- RADIUS centralized password management (IEEE 802.1X),
- SNMPv3 encrypted authentication and access security,
- Support of the TFTP and Sntp.

### **(7) Environmental Specifications**

Provide a firewall appliance that adheres to the following environmental constraints if located within a climate-controlled environment:

- Operating temperature range: 32°F to 104°F,
- Storage temperature range: 14°F to 158°F, and
- Operating relative humidity range: 10% to 90%, non-condensing.

### **(F) Network Management Software**

Provide network management software that provides configuration, troubleshooting, security and system monitoring for the ITS communications network. Ensure that the system includes the following features:

- Able to create and maintain system and user identification and passwords,
- GUI interface,
- Syslog and SNMP alarm manager,
- Distributed server support for scalable management,

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- Physical and logical topology for viewing every element on the network and how it is connected,
- Fault management and alarm view to see the health and status of every element on the network,
- Configuration management for configuring multiple elements and images, perform multi-step upgrades and archive device configurations,
- HTML report generator for Web-based reports,
- Switch configuration and monitoring,
- Inventory tool for the managed devices,
- VLAN manager,
- IP/MAC Address finder,
- Administration tool,
- Abstract Type Library for adding support for future hardware and software in the field,
- Spanning Tree monitor,
- Monitoring of third-party devices,
- Support industry standard protocols such as SNMP, ANS.1, and XML,
- Handle commands from system clients via ASN.1 and/or XML-defined protocol over a standard TCP/IP connection,
- Command underlying nodes (devices such as decoders, encoders, and switches),
- Report status of system nodes and alarms,
- Monitor system node connections,
- Store recent alarms in an internal database,
- Cooperate with another server in redundant set (when working in redundant configuration),
- Receive SNMP traps generated by network infrastructure, translate SNMP traps as system alarms, and send alarms as SNMP traps,
- Support remote configuration and diagnostics, and
- Restore video and connections in case of system component restarts.

*Interface:* Ensure that the network management software interface meets the following requirements:

- Network interface: Any network/telecom adapter supporting MS Windows TCP/IP stack.
- Network: Microsoft TCP/IP service software must be installed and configured correctly in the project's network environment.

Furnish client-server based application that supports installed client application and browser based client.

**(G) Uninterruptible Power Supply (UPS)**

Provide UPS units that produce uninterruptible power and power conditioning for the devices listed below. In the Signal Shop, provide UPS for the ITS Server and Ethernet distribution switch.

Provide external battery units as necessary to achieve the minimum runtime.

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Ensure that the UPS units comply with the following standards:

- ANSI,
- ASTM,
- CSA, and
- UL.

**(2) Functional**

Each UPS shall provide adequate capacity to run its respective equipment without commercial power for at least 20 minutes. Size the UPS units for the proposed loads. Provide load calculations for each configuration of equipment connecting to a UPS assuming a minimum run time of 20 minutes.

Ensure that the UPS and its remote monitoring software perform the following functions:

- Remote environmental monitoring of temperature and humidity,
- Data logging,
- Event logging,
- Fault notification,
- Hibernation,
- Radius authentication,
- Protocols: HTTP, HTTPS, IPv4, IPv6, SMTP (v1-v3), Telnet, SSH v2, SSL,
- Manage all network UPS units,
- Operating system shutdown,
- Load shedding to turn off selected devices or groups of devices,
- Outlet control to turn off, reboot, or shutdown outlets,
- Power event summary,
- Recommended actions,
- Risk assessment summary,
- Run command file, and
- System event log integration.

**(3) Physical Features**

Supply each UPS unit described above with 25 percent spare outlets. Ensure that the UPS meets the following material requirements:

- Input voltage 120 volts nominal,
- Output voltage 120 volts nominal,
- Rack-mounted
- Sealed AGM type, maintenance free batteries,
- LCD control panel with status indicators and screen indicating operating mode, efficiency, wattage or amperage of load, input and output voltage, battery capacity and runtime,
- Ethernet network management card using 10/100 Base TX communications,
- USB interface port,



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- Remote environmental monitoring of temperature and humidity with telnet management,
- Status lights: power on, power source and overload,
- Alarms: audible and remote notification,
- Manual power on/off switch, and
- Supply UPS unit with multi-pole noise filtering. Supply UPS with a terminal for connecting the UPS to a surge protection device.

For the Signal Shop UPS, provide four NEMA 5-15R and two NEMA 5-20R outlets.

#### **(4) Environmental Specifications**

Verify that the UPS meets all specifications and is capable of performing all of its functions during and after being subjected to:

- Operating temperature: 0° F to 104° F,
- Operating relative humidity: 95%,
- Storage temperature: 5° F to 113° F, and
- Storage relative humidity: 95%.

Provide UPS units with UL 1449 surge protection and power filtering.

### **32.3. CONSTRUCTION METHODS**

#### **(A) General**

Ensure that all communications hardware is UL listed.

Verify that network/field/data patch cords meet all ANSI/EIA/TIA requirements for Category 5e four-pair unshielded twisted pair cabling with stranded conductors and RJ-45 connectors.

Receive approval for the System Design Report described in these Project Special Provisions before submitting product submittal data, purchasing, installing and configuring the computer and communications hardware at each facility.

Ensure that all project IP addresses are assigned as defined in the System Design Report. Utilize the City's IP address schema. Ensure the as-built documentation includes the identification of all IP addresses and VLANs, and associated hardware devices and device locations. Configure the Ethernet network so the traffic signals and CCTV cameras are in separate VLANs.

The City will designate who their network administrator is for the ITS LAN. Upon project completion ensure that the City's network administrator will be able to remotely manage the Ethernet switches for switch configuration, performance monitoring, and troubleshooting.

#### **(B) Ethernet Switches**

##### **(1) General**

Ensure that all project IP addresses and VLAN IDs are assigned as defined in the System Design Report. Ensure that at a minimum, the switch configuration includes the following features: SNMP, STP, Port Security, all required VLANs, Unicast Routing protocols, and Multicast Routing protocols. Ensure unused switch ports are disabled.

Ensure that the City's network administrator will be able to manage each Ethernet distribution switch individually or as a group/cluster for switch configuration, performance monitoring, and troubleshooting. Note that these specifications require additional minimum management intelligence (i.e., Layer 2+) typical of most current industrial Ethernet deployments. Ensure that the managed Ethernet switches include Layer 2+ capability providing architecture standardization, open connectivity (i.e., interoperability), bandwidth management, rate limiting, security filtering, and general integration management of an advanced Ethernet switching architecture.

Verify that fiber-optic jumpers consist of a length of cable that is connectorized on both ends, primarily used for interconnecting termination or patching facilities and/or equipment. Use fiber-optic jumpers that are factory assembled and connectorized and are certified by the fiber-optic jumpers' manufacturer to meet the relevant performance standards required below. Verify that network/field/data jumper cables meet all ANSI/EIA/TIA requirements for Category 5e 4-pair unshielded twisted pair cabling with stranded conductors and RJ45 connectors.

### **(2) Ethernet Core Switch**

The Ethernet core switch shall act as the central data aggregation node for the new communications network. Locate the Ethernet core switch in the TOC as shown in the Plans and provide full Layer 3 functionality. Ensure that the Ethernet core switch communicates with the Ethernet distribution switch, firewall, existing and proposed ITS servers, field device cabinets, 332 traffic signal and 336 CCTV test cabinets, video server, video processing units and the proposed network video recorder(s) at Ethernet data transmission rates of 1 Gbps and the Ethernet edge switches at Ethernet data transmission rates of 100 Mbps. Connect the Ethernet core switch to the firewall in the TOC with Ethernet patch cords.

Install and configure the Ethernet core switch to be fully compatible with the Ethernet distribution switch and the Ethernet edge switches as defined in these Project Special Provisions. Ensure that at a minimum, the Ethernet core switch configuration includes following features: SNMP, STMP, Port Security, all required VLANs, Unicast Routing protocols, and Multicast Routing protocols. Ensure unused switch ports are disabled.

Ensure all fiber connections of the Ethernet core switch are connected to two pairs of single mode fiber strands via fiber-optic interconnect center for redundant communications.

### **(3) Ethernet Distribution Switch**

Mount the Ethernet distribution switch inside the communications rack in the Signal Shop within the Traffic Services Center. Connect the Ethernet distribution switch to the following items in the Signal Shop: UPS, five wall mounted Ethernet jacks, Type 332 signal test cabinet, workstation and existing copier/printer using Ethernet patch cords and to the Ethernet core switch over single-mode fiber-optic cable as shown in the Plans.

### **(4) Ethernet Edge Switch**

Mount the Ethernet edge switch inside each field cabinet by securely fastening the Ethernet edge switch to the vertical rail of the equipment rack or to a shelf using manufacturer-recommended or Engineer-approved attachment methods, attachment hardware and fasteners. Ensure that the Ethernet edge switch is mounted securely in the cabinet and is fully accessible by field technicians without blocking access to other equipment. Verify that fiber-optic jumpers consist of a length of cable that is connectorized on both ends, primarily used for interconnecting

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termination or patching facilities and/or equipment. Use fiber-optic jumpers that are factory assembled and connectorized and are certified by the fiber-optic jumpers' manufacturer to meet the relevant performance standards required below. Verify that network/field/data jumper cables meet all ANSI/EIA/TIA requirements for Category 5e 4-pair unshielded twisted pair cabling with stranded conductors and RJ45 connectors.

**(C) Firewall**

Install the firewall appliance in a rack as shown in the Plans in the TOC. Connect the Ethernet core switch to the firewall in the TOC with Ethernet patch cords. Install the latest General Availability (GA) software release available from the manufacturer. Ensure all firewall appliances are running the same revision of software.

Configure a minimum of two (2) zones. Configure appropriate security policies to protect the City's internal ITS network from Internet-based attacks from the City LAN and the Internet. Configure an IPsec VPN on each firewall to connect to NCDOT via a secure link over the City and NCDOT dedicated fiber-optic communications network. Configure access to provide video to the City's IS Department. This VPN connection shall be a site-to-site VPN and shall not require VPN client software. Configure remote access VPN capability to allow City staff to access the network remotely via a secure connection from the Internet. If a VPN client is required for the remote access VPN, the Contractor shall provide a sufficient number of licenses for the required client software. If a server license is required, the Contractor shall provide all licenses for the server software as well.

Ensure that the firewall appliance communicates with the Ethernet core switch at Gigabit Ethernet data transmission rates (1000 Mbps).

Ensure that the network administrator will be able to remotely manage each firewall appliance for configuration, performance monitoring, threat detection, and troubleshooting.

Install and configure the firewall appliance to be fully compatible with the Ethernet core switch.

**(D) Network Management Software**

Install the Network Management Software (NMS) server application on the ITS communications server. Configure the NMS to monitor and manage the ITS servers, and Ethernet edge switches. Install software to provide access to the NMS software from the workstations and laptop computers connected to the network. Establish user access rights, designate who has administrative, manager and monitoring rights. Build the database through an automatic utility within the NMS or manually enter the data. Establish groupings of devices with like functions or features, this would include geographically related, device types, owners. Setup automatic database and configuration backups. Setup system and device alarms and alarm notifications.

Setup graphical network views. Use mapping images provided by manufacturers to geographically locate devices.

**(E) Uninterruptible Power Supply (UPS)**

Install UPS units in the Signal Shop and connect it to the Ethernet distribution switch and ITS server. Configure the UPS for remote monitoring.

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**32.4. MEASUREMENT AND PAYMENT**

The Ethernet switches include all appropriate ports, cabling, grounding, redundancies, labeling and any integration between the Ethernet switches and the communications network as necessary to make a fully working installation. All power supplies, power cords, adapters, mounting hardware, DIN rail mounting brackets, DIN rails, connectors, serial cables, signs, decals, disconnect switches, installation materials, and configuration software necessary to complete this work, will be included and will be incidental.

*Ethernet core switch* will be measured and paid as the actual number of Ethernet core switches furnished, installed, and accepted.

*Ethernet distribution switch* will be measured and paid as the actual number of Ethernet distribution switches furnished, installed, and accepted.

*Ethernet edge switch* will be measured and paid as the actual number of Ethernet edge switches furnished, installed, and accepted.

*Firewall* will be measured and paid as the actual number of firewalls furnished, installed, and accepted.

*Network management software* will be measured and paid as lump sum furnished, installed, and accepted.

*UPS* (\_\_\_\_\_) will be measured and paid as the actual number of UPS units by location furnished, installed, and accepted.

Additional software licenses for the network management software shall be incidental to modify network management software.

No separate measurement will be made for SMFO jumpers, coaxial cables, communication cables, Ethernet patch cables, electrical cables, mounting hardware, nuts, bolts, brackets, connectors, risers, grounding equipment, surge suppression, or training as these will be considered incidental to the pay items listed above.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Ethernet Core Switch	Each
Ethernet Distribution Switch	Each
Ethernet Edge Switch	Each
Firewall	Each
Network Management Software	Lump Sum
UPS (Signal Shop)	Each

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### 33. DIGITAL VIDEO EQUIPMENT

#### 33.1. DESCRIPTION

Furnish and install digital video hardware encoders in NCDOT camera cabinets on US 311 Bypass for converting analog to digital video. Furnish and install digital video hardware decoders for converting digital to analog video at the TRTMC and in the Municipal Building for the City's video feed to the media.

Furnish and install a video server to support the video management software. Furnish and install video processor units and monitors for a replacement monitor wall in the TOC.

Provide USB-based joysticks for CCTV selection and control.

Provide network video recorders to record streaming digital video streams.

#### 33.2. MATERIALS

##### (A) Digital Hardware Encoders and Decoders

Furnish digital hardware video encoder and decoder components that utilize the Moving Picture Experts Group's (MPEG's) H.264 video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 13818 and 14496-14 standards, respectively. Provide the ability for the user to select the video compression technology. Ensure that the hardware video encoder is capable of unicast and multicast operation, and that they support the Session Announcement Protocol (SAP) as recommended by the Internet Engineering Task Force (IETF) RFC 2974, and Differentiated Services/Quality of Service (DiffServ/QoS) software components. Ensure that the digital video encoders and decoders provides 99.999% error-free operation.

Provide digital hardware video encoder and decoder components that are hardware-based network devices able to accept a minimum of one analog National Television System Committee (NTSC) video input and digitize it for transport across IP networks.

##### (1) Video Specifications

Ensure that any video input utilizes a BNC connector and delivers one-volt peak-to-peak (Vp-p) NTSC composite video signals for encoding. Ensure that the DVE operates with both color and monochrome video, and that they allow the user to select and adjust video resolution. Ensure that the DVE support resolutions that include, but are not limited to those in table below. Ensure that the MPEG-4 DVE is capable of delivering color and monochrome video at 30 fps regardless of resolution, and that they can do so using variable, programmable bit rates from 32 Kbps to 4 Mbps. Ensure that the DVE provides fixed and variable bit rate modes. Provide resolutions of QCIF, CIF, 2CIF, 4CIF, and D1.

##### (2) Serial Interface

Use hardware-based digital video encoders and decoders having a minimum of two serial data interfaces and connectors that conform to EIA-232/422/485 standards. Ensure that the serial interfaces support EIA-232 as well as 2-wire and 4-wire EIA-422/485 connections. Ensure that the serial port(s) support data rates up to 115.2 Kbps. Serial interface parameters, such as data format, number of bits, handshaking, and parity, shall be software programmable through local

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connection to the digital video encoders and through connections over the network. Serial interface ports may utilize RJ-45 connectors, D-sub connectors, or screw terminals.

**(3) Network Interface**

Ensure that the digital video encoder and decoder local area network (LAN) connection supports the requirements detailed in the IEEE 802.3 standard for 10/100 Ethernet connections. Provide a DVE having a minimum of one Ethernet port, which shall be a 10/100 Base-TX connection. Ensure that the connector complies with the EIA and Telecommunications Industry Association (TIA) requirements as detailed in the EIA/TIA-568-A standard. Provide copper-based network interface ports that utilize RJ-45 connectors.

Ensure that all Category 5e unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-B standard. Ensure that the network communication conforms to User Datagram Protocol (UDP), Version 4 of the Internet Protocol (IP) and Version 2 of the Internet Group Multicast Protocol (IGMP).

**(4) Front Panel Status Indicators**

Ensure the digital video encoders and decoders have light-emitting diode (LED) displays, liquid crystal displays (LCDs), or similar illuminated displays to configuration and management. Provide digital video encoders that support local and remote configuration and management. Configuration and management functions shall include access to all user-programmable features, including but not limited to addressing, serial port configuration, video settings, device monitoring, diagnostic utilities, and security functions. Ensure that the digital video encoders and digital video decoders support configuration and management via serial login, telnet login, and Simple Network Management Protocol (SNMP).

**(5) Hardware Specifications**

Furnish digital hardware video decoders that are card mounted and mount in a card cage. Each card shall fit in a 5.2" x 0.9" card slot. Furnish digital hardware video encoders that are shelf mounted.

**(6) Electrical Specifications**

Ensure that all wiring meets NEC requirements and standards. The decoder cards shall operate on 12 volts DC. The encoders shall operate on 120v AC.

Ensure that all wiring meets NEC requirements and standards. Provide equipment that operates on a nominal voltage of 120 VAC. The equipment shall operate within a voltage range of 89 VAC to 135 VAC. The operating frequency range for power shall be 60-hertz  $\pm 3$  Hz. If the device requires operating voltages of less than 120 VAC, supply the appropriate voltage converter.

Furnish, install and integrate the digital video encoders in each CCTV cabinet shown in the Plans. Connect the analog input of the digital video encoder to the CCTV camera as defined above. Connect the Ethernet output of the digital video encoder to Ethernet edge switch. Use standard coax cable with BNC (gold-plated center pin) connectors. Connect the RS-422 PTZ serial communications from the camera to the serial port of the digital video encoder. Configure ports and IP addresses for multicast broadcast and VLANs.

**C-5558****ITS-287****Guilford County****(7) Environmental Specifications**

Unless stated otherwise in the Plans, provide digital video encoders and decoders that meet all specifications during and after being subjected to an ambient operating temperature range of -30°F to 165°F as defined in the environmental requirements section of the NEMA TS 2 standard, with a maximum non-condensing relative humidity of 95%.

Ensure that cabinets housing system components comply with the environmental requirements detailed in the NEMA TS 2 standard. House the digital video encoder in a field cabinet with protection from moisture and airborne contaminants, blowing rain, wind, blowing sand, blowing dust, humidity, roadside pollutants, vandalism, and theft. Ensure that the digital video encoder is resistant to vibration and shock, and conforms to Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.

Ensure that the digital video encoder is resistant to vibration and shock, and conforms to Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.

**(8) Digital Hardware Video Encoder (DVE)**

Furnish digital hardware video encoder hardware to create a video-over-IP network system, as shown in the Plans. Provide video encoder units that are shelf mounted.

Provide digital video encoders that provides a minimum of two serial data interfaces for transmission of command and control data to other devices (typically camera PTZ commands), as well as console and configuration functions.

**(9) Digital Hardware Video Decoders (DVD)**

Furnish single channel digital hardware video decoder cards to create a video-over-IP network system, as shown in the Plans. The video decoder units shall be rack-mounted in the TRTMC. The digital video decoder in the STOC for the media shall be rack rail or DIN-rail mounted.

Use a digital hardware video decoder that provide a serial data interface for transmission of command and control data to other devices (typically camera PTZ commands), as well as console and configuration functions.

**(10) Card Cage**

Furnish card cages that include a dual power supply and 12 slots to hold decoder cards. Each card slot shall accommodate a 5.2" x .9" card. The dual power shall operate in a redundant operation using a nominal 115 volts AC. The power supply shall supply 12 volts DC. The card cage shall occupy no more than four rack units high.

**(B) Video Server**

Provide a video server to the same requirements as an ITS server as described in the Section "Computer Hardware" in these Project Special Provisions to host the video management software.

**C-5558****ITS-288****Guilford County****(C) Video Processing Units**

Provide video processor units meeting the following minimum requirements:

- Processor: Dual quad core Intel Xeon E5-26670 or better at 2.9 GHz or greater, 15 MB cache processor, Turbo, L2 cache at 1600 MHz,
- Memory: Minimum 8 GB dual-ranked UDIMMS for two processors at 1600 MHz,
- Backplane: 1x6 backplane for 3.5 inch drives, expandable to eight drives,
- Power Supply: Single power supply with cord,
- Riser: Riser with four PCIe x 16 Gen 2 and Gen 3 cards
- Drive Controller: SATA 6 Gbps SAS,
- Hard Drives: 500 GB, 7200 RPM SATA drive, , 3.5 inch,
- CD-ROM: DVD +/-RW SATA Drive, internal,
- Mounting: Slide ready rails and cable management
- Embedded Controller: out of band management, and
- Operating System: Microsoft Windows Professional Edition.

Provide two professional grade graphics cards in each video processor to drive a total of eight HD displays per video processor unit meeting the following minimum requirements:

- Integrated video chipset controller,
- PCIe 3.0 compliant,
- RAM: 4 GB GDDR5,
- Display Ports: Four, with adaptors for HDMI eight monitor inputs,
- Maximum Display Port 1.2 Resolution: 4096 x 2160,
- Maximum Display Port 1.1 Resolution: 2560 x 2600,
- Memory bandwidth: 154 GBps ,
- DirectX 11.1,

Provide video processor units with a maximum size of three RUs. Provide servers meeting the minimum following power requirements:

- Power supply: 110-130 VAC.
- Power consumption: Typical 1100w per power supply.

Provide servers meeting the following data port requirements:

- Serial: One standard serial port,
- Audio: Three jacks – channel out, line in, and microphone.
- Ethernet: 1000 Base T Ethernet with RJ-45 connectors, and
- USB port: Four USB 2.0 ports.

**(D) Digital Video Monitors**

Provide twenty-five (25) 23-inch LED monitors that shall comprise a monitor wall in the TOC. Provide only new video monitors; do not furnish used or refurbished monitors. Furnish monitors made by the same manufacturer, regardless of whether they are being installed in the



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TOC. Provide power cords for all monitors of sufficient length to plug into duplex wall receptacle adjacent to monitor mounting location.

Provide mounting brackets specifically designed for mounting the size of LED monitors described below on both metal and wood stud walls. Provide brackets that allow vertical and horizontal tilt to optimize viewing angles. Provide brackets with locking setscrews to prevent the monitor from falling or sliding off the bracket. Provide all mounting hardware and fasteners and plywood backboard necessary for securely attaching monitor mount brackets to metal stud and wood stud walls. Provide monitors with a rated life of 50,000 hours.

Provide 23" monitors meeting the following requirements:

- Display Type: LED, widescreen flat panel,
- Mounting: Wall-mount,
- Resolution: 1,920 x 1,080 dpi,
- Pixel Pitch: .265 mm,
- Response Time: 8 ms,
- Colors: Minimum 16.7 million colors,
- Horizontal Scanning Frequency: >85 kHz,
- Vertical Scanning Frequency: 50-86 Hz,
- Contrast Ratio: 1000:1,
- Aspect ratio: 16:9,
- Viewing Angle (Horizontal): 178 degrees,
- Viewing Angle (Vertical): 178 degrees,
- Brightness: 250 cd/m<sup>2</sup>,
- HDTV Supported Formats: 720p and 1080p,
- Digital Inputs: DisplayPort, HDMI, and DVI-D
- Analog Inputs: HD-15 VGA and,
- Audio Inputs: RCA Audio, stereo mini-jack, DisplayPort audio, HDMI audio.

Provide HDMI video cables with the monitors to reach from the video server outputs in the TOC to the wall monitors and from the monitor in the Signal Shop to its respective workstation. Provide HDMI cables and connectors meeting the following requirements:

- Cable: Individually insulated, 26 AWG copper conductors,
- Connectors: 24x1 pin male on both ends,
- Pins: Gold Plated,
- RFI and EMI Noise Reduction: Clip on ferrites,
- Maximum Resolution: 4096 x 2160P at 24Hz,
- Bit Rate: 24-bit, and
- Bandwidth Rating: 14.93 Gbps at 340 MHz.

**(E) Network Video Recorder**

The network video recorders (NVR) shall interface to the IP network and be able to record video images from the CCTV cameras to an internal hard drive, play back a video stream to wall monitor, and write those images to a DVD for viewing on a workstation or wall mounted monitor. Furnish and install two network-based NVRs in the TOC. Provide NVRs with the capability to record from IP streams 27 IP cameras each simultaneously. Record cameras at

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H.264 compression, 1080P resolution, camera resolution up to 5 Mbps, 30 frames per second with storage time for seven days. Provide NVRs meeting the following requirements:

- Processor: Intel Xeon E5-2407 processor at 2.40 GHz or greater, 6.4 Tbps,
- Memory: 2 x 4 GB RDIMM 1333 MHz, single rank,
- Hard Drive: 9 TB SATA, 7200 RPM, 64 MB cache 6 Gbps interface, RAID 5 hot plug,
- Network: Dual port 10/100/1000 Base T Ethernet with RJ-45 connectors,
- Video Card: 512 MB RAM with DirectX 11.1,
- Operating System: Windows 7 Professional, latest version.

Provide an NVR meeting the minimum power requirements:

- Input voltage: 90-135 V at 50/60 Hz, and
- Output wattage: 350 W.

Provide an NVR meeting the minimum port requirements:

- Audio: Miniature phono plugs for line in, line out and microphone,
- Video: SVGA, and
- USB Port: Four USB 2.0 ports.

**(F) PTZ Joysticks**

Provide replacement USB based joysticks. The joystick controls shall include a variable speed, joystick for precise PTZ control, jog control for video playback, a keypad for camera and monitor selection and control. The joysticks shall meet the following requirements:

- Input Voltage: 100-240 VAC, 50/60 Hz
- Keyboard Interface: USB 2.0 with cable and captive connectors
- Audio Output: Embedded speaker,
- Keyboard Keypad: Numeric keys 0-9, camera, monitor, and multiple Proportional PTZ, variable speed with zoom, iris, and focus controls, and
- Jog/Shuttle: Proportional, fast forward, reverse, and video transport.

The joysticks shall meet the following environmental requirements:

- Storage Temperature: 70 degrees F to 74 degrees F,
- Operating Temperature: 32 degrees F to 104 degrees F, and
- Storage Temperature: -40 degrees F to 149 degrees F.

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### 33.3. CONSTRUCTION METHODS

#### (A) General

Receive approval for the System Design Report described in these Project Special Provisions before submitting products submittal data, purchasing, installing and configuring the central video equipment described in this section of the Project Special Provisions.

Use standard coax cable with BNC (gold-plated center pin) connectors. Configure ports and IP addresses for multicast broadcast and VLANs.

Utilize video inputs on the video matrix switch in the TRTMC as assigned by the Engineer.

#### (B) Digital Hardware Encoders

Install the digital hardware video encoders in the NCDOT CCTV cabinets along US 311 Bypass listed below. Connect the Ethernet network port to the proposed Ethernet edge switch. Connect the RS-422 PTZ serial communications cable and coaxial cable from each CCTV to the serial and video ports of the respective digital hardware video encoder. Remove the existing video data transceiver in each cabinet and in the TOC.

##### Location of NCDOT CCTV Cabinets

- CCTV 43, I-74/US 311 Bypass at Business 85
- CCTV 44, I-74/US 311 Bypass at East Green Drive/Triangle Lake Road
- CCTV 45, I-74/US 311 Bypass at East Kivett Street
- CCTV 46, I-74/US 311 Bypass at Greensboro Road
- CCTV 48, I-74/US 311 Bypass at Johnson Street
- CCTV 83, I-74/US 311 Bypass at Jackson Lake Road
- CCTV 89, I-74/US 311 Bypass at I-85 North
- CCTV 90, I-74/US 311 Bypass at I-85 South

#### (C) Digital Hardware Video Decoders

Install the ten digital hardware video decoders in the TRTMC, in proposed card cages in the existing communications racks as directed by the Engineer. Connect the Ethernet network port to the existing managed Ethernet switch. Connect the video outputs to the existing analog video matrix switch. Connect the serial PTZ outputs to the existing port server.

Install one digital hardware video decoder in the TOC, mounted on a din-rail or rack rail in one of the proposed communications racks as directed by the Engineer. Connect the Ethernet network port to the Ethernet core switch. Connect the video outputs to the existing analog video cable to the 3<sup>rd</sup> floor. Do not connect any PTZ cable to the decoder.

#### (D) Card Cage

Install the card cages in the communications rack installed in the TRTMC as part of NCDOT Project U-2579B. Connect the power supply of each card cage to the power strip on the communications rack.

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Install the video server in the communications racks in the TOC as shown in the Plans. Connect power cords to adjacent receptacles (provided by others) in wall. Connect the video server to the Ethernet core switch. Reinstall the existing video management software on the video server.

**(F) Video Processing Units**

Install the video processor units in the communications racks in the TOC as shown in the Plans. Connect power cords to adjacent receptacles (provided by others) in wall. Connect each video processor unit to the Ethernet core switch using Cat 5e cable and to a maximum of eight monitors using HDMI cable.

**(G) Digital Video Monitors****(1) 65" Monitors**

Reuse the existing 65" HD video monitors. City staff will relocate the 65" monitors and their mounting brackets to the new monitor wall. Use new HDMI cables. Route cabling under floor to video processor units.

Connect power cords to adjacent receptacles (provided by others) in wall.

Conceal all video cabling between each 65" monitor and the video processing units in the wall as shown in the Plans using low voltage outlet boxes installed by others. Connect the HDMI video input of a monitor with a HDMI video output of the video server. Install ferrites to reduce RFI and EMI noise. Ensure when completed the power and video cables will be concealed behind the monitors.

**(2) 23" Monitors**

Use mounting brackets specifically designed for wall mounting 23" monitors. Ensure the mounting brackets are secured to wall studs or plywood backboard according to the manufacturer's recommendations.

Mount the 23" monitors on the TOC monitor wall. The 23" monitors shall align vertically and horizontally with each other as shown in the Plans.

Connect power cords to adjacent receptacles (provided by others) in wall.

Conceal all video cabling between each monitor and the video processing units in the wall as shown in the Plans using low voltage outlet boxes installed by others. Connect the HDMI video input of a monitor with a HDMI video output of the video server. Install ferrites to reduce RFI and EMI noise. Ensure when completed the power and video cables will be concealed behind the monitors.

**(H) Network Video Recorder**

Install the NVRs in proposed server rack and connect to Ethernet network. Connect power cords to adjacent receptacles (provided by others) in wall. Connect the NVRs to the Ethernet core switch using Cat 5e cable. Configure the NVRs for remote control and scheduled recording. Configure for H.264 compression at 1080P resolution and 30 frames per second. Configure the storage to overwrite after seven days.

**C-5558****ITS-293****Guilford County****(I) PTZ Joysticks**

Install replacement joystick controls for camera control in the following locations: one in Transportation Department conference room (2nd floor of Municipal Building); two in TOC (1<sup>st</sup> floor of Municipal Building); and one in Signal Shop. Connect each joystick with its respective workstation.

**(J) Removal of Existing Equipment**

Upon completion of the integration of the new Ethernet based center-to-center (i.e., C2C) video sharing equipment remove the existing video multiplexers and demultiplexers in the TOC and the TRTMC. Remove the existing video monitors (all but the 65" monitors which are being retained and relocated) in the TOC to install the new digital video monitors.

**33.4. MEASUREMENT AND PAYMENT**

The materials provided in this section include all appropriate ports, cabling, grounding, redundancies, labeling, and any integration between the devices and the communications network as necessary to make a fully working installation.

For furnish and install and for furnish only materials all power supplies, power cords, adapters, mounting hardware, din-rails, connectors, serial cables, coaxial cables, installation materials, and configuration software necessary to complete this work, are to be included and will be incidental to the pay items listed below.

*Digital hardware video encoder* will be measured and paid as the actual number of digital hardware video encoders furnished, installed, and accepted.

*Digital hardware video decoder* will be measured and paid as the actual number of digital hardware video decoders furnished, installed, and accepted.

*Video processing unit* will be measured and paid as the actual number of video processing units furnished, installed, and accepted.

*Digital display monitor (size)* will be measured and paid as the actual number of digital display monitors by size furnished, installed, and accepted.

*Card cage* will be measured and paid as the actual number of card cages furnished, installed, and accepted.

*Network video recorder* will be measured and paid as the actual number of network video recorders, furnished, installed, and accepted.

*PTZ joysticks* will be measured and paid as the actual number of PTZ Joysticks furnished, installed, and accepted.

The video server will be paid for as an "ITS Server" as described in "Computer Hardware and Peripherals" section of these Project Special Provisions.

No separate measurement will be made for coaxial or serial cables, cable connectors, Ethernet cables between equipment housed within the same room/rack/cabinet, electrical cables, mounting hardware, nuts, bolts, brackets, connectors, grounding equipment, surge suppression or documentation as these will be considered incidental to the pay items listed above.

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No separate measurement will be made for the removal of the video multiplexers and demultiplexers and video data transceivers as these will be considered incidental to the pay items listed above.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Digital Hardware Video Encoder	Each
Digital Hardware Video Decoder	Each
Card Cage	Each
Video Processing Unit	Each
Digital Display Monitor (23")	Each
Network Video Recorder	Each
PTZ Joystick	Each

### 34. COMMUNICATIONS RACKS

#### 34.1. DESCRIPTION

Furnish and install freestanding enclosed communications racks at the Municipal Building in the TOC. Furnish and install a wall-mounted communications rack in the Signal Shop.

#### 34.2. MATERIALS

##### (A) TOC Communications Racks

Provide freestanding enclosed communications racks for the TOC meeting these minimum performance requirements:

- All equipment shall comply with ANSI/EIA RS-310D,
- Provide frame and external components with zinc coating per ASTM B633,
- Paint interior and exterior components per RAL 7035, and
- The thermostatically controlled fans shall provide up to 300 cubic feet per minute (cfm) of exhaust. Thermostats shall monitor both humidity and temperature.

Provide freestanding enclosed communications racks meeting the following minimum material requirements:

- 19-inch EIA single-bay,
- Full size rack cabinet for TOC Server Room: 42 rack units high (approx. 78 inches),
- Nominal 4-inch-high ventilated base,
- Nominal depth: 30 inches,
- All-metal components,
- Full-height locking window door on the front,
- Urethane gaskets for window sealing,
- ¼-inch-thick Plexiglas® window panes,
- Solid metal removable side panels with bottom vents,
- Full-height solid metal door for the back of each cabinet, and
- Vented top with three integral, thermostatically controlled, prewired fans.
- Set of four (4) heavy-duty, locking casters on base.

*Mechanical:* Construct all rack frames from 12-gauge, cold-formed steel. Construct all side panels and door panels of 14-gauge steel. Construct the vented base from 16-gauge steel. Construct the 19-inch electrical rack angles from 12-gauge steel.

*Doors:* Equip all doors with grounding brackets and doorstop kits. Door hinges shall have a maximum opening range of 130-140 degrees. Hinge kits shall permit left or right side mounting. Furnish the racks with tamper-proof hinges and removable hinge pins.

Provide the rack with flush swing handles with tamper resistant locks on all doors. Key all locks to the same key with two sets of keys provided for each unit. Locks shall have a three-point latch mechanism.

*Wall Panels:* Provide removable solid side panels with hanger tabs for easy alignment and assembly. Provide vents on front and rear panels, along with wire entry access plates with dust-tight seals.

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*Finish:* Furnish factory-applied paint or powder-coating that is black in color on the exterior and interior of all components.

Furnish and install one metal shelf kit per communications rack. Provide each shelf the full width and depth of the rack angles and attach directly to the rack angles. Furnish and install one metal keyboard slide out drawer per full-height communications rack.

**(B) Signal Shop Communications Rack**

Furnish a wall-mounted EIA 19-inch equipment rack cabinet for mounting in the Signal Shop to house of a fiber-optic splice/termination center, an Ethernet distribution switch and a rack-mounted UPS. The unit shall be an enclosed rack at least 20 rack units high with approximate dimensions of 36”H x 21” W x 26” D. The rear mounting plate that attaches the cabinet to the wall shall be hinged along one side with latches on the opposite side so that the cabinet can be swung open to access the rear of the cabinet.

Provide a power strip inside that uses 120 VAC 60 Hz power; the power strip shall contain at least six outlets and a six-foot power cord. Provide grounding bus bar system to ground rack-mounted electrical equipment.

Provide racks constructed of all metal components. Supply all screws, nuts, washers, lock nuts, brackets and hardware necessary to assemble equipment described herein. Vents shall be on front and rear panels. Furnish wire entry access plates with dust tight seals.

Provide cable management hardware for attachment to rack frame and between 19-inch rack angles. The hardware shall include cable organizers and clamps to provide strain relief and cable mounting. Provide one shelf.

Construct all rack frames and rack angles of 12-gauge steel or greater. Construct the sides, top and bottom panels of 16-gauge steel or greater.

Paint the panels, rack frames, and rack angles with black polyester powder coating or baked on paint.

**34.3. CONSTRUCTION METHODS**

**(A) General**

Ground the racks to a building ground.

**(B) TOC Communications Racks**

Furnish and install an outlet strip and 10-foot power cord along one rear vertical rack frame. Furnish and install strips that use 120 VAC 60 Hz power and shall contain at least 10 outlets over the 70 inches for full size racks. Furnish and install grounding bus bar system to ground the rack-mounted electrical equipment. Equip door with grounding studs.

Furnish and install cable management hardware for attachment vertically along the rack frame and horizontally between 19-inch rack angles. Cable management hardware shall run vertically up one rear rack frame and shall include six horizontal runs per rack. Provide hardware including cable organizers and clamps to provide strain relief and cable mounting.

Install the full-height communications rack cabinets in the TOC as shown in the Plans.



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Install a keyboard shelf at a height comfortable for operator use when sitting on a stool. Provide tamper-resistant but removable screws through hinges and exterior panels. Furnish any special tools required to remove tamper resistant screws.

Install shelf in the server rack for servers to be installed by others as shown in the Plans.

**(C) Signal Shop Communications Rack**

Install the wall-mounted communications rack cabinet on the wall of the Signal Shop as shown in the Plans. Remove the existing wall-mounted NEMA cabinet shell and mount the wall-mounted communications rack in its place. Install the fiber-optic splice center, Ethernet distribution switch and rack-mounted UPS in the rack inside the cabinet.

Furnish and install a power strip and 10-foot power cord on the rear of the rack frame. Furnish and install the power strip that uses 120 VAC 60 Hz power and that contains at least 5 outlets. Connect the power strip to the wall-mounted outlet above the wall-mounted rack. Furnish and install grounding bus bar system to ground the rack-mounted electrical equipment. Equip door with grounding studs.

Furnish and install cable management hardware for attachment vertically along the rack frame and horizontally between 19-inch rack angles. Cable management hardware shall run vertically up one rear rack frame. Provide hardware including cable organizers and clamps to provide strain relief and cable mounting.

**34.4. MEASUREMENT AND PAYMENT**

*Communications rack (TOC)* will be measured and paid as the actual number of full-size, freestanding, enclosed communications racks furnished, installed, and accepted in the TOC.

*Communications rack (Signal Shop)* will be measured and paid as the actual number of wall-mounted communications racks furnished, installed, and accepted in the Signal Shop.

No separate measurement and payment will be made for rack set-up and assembly, shelves, keyboard drawers, power strips, mounting of all accessories and equipment specified for installation within the rack, all brackets, fasteners, and hardware required for properly mounting equipment in the rack, as such materials and work will be considered incidental to furnishing and installing the communications racks.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Communications Rack (TOC)	Each
Communications Rack (Signal Shop)	Each

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**35. BUILDING MODIFICATIONS AND FIBER-OPTIC CABLE TERMINATION****35.1. DESCRIPTION**

At locations called for in the Plans, route fiber-optic cable in new and/or existing conduits and install conduits into buildings as shown. Terminate fiber-optic cable in fiber-optic splice centers in building as shown in the Plans. Furnish and install cable and cable routing facilities as shown in the Plans. Furnish and install additional shelves in the modular video wall furniture in the TOC. Install a wall-mounted shelf in the Signal Shop.

All construction to reach a building 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. Electrical work inside the buildings and construction/relocation of walls/partitions will be performed by the City.

**35.2. 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 intermediate metallic conduit (IMC) that complies with the NEC and EIA/TIA Standard 569 and commercial building standards for telecommunications pathways.

Furnish Ethernet outlet boxes equipped with both a single RJ-45 jack and two RJ-45 jacks as shown in the Plans.

**(B) Fiber-Optic Splicing and Termination**

Furnish SMFO pigtails with each splice housing, connector housing and interconnect center. Provide pigtails that are a maximum of 6 feet in length with a factory assembled LC connectors 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 LC connectors on one end (i.e., the splice/interconnect center end) and, on the other end, factory-assembled connectors of the same type provided on the Ethernet edge switch and provided on the Ethernet core switch. Ensure that SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled. Provide all of SMFO jumpers with all of the connector combinations necessary to provide the connectivity indicated in the Plans and required by these Project Special Provisions to produce a fully-functional Ethernet communications system.

Provide connector panels with LC-type connectors for connector housings and interconnect centers installed in all facilities.

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For each splice housing and interconnect center, 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.

**(C) Rack-Mounted Interconnect Centers - General**

Furnish rack-mountable modular interconnect centers each comprising integrated connector panels and splice trays for splicing the fibers in the incoming signal system trunk cables to SMFO fiber-optic pigtails and terminating on patch panels in the communications cabinet being installed in the TOC and Signal Shop (i.e., one interconnect center for each incoming cable). Each interconnect center shall have LC-compatible connector panels and shall have a capacity for terminating a minimum of 24-36 fibers on the patch panel. Provide splice trays that hold, protect, organize optical fibers, and secure fibers inside splice tray. Design and size the splice trays to be dielectric, to accommodate all fibers entering splice tray, and to provide sufficient space to prevent microbending of optical fibers.

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

Each interconnect center shall occupy no more than two rack units. Provide all hardware needed to install these units in the communications racks.

In the Signal Shop, store a minimum of 20 LF of each fiber-optic cable inside the wall-mounted communications rack cabinet that contains the interconnect center.

**(D) TOC Building Modifications****(1) Rack-Mounted Interconnect Centers**

Furnish one rack-mountable interconnect center for splicing and terminating all fibers in the SMFO cable installed into the TOC (i.e., one interconnect center for each incoming cable). Furnish interconnect centers that comply with the requirements of interconnect centers in the "Splice Centers" section of these Project Special Provisions. Store a minimum of 20 LF of each fiber-optic cable inside the communications rack cabinet that contains the interconnect center.

**(2) Flexible Fabric Innerduct**

Furnish a flexible, multi-celled, textile innerduct system for installation in the existing 4" metal conduit entering the Municipal Building and routed to the TOC housed therein. Provide a plenum-rated fabric innerduct system that meets UL 2024A standards for Plenum Optical Fiber/Communications raceways. Provide a flexible fabric innerduct comprised of three cells each with a 200 lb. nylon resin flat woven, plenum-rated pull tape preinstalled to facilitate installation of up to six fiber-optic communications cables (two per cell). Provide a textile innerduct system constructed from white Nylon-6 resin containing melamine-cyanurate polymer.

**(E) Signal Shop Modifications****(1) Rack-Mounted Interconnect Center**

Furnish a rack-mounted interconnect center for splicing and terminating all 24 fibers for the SMFO cable into the Signal Shop. Furnish an interconnect center that complies with the requirements of interconnect centers in the "Splice Centers" section of these Project Special

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Provisions. Store a minimum of 100 LF of each fiber-optic cable inside the communications rack cabinet that contains the splice and connector housings.

Furnish a duplex receptacle for installation on the end of the 1" IMC electrical conduit on the wall above the communications rack.

**(2) Conduit, Conduit Fasteners and Fittings for Entrances**

Furnish all conduit, conduit fittings, outlet bodies, conduit straps, conduit-to-beam fasteners, rod-to-beam fasteners, threaded rods, conduit fasteners, bushings, duct sealant, heat shrink tubing, and any other hardware required to provide conduit to install:

- Missing conduit in the garage area of the Signal Shop to convey the replacement fiber-optic communications above the drop ceiling in the Signal Shop building as shown in the Plans.
- New conduit and network boxes (i.e., Ethernet outlets) in the Signal Shop to convey Ethernet cabling within the Signal Shop as shown in the Plans.

**35.3. CONSTRUCTION METHODS**

**(A) General**

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

Whenever possible, use existing cable raceways, ducts and drop ceilings to route fiber optic cable.

When working inside the buildings, cover all furnishings, including chairs and electronic and computer equipment with drop cloths to protect them from debris and to aid in cleanup. Replace the raised floor panels and ceiling panels and clean up all dust and debris by the end of each work period unless otherwise approved by the Engineer. Replace any floor panels damaged during installation of the above ceiling conduit at no expense to the Department.

Perform all work called for in the Plans to install cable in conduits and cable raceways, and to route cabling under raised floors, above suspended ceilings, and new and existing conduits.

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

Install splice centers with connector panels, splice trays, storage for slack cable or fibers, mounting and strain relief hardware, and all necessary hardware. Comply with all requirements of the "Fiber-Optic Splice Centers" section of these Project Special Provisions.

**(B) Traffic Operations Center (TOC)**

**(1) General Requirements**

Install equipment and route cable into the TOC through existing rigid metal and IMC conduit provided by others as shown in the Plans. Contact James Baker, Signal System Supervisor, at (336) 883-8540 at least 30 days in advance of work to confirm work schedule, work restrictions and to make arrangements for gaining access to the building. Perform all work in accordance with NESC regulations and guidelines.

When working inside the Municipal Building, cover all furnishings, including chairs and electronic/computer equipment with drop cloths to protect them from debris from above-ceiling work and to aid in cleanup. Carefully remove ceiling panels and fiberglass insulation above the

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removed panels. Replace the insulation and panels and clean up all dust and debris by the end of each work period unless otherwise approved by the Engineer. Replace any drop ceiling panels damaged during installation of the above ceiling conduit at no expense to the Department.

When working in a stairwell, do not block access to fire doors or to the stairs at any time and keep floor in front of stairwell door and stairs free from tripping hazards.

Install a continuous, plenum-rated, 3-cell flexible textile innerduct system inside spare 4" metal conduits entering the ground floor of the Municipal Building and continuing inside the building to facilitate installation of fiber-optic communications cables in those conduits. Install the fabric innerduct system in accordance with the manufacturer's instructions, using a breakaway swivel. Install the fabric innerduct in a continuous, unspliced length from the underground vault outside the building to the TOC on the ground floor of the building.

### (2) Signal System FO Cables & TOC Equipment

Pull the proposed signal system fiber-optic communications cables inside the building and into the TOC using one cell of the innerduct installed in one of the spare conduits. Leave the remaining cells and their pre-installed pull tapes for use by others for pulling additional fiber-optic communications cables into the Municipal Building and TOC at a later date.

Install the required rack-mounted interconnect centers in the communications racks in the TOC as shown in the Plans. Fusion splice all fibers in the entering fiber-optic cables to SMFO pigtailed inside rack-mounted interconnect center, then connect the pigtailed to the appropriate connectors in the interconnect center. Terminate all pigtailed from the incoming cable. Clearly label the patch panel of the interconnect center using an approved labeling method. Install SMFO jumpers between the connector panels and the Ethernet core switch.

Remove the existing composite video cable to the Transportation Department conference room on the first floor of the Municipal Building. Install new Ethernet cable for the new workstation in that conference room. Terminate the cable in the conference room on a wall plate. Terminate the cable in the TOC on the Ethernet patch panel.

City staff will remove and relocate the existing 65" video monitors to the new monitor wall. Remove the remaining existing video monitors and install new digital video monitors in the TOC in accordance with the "Digital Video Equipment" section of these Project Special Provisions.

### (3) Hi tran and Off-Street Parking Division FO Cables

Perform the following work to relocate the existing Hi tran and Off-Street Parking Division fiber-optic cables from the 4" conduit in which they currently reside to an adjacent spare 4" conduit with a recently installed flexible fabric innerduct.

**Notify the Engineer, the City of High Point Signal System Supervisor at (336) 883-8540 at least two weeks prior to rerouting the existing Hi tran and Off-Street Parking Division fiber-optic cables into the Municipal Building and TOC.** Provide the City of High Point Signal System Supervisor and the Engineer with updated splice details for the corresponding existing rack-mounted splice centers in the TOC, along with Contractor emergency contact information prior to beginning work. The interruption of connectivity of these Hi tran and Off-Street Parking Division fiber-optic cables shall be limited to 48 hours or less, and shall occur only on a non-holiday, non-High-Point-Market weekend. **Liquidated damages** for failure to restore communications in these existing Hi tran and Off-Street Parking Division communications cables within 48 hours are **\$1500 per 24-hour period or any portion thereof.**

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Prior to disconnecting the existing cables from the rack-mounted splice center in the TOC and pulling the cable out of the existing conduit, test the existing fiber-optic cable in the presence of the Engineer using an OTDR to verify that all fibers are operational and in good condition. Promptly report any failures or defects in the existing cable to the Engineer prior to disconnecting and removing the cable to avoid being held responsible for existing damage to or defects in the existing cable. Take photographs and make notes/sketches of existing splicing and fiber connectivity within the rack-mounted splice centers to ensure proper re-termination and reconnection of the fibers after the cables have been rerouted.

Upon completion of cable testing observed by the Engineer, carefully remove the existing communications cable from the existing conduit by pulling it back to the underground vault outside the Municipal Building. Pull the cable back into the Municipal Building and TOC through an adjacent spare conduit using one cell of the newly installed flexible fabric innerduct. Leave the remaining cells and their pre-installed pull tapes for use by others for pulling additional fiber-optic communications cables into the Municipal Building and TOC at a later date. Resplice the fibers in the existing Hi tran and Off-Street Parking Division communications cables to new SMFO pigtails in the existing rack-mounted splice centers and re-terminate the fibers on the splice center patch panel as they were before cable relocation.

Comply with the construction methods in the "Fiber-Optic Cable" section of these Project Special Provisions when pulling the cable through conduit. Re-test the fiber-optic cable using an OTDR in the presence of the Engineer to demonstrate that cable incurred no damage while being pulled back and subsequently reinstalled.

The Contractor, at his own expense, will be responsible for the replacement of the entire length of the existing fiber-optic communications cable between the underground vault outside the Municipal Building and the existing rack-mounted splice center in the TOC inside the Municipal Building if any damage is done to the existing Hi tran and Off-Street Parking Division fiber-optic communications cables while removing and reinstalling the existing cables.

Repair at own expense, any damage to the Hi tran and Off-Street Parking Division fiber-optic cables within 48 hours of notification of the incidence of damage. **Liquidated damages** for failure to repair a damaged Hi tran and Off-Street Parking Division fiber-optic communications cable and restore communications within 48 hours are **\$1500 per 24-hour period or any portion thereof.**

**(C) Signal Shop**

Install equipment and route cable into the Signal Shop through proposed rigid metal and IMC conduits as shown in the Plans. Contact James Baker at (336) 883-8540 at least 30 days in advance of work to confirm work schedule, work restrictions and to make arrangements for gaining access to the building. Perform all work in accordance with NESC regulations and guidelines.

Disconnect the existing conduits in the existing wall-mounted NEMA equipment cabinet and replace it with a new wall-mounted communications cabinet. Reinstall the conduits to terminate into the new rack. Terminate the conduit with a bushing to protect the cable from damage. Connect the power conductors to the power strip using appropriate methods. Install rack-mounted equipment inside the new wall-mounted communications rack.

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Install a surface mounted duplex receptacle on the end of the existing 1” IMC conduit that conveys electrical conductors to the communications rack. Plug the power strip from the rack into the receptacle.

Install 2” IMC conduit near the building entrance as shown in the Plans to complete a gap in the conduit. Install new IMC conduit in the Signal Shop as shown in the Plans. Attach the conduit to the wall using approved conduit straps anchored into the wall. Terminate the conduit with a bushing to protect the cable from damage.

Install the proposed fiber-optic and Ethernet cables in existing and proposed IMC conduits as shown in the Plans. Install the new fiber-optic cable above the ceiling where shown in the Plans and secure it. Follow procedures in the TOC subsection above for protecting equipment, cleaning up and terminating cable.

Feed the cables down through the conduit, into the rack-mounted fiber-optic interconnect center mounted in the wall-mounted communications rack. Install the required rack-mounted fiber-optic interconnect center in the Signal Shop as shown in the Plans. Fusion splice all fibers in the entering fiber-optic cables to SMFO pigtails inside rack-mounted interconnect center, then connect the pigtails to the appropriate connectors in the interconnect center. Install SMFO jumpers between the connector panels and the Ethernet distribution switch.

Apply an Engineer-approved, UL-listed fire-stop sealant (putty, caulk, mortar, etc.) to reseal gaps between any existing conduits and holes through interior building walls and partitions.

Reuse the existing video monitor in the Signal Shop in accordance with the “Building Modifications” section of these Project Special Provisions.

#### **35.4. MEASUREMENT AND PAYMENT**

*TOC modifications* will be measured and paid at the contract lump sum price. The price and payment will be full compensation for all work required to route and terminate the fiber-optic cable into the TOC as shown in the Plans, as well as any other work not called for under other items but required to accomplish the building modifications.

No separate measurement and payment will be made of the following items as they will be considered to be included in the payment for the TOC modifications:

- Furnishing and installing flexible fabric innerduct system installed in existing conduit underground conduit entering the Municipal Building and existing conduit inside the building leading to the TOC building;
- Pulling the existing Off-Street Parking Division and Hi tran SMFO cables out of the existing conduit and reinstalling them in a spare conduit entering the Municipal Building and TOC;
- Re-terminating the existing Off-Street Parking Division and Hi tran cables in their existing rack-mounted splice centers inside the TOC once reinstalled into the Municipal Building, including all necessary splice trays, SMFO pigtails, connectors and splice protectors.
- Removal of existing traffic signal system communications cable from the conduits into the Municipal Building and TOC;

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*Signal shop modifications* will be measured and paid at the contract lump sum price. The price and payment will be full compensation for all work required to install conduit and route the fiber-optic cable into the building as shown in the Plans, and then terminate the fiber-optic cable in a rack-mounted interconnect center, as well as any other work not called for under other items but required to accomplish the building modifications.

The Ethernet cables in the TOC and in the Signal Shop will be measured and paid for in accordance with the "Ethernet Cable" section of these Project Special Provisions.

No separate payment will be made for rack-mounted interconnect centers, patch panels, splice trays, splicing, conduit, conduit fittings, conduit hangers, conduit surface mounting hardware and brackets, duplex electrical receptacles, Ethernet outlet boxes with RJ-45 jacks, and fire-stop sealant as these will be considered incidental to the building modifications.

No separate measurement will be made for mounting hardware, nuts, bolts, brackets, connectors, grounding equipment as these will be considered incidental to the pay items listed above.

Computer hardware, Ethernet switches, digital video display monitors, video head-end equipment and communications racks will be measured and paid for separately in accordance with other sections of these Project Special Provisions.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
TOC Modifications	Lump Sum
Signal Shop Modifications	Lump Sum



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### 36. SUBMITTAL DATA AND DOCUMENTATION

#### 36.1. DESCRIPTION

Provide project documentation for Department review and approval as described below.

#### 36.2. SUBMITTALS

##### (A) General

The intent of this subsection of the Project Special Provisions is to provide the requirements for submittal data (i.e., shop drawings, catalogue cuts, manufacturers' literature, proposed changes to splice drawings, construction schedule, system design report, etc.) and the process by which submittal data will be reviewed.

Provide all submittal documentation in either 8½" x 11" or 11" x 17" format. No documentation smaller than 8½" x 11" will be accepted. No documentation larger than 11" x 17" will be accepted without the prior approval of the Engineer. All submittals will be reviewed and approved by the Department. Absence of comment will not grant approval.

##### (B) Project Construction Schedule

Prepare and submit for approval by the Engineer a schedule of the proposed working progress on the project in accordance with the instructions and on forms furnished by the Department. Update and submit the schedule no less than monthly.

The project schedule shall include a monthly schedule of values. At the end of each calendar month shown on the schedule, show a value (in dollars) of the cumulative project work projected to be completed. The initially proposed project schedule shall be submitted no later than 5 business days prior to the date of the project preconstruction conference and shall be approved before any work is begun on the project. Update and submit the project schedule five business days prior to the monthly construction meetings.

When conditions beyond the Contractor's control have adversely affected the Contractor's progress, or the Department has extended the completion date, the Contractor may submit a revised progress schedule to the Department for approval. Such revised progress schedule will not be approved unless accompanied by a detailed written statement giving the Contractor's reasons for the proposed revision.

The project construction schedule shall show at least:

- Major Activities,
- Critical Path,
- Task Dependencies,
- Float Time for Each Task,
- Project Start and Completion,
- Task Durations,
- Task Begin and End Dates,
- Milestones,
- Material Submittals,
- Submittal Review Periods,
- Equipment Deliveries,

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- Sample and Material Testing,
- Acceptance and Demonstration Testing,
- Training,
- Observation Period,
- Final Acceptance.

**(C) 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.

The ITS & Signals Qualified Products List (QPL) is available on the North Carolina Department of Transportation's Website at:

<https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals-Qualified-Products.aspx>

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.

**(D) System Design Report**

Prepare a System Design Report to describe the proposed network architecture and its configuration. Provide schematics to illustrate the network architecture and configuration, in addition to the written description. Provide a detailed description of the hardware and software to be installed. The report shall depict and describe the entire layout of the equipment and their connectivity. Provide a detailed listing of the hardware including brand and model numbers, functions and descriptions. Provide a detailed listing of the VLAN configuration and IP addresses. Bind the report either in a 3-ring notebook or other type of binding approved by the Engineer.

Submit the bound report and obtain approval before providing material submittals for the following packages of items as described below: central video equipment, software, computer hardware, and communications equipment.

**(E) Fiber-optic Splicing Drawings**

Submit drawings that illustrate any proposed changes to the fiber-optic splicing details for Department review and approval at least 10 working days prior to beginning fiber-optic splicing. Do not perform any fiber-optic splicing until the Department approves the proposed changes.

**(F) Submittal Requirements**

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.

The intent of submittals is to show that the materials completely meet the requirements of the Plans and Project Special Provisions and how the Contractor intends to construct or configure the

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materials. The Contractor shall clearly demonstrate in the submittals that the desired materials shall meet or exceed the requirements of the Plans and Project Special Provisions. Each submittal shall be sufficiently complete and detailed for the Department to review and approve the submittal. If the Department deems the submittal insufficient in detail or completeness for review or approval, the submittal will be returned as rejected. Additional time will not be granted for resubmittal.

Before material submittal data begins, provide to the Department a list of all submittals with approximate dates of submission that the Contractor intends to make. It is incumbent upon the Contractor to schedule reviews in a timely manner that will not delay his schedule.

Certain groups of materials are related in function and operate as a subsystem together. To ensure individual and subsystem compliance with the project requirements materials shall be submitted as packages as follows:

<b>Submittal Package</b>	<b>Description</b>
System Design Report	See "System Design Report" subsection above.
Controllers and Cabinets	2070E Controllers, 332A and 336S Cabinets, Conflict Monitors, Base Adapters, Base Extenders, Integrated Base Adapters, Preformed Cabinet Foundations
Fiber-optic Cable	Fiber-optic Cable, Drop Cables, Splice Enclosures, Interconnect Centers, Splice Trays, Cable Addition Kits, Delineator Markers, Junction Box Markers, Communications Cable Identification Markers
CCTV Equipment	Composite Cable, CCTV camera, CCTV cabinets (336A & NEMA Type 4); 2-way, side-of-pole bracket
Video Equipment*	Digital Video Encoders, Digital Video Decoders, Video Processor Units, Video Monitors, Video Joysticks
Computer Hardware	ITS Servers, Workstations, Laptops, Ethernet Cable
Communications Equipment*	Ethernet Core Switch, Ethernet Distribution Switch, Firewall, Ethernet Edge Switches, KVM Switch, Network Management Software (see "Communications Hardware" section of these Project Special Provisions for further requirements); Communications Racks.
Field Infrastructure	Conduit, Junction Boxes, Junction Box Replacement Covers, Terminal Splice Boxes/Cabinets, Electrical Service Equipment (Disconnects, Meter Bases, Combination Panels), Generator Transfer Panels, Heat Shrink Tubing and Retrofit Kits, Signal Heads, Stainless Steel Banding Hardware, and Misc. Hardware

\* Indicates submittal packages that cannot be submitted for review until the System Design Report has been submitted and approved.

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Identify all proprietary parts in Contractor-furnished material. The Department reserves the right to reject material that uses proprietary components not commercially available off-the-shelf products.

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 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. For submittals showing a variety of models and parts available from the manufacturer, clearly identify by circles, marking our other means the specific materials for which approval is requested.

Allocate 40 consecutive calendar days for the Department to review and respond to a submittal. Do not deviate from what is approved without approval by the Department. Do not fabricate or order material until receipt of the Department's approval. All submittals will be returned as either "Approved (as submitted)", "Approved as Noted" or "Rejected." The Contractor may proceed with fabrication or ordering for items marked "Approved." If an item is marked "Approved as Noted" without any stipulation for resubmittal, then the Contractor may proceed with fabrication or ordering. For any other notations, the Contractor shall revise the submittal, address comments and resubmit for approval.

### **36.3. DOCUMENTATION**

#### **(A) General**

Provide all manuals and plan of record (i.e., "as-built") documentation. All as-built plans and documentation shall be reviewed and accepted by the Engineer prior to final acceptance of the project. All documentation, except as otherwise specifically approved by the Engineer, must meet the following requirements:

1. Provide final as-built plans on 11" x 17" paper along with a PDF of each as-built plan sheet. Provide draft as-built plans for Department review on 22" x 34" paper. No documentation for as-built plans smaller than 11" x 17" will be accepted.
2. Provide any documentation that exceeds the size of 11" x 17" paper in a reproducible format 22" x 34" in size.
3. For electrical schematics and cabinet wiring diagrams not bound into printed manuals, provide paper copies at least 22" x 34" in size.
4. No non-plan documentation smaller than 8.5" x 11" will be accepted.
5. Do not fold or crease reproducibles.

As a minimum, provide the documentation described in the paragraphs below.

#### **(B) Plan of Record Documentation**

Provide as-built drawings that depict any changes of components, measurement or layout of the Plans. Show 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 splicing and terminations, etc., in detail in a reproducible format. Submit as-built construction changes within 10 consecutive calendar days after the Observation Period begins. Note and date

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each change on the drawings. Failure to revise as-built documentation to reflect current work may result in withholding of payments until the as-built documentation is brought current. The submitted as-built documentation 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. Include all field installation including the SMFO cable network installed on the drawings.

For underground conduit systems that house communications cable, furnish the Engineer with a plan of record drawing detailing the locations of the conduit system, including junction boxes and their corresponding GPS coordinates. For directionally-drilled underground conduit systems, identify the vertical location (i.e., depth) of the conduits along the run.

Store documentation for signal installations in a manila envelope placed in a weatherproof holder inside the cabinet drawer. Store all documentation furnished with the controllers and cabinets, including manuals, electrical schematic diagram, and cabinet wiring diagram inside the envelope in the weatherproof holder. Provide two marked-up "redline" copies of the signal plan and the electrical and programming detail, placing one copy in the weatherproof holder inside the cabinet drawer immediately upon installation of the cabinet and giving the second copy to the Engineer.

For CCTV camera assemblies, provide two copies of a parts list(s) that includes serial and model numbers of all Contractor-furnished equipment prior to final acceptance. All equipment and appurtenances shall be identified by name, model number, serial number, technical support and warranty telephone numbers, and any other pertinent information required to facilitate equipment maintenance.

The Department will provide the Contractor one electronic copy of the Plans for his use in developing the as-built drawings. Modify the original electronic file such that all changes are marked with callout boxes or other method approved by the Engineer. Any other base maps that may be necessary for the Contractor to prepare the as-built drawings in accordance with these Project Special Provisions will be the Contractor's responsibility. Use CADD conventions that are consistent with those used on the original plans.

Within 10 consecutive calendar 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-built drawings on 22"x 34" bond plan sheets.

Upon receipt of review comments from the Engineer, correct any errors and make all necessary revisions to the draft as-built plans prior to final acceptance of the project. Submit final as-built plans in electronic and hard copy format. Provide final hard copy as-built drawings on 11"x 17" bond plan sheets. Provide electronic plans in MicroStation (latest release in use by the Department) format along with copies of the same files saved/exported in AutoCAD format (for City use). Provide the electronic files on CD or DVD.

**(C) Manuals**

Provide at least five hard copies along with one electronic copy (on CD or DVD) of the following manuals:

- Operator's manuals containing detailed operating instructions for each different type or model of equipment. Ensure that manuals contain instructions for possible modification to equipment.

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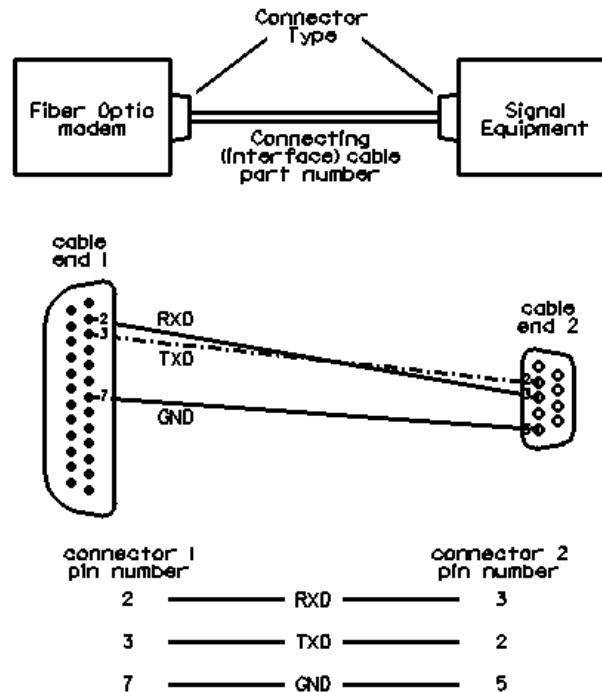
- Maintenance procedures manuals containing detailed preventative and corrective maintenance procedures and troubleshooting procedures for each different type of model of equipment.
- Installation, operations and training manuals for all Contractor-provided software.

The manuals provided above shall be in addition to manuals provided with and stored inside each control equipment cabinet.

#### (D) Wiring Diagrams

Provide detailed wiring diagrams that include interconnection (wired and wireless) of equipment with pin-out configurations, pin functions, and cable parts numbers. This includes configuration at each field equipment cabinet or equipment cabinet 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 format.

Example:



#### (E) Splice Diagrams

Prepare as-built splice diagrams that depict the communications cable plant as constructed. Depict the splices made at each splice enclosure by identifying spliced fiber and buffer tube. Ensure the splice diagram is in a similar format to those provided with the project plans. Identify all expressed fibers, spare fibers, used fibers and capped fibers.

Original splice diagrams will be provided in electronic format in MicroStation format. Designate any changes to these diagrams by using a method approved by the Engineer. Furnish as-built splice diagrams in MicroStation format along with copies of the same files saved/exported in AutoCAD format (for City use). Provide the electronic files on CD or DVD.

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Provide digital photographs of each fiber-optic splice. Include the splice number in the filename for each digital photo. Organize the photos in a logical folder structure and deliver them on CDs, DVDs or USB jump drive.

**36.4. 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.

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### 37. SYSTEM SUPPORT AND TEST EQUIPMENT

#### 37.1. DESCRIPTION

Furnish fiber-optic system support and test equipment and signal system support and test equipment with all necessary hardware in accordance with the Plans and Project Special Provisions.

#### 37.2. 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.

Before starting any system testing or training, furnish all fiber-optic communications system support and test equipment as well as signal system support and test equipment.

##### (B) Fiber-Optic Restoration Kit

Furnish a fully functional fiber-optic restoration kit consisting of the following items (minimum):

- Pliers-type strippers,
- Non-nicking fiber stripper tool with procedures,
- Buffer tube stripper tool with procedures,
- Fiber-optic cleaver with diamond blade and average cut less than 0.5 degrees from perpendicular,
- Screw driver set,
- Fiber-optic cable for cleaning alignment sleeves and LC connectors and jumper ends,
- Fifty 2.5 mm swabs,
- Twenty-four 2.5 mm cleaning tips for cleaning and LC connectors, ferrules, and termini faces,
- Two rolls of electrical tape, ¾-inch width,
- Laboratory type cleaning wipes,
- Metal ruler,
- Tweezers,
- Crimping pliers,
- Mechanical splice assembly manual,
- Mechanical splice assembly fixture,
- 12 non-adhesive, mechanical splices,
- Scissors,
- Hard-sided, padded storage case.
- Premises Service Kit includes tool frame, RJ-11/12 and RJ-45/CATV "F" die sets, round cable cutter/stripper, LC CST coax stripper, punch down tool with 110 and 66 blades, LAN & Telecom Cable Testing Kit, coax and data tester, plier type cutter/strippers, RJ-45 adapter and 2 BNC to CATV adapters.



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- 2 Mechanical Splice Trays with 12 mechanical splice capacity, compatible with the interconnect centers being installed in the traffic signal controller cabinets and CCTV cabinets.

**(C) Spare Cable and Connectors Kit**

Furnish a minimum of 10 of each type of fiber-optic jumper of each length and each type of connector combination used on the project. In addition, furnish the following:

- 500 feet of outdoor-rated, UV-resistant CAT 5e cable,
- 10 BNC crimp-on male connectors,
- 20 CAT 5e patch cords, 5 feet long with molded strain relief cables,
- 6 CAT 6 patch cords, 5 feet long with molded strain relief cables, and
- 20 RJ-45 male connectors

**(D) Fiber-Optic Power Meter**

Furnish one fiber-optic power meter 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:  $\pm 3$  percent ( $\pm 0.1$  dB) at -20 dBm at 70 degrees F at calibrated wavelengths,
- Readout resolution: 4 digits, 0.01 dBm,
- Display: Backlit LCD,
- Fiber-optic connector: LC, SC and ST,
- 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° F,
  - Storage: 0° to 150° F,
- Relative humidity: 5 to 95 percent, non-condensing,
- Battery power: Alkaline: 28 hours; NiCad: 8 hours (recharger and NiCad batteries provided)
- Carrying case

**(E) Optical Light Generator**

Furnish optical light generators for testing link losses and trouble-shooting single-mode fiber-optic cables and networks. Provide a lightweight, compact, handheld unit constructed of rugged, durable materials. Provide a unit with automatic wavelength detection mode and the following additional features:

- Emitter type: Class I laser
- Spectral width: 5 nm or less,
- Nominal wavelengths: 1310 and 1550 nm,
- Warm-up period: 15 minutes or less

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- Display: Backlit LCD,
- Fiber-optic connector: LC, SC and ST
- Power/signal stability:  $\pm 0.10$  dB,
- Modulation: 270, 1k, 2k Hz,
- Weight with batteries: 1.2 lb. max.
- Temperature (minimum range):
  - Storage: 32° to 122° F
  - Operating: -10° to 150° F,
- Relative humidity: 0% to 95% non-condensing,
- Batteries: Alkaline: 28 hours; NiCad: 8 hours (recharger and NiCad batteries provided)
- Carrying case.

**(F) Visual Fault Locator**

Furnish one lightweight, compact, handheld, battery-powered visual fault locator (VFL) designed for visually locating faults in single-mode fiber-optic cables, jumpers, pigtails and patch panels, such microbends, breaks, bare fibers, poor connectorization and poor splicing. Provide a unit with a red laser light source that when coupled with an optical fiber will identify a fault in the optical path by emitting light (e.g., producing a glow) at the point of the fault. Provide a unit constructed of rugged, durable materials and which has a dust cap tethered to the unit to protect the optic interface when not in use. Provide batteries of the required size and quantity and a carrying case or protective belt holster with each visual fault locator. Provide the following additional features:

- Emitter Type: Class II Visible Red Laser
- Wavelength: 635 - 670 nm
- Peak Output Power: 1mW
- Selectable Output Modes: Continuous (steady; constant-on) and pulsed (flashing; blinking) at 2-3 Hz frequency
- Batteries: No more than two AA or two AAA (alkaline)
- Battery Life: Minimum of 30 hours of continuous operation in continuous mode
- Connector Interface: 2.5mm ferrule connector, Type LC, SC or ST
- Weight with Batteries: 5.7 oz. (180 g) maximum
- Operating Temperature (min. range): 14°F to 113°F (-10°C to +45°C)
- Storage Temperature (min. range): -4°F to 140°F (-20°C to +60°C)

**(G) Conflict Monitor Tester with Notebook Computer**

Furnish a standalone, portable conflict monitor test unit with notebook computer intended for use on workbench. 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 conflict 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 or DVD 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 electronically to a disc file. A "No Faults Detected" indication shall be displayed as appropriate.

**C-5558****ITS-315****Guilford County****(H) Test Controllers with Cabinets**

Furnish and install a 2070E controller with a 332A test cabinet at both the Signal Shop and the TOC. Each test cabinet shall include a full complement of detector cards, switch packs, a conflict monitor, two (2) AC isolators, two (2) DC isolators and a railroad preemption test panel. Provide a railroad preemption panel that is identical to those installed at railroad preemption locations in the field under this contract. Fully label the test cabinet and panels. Equip the 332 test cabinet with an auxiliary output file to simulate flashing yellow arrow phasing. Provide controllers and cabinets that comply with the material requirements for controllers and cabinets in preceding subsections of this Project Special Provision. Fully label each test cabinet. Plug the power cord from the test cabinet into an existing wall receptacle adjacent to the cabinet.

**(1) Construction**

Furnish each test cabinet with a heavy-duty aluminum dolly base with heavy-duty, locking casters. The base shall accommodate a fully equipped, base-mounted cabinet. Attach a pole or pedestal to each base to support a display panel, which shall be located beside the cabinet for convenient use by maintenance personnel. The display panel shall have all indicators and switches on the front and shall have a suitable aluminum enclosure. The panel shall be fully labeled.

**(2) Indicators**

The panel shall contain indicators to display the outputs of all the cabinet's traffic signal load switched. 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 signal displays and 4 special functions. The indicators shall use LED's that are user replaceable.

**(3) Controls**

Equip the display panel with controls that are connected to simulate all the inputs, for test purposes, to the controller which are not already accommodated by switches in the controller cabinet.

**(4) Harnesses**

Connect the display panel to the controller cabinet by means of harnesses. Conceal the harnesses inside the pedestal or pipe supporting the panel and route the harnesses into the test cabinet through the bottom of the cabinet.

**(5) Connection to the System**

Furnish and install Ethernet cables to connect the test controllers and their corresponding conflict monitors to the Ethernet switch at their respective locations.

**(I) CCTV Test Cabinet**

Furnish and install a Type 336A CCTV test cabinet in the TOC. The test cabinet shall include a Type 336A cabinet be configured identically as installed at field locations under this project. The test cabinet shall include a complete CCTV camera with enclosure and built-in encoder, CCTV test panel, and all cabling necessary to integrate the camera and all cabinet equipment. The test cabinet and panel shall be fully labeled. Wire the CCTV to the cabinet.

Integrate the CCTV test cabinet with a CCTV assembly furnished under the "CCTV Field Equipment" section of these Project Special Provisions.

**C-5558****ITS-316****Guilford County****(1) Construction**

Mount the Type 336A CCTV test cabinet on a heavy-duty aluminum dolly base with four (4) heavy duty locking casters. The base shall accommodate a fully equipped base-mounted CCTV cabinet. A pole or pedestal shall be attached to the base to support a CCTV camera, which shall be located beside the cabinet convenient for use by maintenance personnel.

**(2) Connection to System**

Furnish and install Ethernet cables to connect the CCTV test cabinet to the Ethernet core switch in the TOC.

**37.3. MEASUREMENT AND PAYMENT**

*Furnish fiber-optic restoration kit* will be measured and paid as the actual number of fiber-optic restoration kits furnished and accepted.

*Furnish spare cable and connectors kit* will be measured and paid as the actual number of spare cable and connectors kits furnished and accepted.

*Furnish fiber-optic power meter* will be measured and paid as the actual number of fiber-optic power meters furnished and accepted.

*Furnish optical light generator* will be measured and paid as the actual number of optical light generators furnished and accepted.

*Furnish visual fault locator* will be measured and paid as the actual number of visual fault locators furnished and accepted.

*Furnish video monitor* will be measured and paid as the actual number of video test monitors furnished and accepted.

*Furnish conflict monitor tester* will be measured and paid as the actual number of conflict monitor testers with notebook computers furnished and accepted. There will be no separate measurement and payment for the notebook computer as it will be considered incidental to furnishing the conflict monitor tester.

*Furnish detector card (Model 222)* will be measured and paid as the actual number of Type 222 detector cards furnished and accepted.

*Furnish 2070E controller* will be measured and paid as the actual number of 2070E controllers furnished and accepted.

*Furnish \_\_\_\_\_ cabinet* will be measured and paid as the actual number of each type of controller cabinet furnished and accepted.

*Furnish 2018 enhanced conflict monitor* will be measured and paid as the actual number of Model 2018 enhanced conflict monitors furnished and accepted.

*Furnish Ethernet edge switch* will be measured and paid as the actual number of Ethernet edge switches furnished and accepted.

*Furnish digital hardware video encoder* will be measured and paid as the actual number of digital hardware video encoders furnished and accepted.

*Furnish digital hardware video decoder* will be measured and paid as the actual number of digital hardware video decoders furnished and accepted.

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*Furnish CCTV camera assembly* will be measured and paid as the actual number of CCTV camera assemblies furnished and accepted.

*Furnish CCTV cabinet* (\_\_\_\_) will be measured and paid as the actual number of each type of CCTV cabinet furnished and accepted.

*Test controller with cabinet (2070E, 332)* will be measured and paid as the actual number of 2070E controllers with a 332 test cabinet furnished, installed in the Signal Shop and in the TOC and accepted.

Test cabinets and controllers will not be included in the numbers of spare cabinets and controllers provided for this project.

No measurement will be made of load switches, AC isolator cards, DC isolator cards, detector cards, preemption panels, and auxiliary output files provide with the test controllers and test cabinets as they will be considered incidental to furnishing and installing the test controllers with cabinets. No measurement will be made of Ethernet cables required to connect the test controller and conflict monitor to an Ethernet switch and the power cord required to plug the test cabinet into the existing wall receptacle as they will be considered incidental to furnishing and installing the test controllers with cabinets.

*CCTV test cabinet* (\_\_\_\_) with CCTV camera assembly will be measured and paid as the actual number of CCTV test cabinets by type with CCTV camera assembly furnished, installed and accepted in the TOC. No measurement will be made of the camera assembly nor for the Ethernet cables required to connect the CCTV test cabinet to the Ethernet distribution switch and the power cord required to plug the test cabinet into the existing wall receptacle as they will be considered incidental to furnishing and installing the CCTV test cabinet.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Furnish Fiber-Optic Restoration Kit	Each
Furnish Spare Cable and Connectors Kit	Each
Furnish Fiber-Optic Power Meter	Each
Furnish Optical Light Generator	Each
Furnish Visual Fault Locator	Each
Furnish Conflict Monitor Tester	Each
Furnish Detector Card (Model 222)	Each
Furnish 2070E Controller	Each
Furnish 336S Cabinet	Each
Furnish 332 Cabinet	Each
Furnish 2018 Enhanced Conflict Monitor	Each
Furnish Ethernet Edge Switch	Each

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**Pay Item**

**Pay Unit**

Furnish Digital Hardware Video Encoder

Each

Furnish Digital Hardware Video Decoder

Each

Furnish CCTV Camera Assembly

Each

Furnish CCTV Cabinet (336A)

Each

Furnish CCTV Cabinet (NEMA 4)

Each

Test Controller with Cabinet (2070E, 332)

Each

CCTV Test Cabinet (336A)

Each

**C-5558****ITS-319****Guilford County****38. TRAINING****38.1. DESCRIPTION**

Provide training for the installation, operation and maintenance of:

- Ethernet core switch,
- Ethernet distribution switch,
- Ethernet edge switches,
- Servers,
- Network configuration,
- Fiber-optic communications cable,
  - Fiber-optic interconnect centers,
  - Splice enclosures (aerial and underground)
  - Splice trays and other related fiber-optic equipment in accordance with the Plans and Project Special Provisions,
- CCTV field equipment,
- Digital video encoders and decoders,
- Video processing units,
- Video monitors,
- Signal System Software,
- Controller hardware and local controller software including:
  - 2070E Controllers,
  - Cabinets,
  - Conflict monitors,
  - Detectors,
  - OASIS® IP (Version) controller software,
- UPS, and
- System support and test equipment.

**38.2. MATERIALS****(A) General**

Provide training in the installation, operation, maintenance, troubleshooting and repair of all equipment and software. Prepare training outline, agenda, training manuals, training exercises, instructor resumes and any other teaching aids and submit them for approval by the Department prior to conducting training. For each course, provide a training exercise to demonstrate through hands-on activities the subject matter covered in the course lecture or course section. For exercises requiring computers, furnish enough computers to have one computer per two students.

Provide all laptop computers, projectors and projector screens needed for the training. Provide all audiovisual equipment needed for presentations and demonstrations, including video players. Provide new test cabinets, controllers and conflict monitors for use during the training. Furnish all power cords, extension cords, power strips and other cables required for the equipment used in the training.

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Provide draft-training material to the Department for review and approval at least 60 days prior to the scheduled training. Provide adequate time for review and revision of the draft training materials. Furnish all audio-visual equipment, demonstration equipment, including a test cabinet, and "hands-on" equipment in support of the envisioned training. Each training participant shall receive a copy of course materials including both comprehensive and presentation manuals. Assume there will be a maximum of 16 students in each class session. Provide two additional copies of these documents to the Department.

Utilize training personnel well versed in the subject matter and with extensive field experience dealing with real world problems. Utilize training personnel that have been certified by the respective manufacturers.

The City shall provide the training facility. Provide the Department with a 30-day notification to carry out the training so that arrangements can be made for attendance. Coordinate a mutually agreeable date, time and location with the City through the Engineer. The Engineer shall approve the training schedule time and location. A "day" of training shall consist of 8 hours of training.

When two sessions are required, conduct the first session early in the project, scheduling it to occur immediately prior to the first implementation of the given software or hardware so that City and Department staff can become familiar with the software or hardware prior to its implementation on the project. Conduct the second session near the conclusion of the project. If more than two sessions are required, conduct the remaining sessions approximately midway between the first and last sessions. Do not conduct multiple sessions back-to-back or near end of project. **Conduct the first session of training on 2070 traffic signal controllers, cabinets, conflict monitors and controller firmware at least one week prior to installing the first new controller with cabinet on the project.**

Develop the course content specifically for the products supplied for this project. The course shall include the following topics:

- Introductory-level briefing to familiarize attendees;
- Terminology;
- Theory of operation;
- Installation;
- Hardware and software configuration;
- Operating procedures and capabilities;
- Testing, diagnostics and troubleshooting;
- Software applications;
- Use of the system documentation to operate, diagnose, maintain, and expand the system; and
- "Hands-on" use of the system, laptop computer and software, system test equipment, and any other system equipment supplied.



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Provide course lengths as follows:

Course	Type of Training	Total Students	No. of Sessions	Length (Days)
Ethernet Communications and Networking*	Lecture and Hands-on Exercises	16	2	5
Fiber-Optic Communications	Lecture and Hands-on Exercises	16	2	3
CCTV Field Equipment	Lecture and Hands-on Exercises	16	1	1
Digital Video Equipment	Lecture and Hands-on Exercises	16	1	0.5
Signal System Software		16	2	4
2070 Traffic Signal Controllers, Conflict Monitors, Cabinets, and Controller Firmware	Lecture and Hands-on Exercises	16	3	5
UPS	Lecture and Demonstration	16	1	0.25

\* Do not conduct any training on this topic until the System Design Report has been submitted for review and subsequently approved by the Department.

Provide additional specific training as described below.

**(B) Ethernet Communications and Networking**

Provide training using the test and repair equipment furnished for the project. The training session shall be presented by field service specialist(s) employed by the suppliers of the communications system components. Provide training for the Ethernet communications and networking for the following categories and for the minimum number of hours shown:

Course	Type of Training	Length (Days)
<b>Ethernet Communications and Networks</b>		2
Terminology	Lecture	
Theory of design	Lecture	
Network configuration	Lecture	
VLANs	Lecture	
Equipment overview	Lecture	
Network maintenance	Lecture, Demonstration and Hands-on	
System backup, data archiving, routine procedures	Hands-on	
Troubleshooting procedures	Hands-on	
Testing	Hands-on	
System restart and recovery	Hands-on	
Question and answer session	Lecture	
<b>Ethernet Switches (all types and configurations)</b>		2
Introduction	Lecture	
Configuration and programming	Lecture and Hands-on	

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<b>Course</b>	<b>Type of Training</b>	<b>Length (Days)</b>
Review of Maintenance Manual	Lecture and Hands-on	
Review of Operations Manual	Lecture and Hands-on	
Maintenance	Lecture, Demonstration and Hands-on	
Routine	Hands-on	
Troubleshooting procedures	Hands-on	
Testing	Hands-on	
System restart and recovery	Hands-on	
Question and answer session	Lecture	
<b>Network Management Software</b>		
Introduction	Lecture	
Network Configuration (changes in network only)	Lecture and Hands-on	
Question and answer session.	Lecture	

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**(C) Fiber-Optic Cable**

Provide training using the test and repair equipment furnished for the project. Provide training for the fiber-optic system for the following categories and for the minimum number of hours shown:

Course	Type of Training	Length (Days)
<b>Ethernet Switches – Optics</b>		1
Safety	Lecture	
Introduction to Ethernet switch optics	Lecture	
Review of Maintenance Manual – optics	Lecture	
Review of Operations Manual - optics	Lecture	
Question and answer session	Lecture	
<b>Fiber-Optic Cable System</b>		2
Safety	Lecture	
Introduction to fiber-optics, theory, and principles	Lecture	
Fiber and cable types	Lecture and Hands-on	
National Electrical Code considerations	Lecture and Hands-on	
Plenum and riser type cable		
Outdoor cable, etc.		
Introduction to terminating hardware, end equipment, and applications	Lecture, Demonstration and Hands-on	
Connectors (ST, SC, LC, etc.)		
Splice enclosure, splice trays, and connector panels		
Cable placement techniques		
Question and answer session		
Cable handling and preparation (sheath removal, grip installation, etc.)	Lecture, Demonstration and Hands-on	
Splicing and terminating methods	Lecture, Demonstration and Hands-on	
Mechanical splicing using various techniques		
Fusion splicing		
Field termination of connector types		
Introduction to cable plant testing procedures	Lecture, Demonstration and Hands-on	
Proper usage of optical light generator and power meter		
Class project (build working system using cables/connectors made by attendees)	Lecture, Demonstration and Hands-on	
Question and answer session.		
Class project -- Testing and troubleshooting	Lecture, Demonstration and Hands-on	
Cable system maintenance and restoration	Lecture	
Question and answer session.		

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**(D) CCTV Field Equipment**

Provide training that includes operational theory and procedures of the field components of the CCTV system. This training shall be oriented towards the users and maintenance personnel of the system. The training session shall be presented by field service specialist(s) employed by the suppliers of the CCTV field components. This training session shall include exercises that should take one-half of the day. Provide training for the CCTV field equipment and the local CCTV camera software as described below:

Course	Type of Training	Length (Days)
Operations	Lecture	0.5
Theory of operation	Lecture, Demonstration	
Local camera programming	Lecture, Demonstration and Hands-on	
Camera addresses		
Presets		
Privacy zones		
Tours		
Other features		
Maintenance	Lecture	0.5
Routine maintenance	Lecture, Demonstration and Hands-on	
Testing	Lecture, Demonstration and Hands-on	
Troubleshooting	Lecture, Demonstration and Hands-on	

**(E) Digital Video Equipment**

Provide training that includes operational theory and procedures of the central components of the CCTV system. This training shall be oriented towards users and maintenance personnel of the system. This training session shall include hands-on exercises that should take approximately one-half of the session. The training shall address the use of, but not limited to, the following devices: NVR, encoders, software decoder, monitors, and the video server. Provide training for the digital video equipment as described below:

Course	Type of Training	Length (Days)
Operations and Theory of operations	Lecture	0.25
Programming	Lecture, Demonstration and Hands-on	0.25
Maintenance	Lecture	
Routine maintenance	Lecture, Demonstration and Hands-on	
Testing	Lecture, Demonstration and Hands-on	
Troubleshooting	Lecture, Demonstration and Hands-on	

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**(F) Signal System Software**

Provide training that includes operational theory and procedures of the signal system software. This training shall be oriented towards users and maintenance personnel of the system. This training shall include hands-on exercises that should take approximately one-half of the total session. The training session shall be presented by field service specialist(s) employed by the suppliers of the signal system software. Provide training for the signal system central software as described below:

Course	Type of Training	Length (Days)
Part 1	Lecture & Demonstration	1
Overview of Part 1		
Time-of-day operation and event scheduling		
Traffic responsive pattern selection algorithms		
Reporting Capabilities	Lecture, Demonstration and Hands-on	
Interactive database manipulation		
Theory and application of traffic responsive operations		
Special functions		
Part 2	Lecture and Hands-on	1
Review of Part 1/Overview of Part 2		
System operations and recommended procedures		2
Part 3	Lecture, Demonstration and Hands-on	
Review of Parts 1 & 2/Overview of Part 3		
Development and modification of system graphics		
Preparation of dynamically functioning graphics		

**(G) 2070 Controllers, Conflict Monitors, Cabinets and Controller Firmware**

Provide three identical training sessions in the basic theory, operation, routine maintenance and troubleshooting of the 2070 controller equipment, cabinets, conflict monitors, auxiliary output files and other related equipment. **Conduct one of these training sessions prior to the installation of any new controllers and cabinet on the project.** Assume the attendees have no working knowledge through their current use of 2070 controllers.

Provide training, both lecture (i.e., classroom instruction) and hands-on exercise in the use of the local controller firmware, including how to load the firmware onto a new controller. Provide one computer for every two students for the hands-on exercises.

Training for controllers and cabinets shall be integrated into a single session with training exercises for cabinets and training exercises for controllers running concurrently. Instructors from the controller Vendor and instructors from the cabinet Vendor shall be in attendance during all days of the session.

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Controller-specific instruction during the session shall be taught by experienced Vendor personnel who thoroughly understand both the traffic engineering aspects of signal timing and the entry of timing into the controller and internal TBC's. Cabinet-specific instruction during the session shall be taught by a field service specialist(s) employed by the manufacturer.

The signal controller and cabinet assemblies session shall include, but not be limited to, the following:

- Formal classroom presentation of the functional operation of the signal cabinet, including a discussion on each individual component of the cabinet that details its function, installation techniques, and normal operation
- Formal classroom presentation of the functional operation of the 2070E controller.
- Formal classroom presentation of proper cabinet wiring procedures
- Hands-on workshop on installation of electrical components and surge protection for cabinets.
- Formal classroom presentation and hands-on workshop on operation of signal monitor tester
- Hands-on workshop on timing data entry for 2070E controller.
- All local intersection timing parameters
- All coordination timing parameters
- All parameters and threshold levels associated with traffic responsive operation
- Formal classroom presentation and hands-on workshop on operation of local controller utility software
- Formal classroom presentation and hands-on workshop on operation of controller tester
- Hands-on workshop of proper installation, programming, and troubleshooting of conflict monitors
- Hands-on workshop of proper installation, programming, and troubleshooting of detector cards and lead-in cable
- Hands-on workshop wherein maintenance personnel will troubleshoot simulated controller and cabinet assembly faults to the component level

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The lecture, demonstration; hands-on class shall include the following sessions specific to the 2070 related family of hardware and software (controllers, cabinets, signal monitors and detectors):

<b>Course</b>	<b>Type of Training</b>	<b>Length (Days)</b>
Programming	Lecture, Demonstration and Hands-on	1.5
Phasing,		
Timing,		
Preemption,		
Coordination,		
Data transfer		
Operations	Lecture	1.5
Theory of operation	Lecture, Demonstration and Hands-on	
Testing	Lecture, Demonstration and Hands-on	
Maintenance	Lecture	2
Routine maintenance	Lecture, Demonstration and Hands-on	
Troubleshooting	Lecture, Demonstration and Hands-on	

Each of the identical training sessions shall consist of five consecutive days, beginning on a Monday.

**(H) UPS**

Provide training for the UPS units that is 2 hours in length, including both classroom and “hands-on” training.

**38.3. MEASUREMENT AND PAYMENT**

*Training* will be measured and paid at the contract lump sum price. The price and payment will be full compensation for all work required by this section of these Project Special Provisions.

Payment will be made under:

**Pay Item****Pay Unit**

Training

Lump Sum

### **39. TESTING AND ACCEPTANCE**

#### **39.1. GENERAL**

Conduct and complete successfully the following progressive series of tests before acceptance: field demonstration test prior to installation, installed standalone tests, system test of the network hardware, network management software and an operational test. Develop a comprehensive series of test plans for each device to determine the equipment was correctly installed and meets the requirements of materials, workmanship, performance, and functionality required in the plans and project special provisions. The test plans shall describe the functions to be tested, purpose of test, setup requirements, procedures to be followed, any inputs and expected outputs for each test, criteria for pass/fail and any required tools or test equipment. Any software testers shall be pre-approved by the Department.

Develop as part of the Test Plan a Traceability Matrix of all the individual subsystem functional requirements to be used to cross-reference each planned test to a specific contract requirement to be verified. This Test Evaluation/Traceability Matrix shall be used by the Engineer to crosscheck the functional requirements and the results.

A key element of test plans, where appropriate, is the introduction of forced errors into the functional test. The test plan shall check the actual result of the forced error against the anticipated result. Tests will be performed by the Contractor and witnessed by the Department and the City. No deviation from the written test procedure shall be permitted without approval from the Engineer. Any changes to the approved test procedure to accommodate unforeseen events during the time of testing shall be documented in a copy of the master test procedure. Immediately following the conclusion of each test, the Department, the City and the Contractor shall meet to agree on the results observed and recorded during the testing. This will form the basis for the conclusions reported in the test plan. All test results, notes, and observations shall be maintained in both electronic and hard copy. Maintain complete records of all test results during all stages of testing.

#### **39.2. INSTALLED SITE TESTS**

Conduct an approved, standalone equipment installation test at the field site. Test all standalone functions of the field equipment using equipment installed as detailed in the plans, or as directed by the Engineer.

Complete approved test plan forms and turn them over to the Engineer for review as a basis for rejection or acceptance. Provide a minimum notice of 30 calendar days prior to all tests to permit the Engineer or his representative to observe each test.

If any unit fails to pass its stand-alone test, correct the unit or substitute another unit in its place, then repeat the test.

If a unit has been modified as a result of a standalone test failure, prepare a report describing the nature of the failure and the corrective action taken and deliver it to the Engineer prior to re-testing the unit. If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the Department or an extension of the contract period.



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Utilize vendor supplied device software to perform diagnostic tests of each device. The vendor supplied diagnostic software shall be provided to the Department before final acceptance. Test the following features of each competent as described below.

**(A) Fiber-Optic Cable**

Conduct optical time domain reflectometer (OTDR) tests on the cable on the reel and after the cable is installed and terminated. Provide written notification a minimum of ten days before beginning fiber-optic cable testing.

After splicing is completed, perform bi-directional OTDR tests on each fiber, including unused fibers, to ensure the following:

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

Install a 1000-foot pre-tested launch cable between the OTDR and fiber-optic cable to be tested.

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

Test the fiber-optic cable at both 1310 and 1550 nm.

Furnish durable labeled plots and electronic copies on a CD or DVD of test results for each fiber including engineering calculations demonstrating that OTDR test results meet or exceed the attenuation requirements and that optical properties of the cable have not been impaired. Clearly label each OTDR trace identifying a starting and ending point for all fibers being tested.

Provide engineering calculations and tests for fiber-optic cable that demonstrate the loss budget where the fiber originates and where the fiber meets an electronic device. The calculations shall summarize the optical losses versus the allowable losses for the communications equipment between each pair of communications hardware. Provide a summary section or spreadsheet with a labeled tabular summary showing each test segment with begin and end points and actual versus allowable losses. Label the manufacturer's make, model number and software version of the OTDR used for testing.

Furnish one hard copy of each of the OTDR trace results and electronic copies of all trace results on a CD or DVD along with digital photographs of all splices.

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

**(B) Ethernet Communications System****(1) High Point TOC and Signal Shop Wiring**

Test any cable installed as part of this project per TIA 568 specifications for continuity, opens, shorts, split pairs, mis-wiring and reversed pairs. Test for DC resistance, impedance, and line capacitive loading. Correct any faults and retest. If retest fails, replace defective cable or connectors.

**C-5558****ITS-330****Guilford County****(2) ITS Servers, Workstations, and Laptop Computers**

The following operational tests shall be performed for each ITS server, workstation, and laptop computer in accordance with the test plans. After the equipment has been installed:

- Connect all components (displays, mice, keyboards, printers, network cables, power supplies),
- Configure network communications,
- Map network drives,
- Test connections to all devices by pinging,
- Run diagnostic utilities on the hardware,
- Map all network servers, and
- Print test pages for each workstation on each printer to verify printer configuration.

**(3) Ethernet Switches**

Once the Ethernet core switch, Ethernet distribution switch and Ethernet edge switches have been installed, conduct local field acceptance tests of the Ethernet edge switch field site according to the submitted test plan. Perform the following:

- Verify that physical construction has been completed as detailed in the Plans,
- Inspect the quality and tightness of ground and surge protector connections,
- Verify proper voltages for all power supplies and related power circuits,
- Connect devices to the power sources,
- Verify all connections, including correct installation of communication and power cables, and
- Perform testing on multicast routing functionality.

Repair or replace defective or failed equipment and retest.

Upon satisfactory completion of operational test, begin an Observation Period of 60 days prior to system acceptance.

**(4) KVM Assembly**

The following operational tests shall be performed for each KVM assembly in accordance with the test Plans. After the KVM assembly has been installed:

- Connect all servers, monitors, keyboards, mice, and power supplies,
- Program the on-screen display to assign ports and bank numbers and to enter the names of each server in the menu,
- Program the KVM switch for scan features, access privileges, and
- Select each server and ensure the mouse and keyboard work the selected server and the monitor displays the appropriate server.

**(C) Traffic Signal Controllers and Conflict Monitors**

The following items, not otherwise required to be tested elsewhere, shall be tested: cable continuity, grounding, power-up self-test, proper controller sequencing, detector and pedestrian pushbutton calls.

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Perform self-diagnostic tests on all electronic test equipment provided to the Department to ensure the equipment is proper operating order. Utilize the supplied test equipment in the training for the fiber-optic cable.

**(E) CCTV Field Equipment**

Develop an operational test plan that demonstrates all requirements of the equipment and software. Submit for approval before conducting tests.

Notify the Department at least 14 calendar days prior to the proposed date for the tests. The Department and the City shall have the right to witness such tests, or to designate an individual or entity to witness such tests.

Perform the following local field operational tests at the camera assembly field site in accordance with the test Plans. A laptop computer shall provide camera control and positioning. After completing the installation of the camera assembly, including the camera hardware, power supply, and connecting cables, the Contractor shall:

- Furnish all equipment, appliances, and labor necessary to test the installed cable and to perform the following tests before any connections are made,
- Verify that physical construction has been completed,
- Inspect the quality and tightness of ground and surge protector connections,
- Check the power supply voltages and outputs,
- Connect devices to the power sources,
- Perform continuity tests on the surveillance camera's stranded conductor element using a meter having a minimum input resistance of 20,000 ohms per volt and show that each conductor has a resistance of not more than 16 ohms per 984.3 feet of conductor;
- Measure the insulation resistance between the conductors, and between each conductor, ground, and shield using a megger. The resistance must be infinity. Perform all resistance testing after final termination and cable installation, but prior to the connection of any electronics or field devices; and
- Replace any cable that fails to meet these parameters, or if any testing reveals defects in the cable, and retest new cable as specified; and
- Verify installation of specified cables and connections between the camera, PTZ, camera control receiver, and control cabinet,
- Perform the CCTV assembly manufacturer's initial power-on test in accordance with the manufacturer's recommendation,
- Set the camera control address,
- Verify the presence and quality of the video image in the field cabinet with a portable NTSC-approved monitor or laptop computer
- Exercise the pan, tilt, zoom, focus, iris opening, and manual iris control selections, and the operation, preset positioning, and power on/off functions,
- Demonstrate the pan and tilt speeds and extent of movement to meet all applicable standards, specifications, and requirements,
- Verify proper voltage of all power supplies, and

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- Interconnect the communication interface device with the communication network's assigned fiber-optic trunk cable and verify that there is a transmission LED illuminated.

Test the grounding system per ANSI/IEEE C62.41 and ANSI/IEEE C62.45 as applicable. Measure the ground impedance utilizing an instrument designed specifically to measure and document the ground impedance. Provide written test results of the ground impedance for each location to the engineer prior to backfilling the grounding electrode. The test results shall include the instrument model, date of instrument calibration, and local environmental conditions at the time of testing. Certify and sign the test results by the Contractor.

Repair or replace defective or failed equipment and retest.

**(F) Digital Video Equipment**

Test the components of the digital video equipment as follows:

- Check all ground, power, data, Ethernet and digital video connections,
- Run power up self test on each piece of equipment,
- Run all available vendor-supplied self-diagnostics.

**39.3. SYSTEM TESTING****(A) General**

Conduct tests as described below of the traffic signal and CCTV subsystems. Conduct approved device subsystem tests on the field equipment with the High Point TOC equipment including, at a minimum, all remote communications hardware monitoring and control functions. These tests shall be a demonstration of overall system stability. During this test period, limit downtime due to mechanical, electrical, or other malfunctions to a maximum of eight hours. The Engineer has the right to suspend the test to correct deficiencies and restart the test or to extend the test period by time equal to the downtime in excess of eight hours.

Conduct device and subsystem tests of any repaired or replaced equipment.

Display the event log from the traffic signal and CCTV software for a minimum of seven days. Complete approved data forms and turn them over to the Engineer for review, and as a basis for rejection or acceptance.

The Engineer has the right to suspend the test to correct deficiencies and restart the test or to extend the test period by time equal to the downtime in excess of eight hours. If a component has been modified as a result of a test failure, prepare a report and deliver it to the Engineer prior to retesting.

**(B) CCTV Subsystem**

After completing the integration of the CCTV cameras into the CCTV subsystem software, conduct a minimum of a seven-day test of the CCTV subsystem hardware and software. This will include that portion of the communications network serving the CCTV subsystem. The Engineer has the right to suspend the test to correct deficiencies and restart the test or to extend the test period by time equal to the downtime in excess of eight hours. If during that time it is determined by the Department or the City there are hardware or software failures that are the responsibility of the Contractor, the Contractor shall make repairs or replacements to the satisfaction of the Department and the City.

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Test the following features of each competent as described below.

**(1) CCTV Field Equipment**

The following items, not otherwise required to be tested elsewhere, shall be tested for each CCTV site from the City's TOC:

- Power-up self-tests,
- Iris control,
- Preset functions,
- Presence and quality of the video image,
- Preset positioning, and power on/off functions,
- Camera and controller access and security from all laptops and workstations,
- Disconnect camera and take local control and reconnect camera at local cabinet to the communications and verify High Point TOC control is regained,
- Confirm ability to change camera ID,
- Verify unique camera identifier and icons on GUI,
- Viewing of camera image on each monitor.

**(2) Digital Video Equipment**

Thoroughly test all functions of the software from the TOC and the Signal Shop and the TRTMC to ensure correct operation. Test the components of the CCTV central equipment from both the Signal Shop and the High Point TOC as follows:

- Use the GUI interface and the PTZ control to select and view each camera on any monitor in the TOC, Signal Shop and the Transportation Dept conference room,
- Use and the GUI interface and the PTZ control from the TOC, Signal Shop and the Transportation Dept conference room to test the ability to control the pan-tilt-zoom and iris settings of each camera,
- Use the GUI interface and the PTZ control and test the ability to select and place any camera on any monitor,
- Use the large monitors in the TOC and the monitor in the Signal Shop to select and display cable TV channels.
- Test the ability to retrieve any archived video from the NVR and display on the monitor wall in the TOC.
- Utilizing a TRTMC workstation, demonstrate the ability to select, control and view the camera images.
- Verify that all CCTV images can be displayed correctly on each monitor using the CCTV central software.

**(3) CCTV Central Software**

Thoroughly test all functions of the software from the High Point TOC and the TRTMC to ensure correct operation. Test the components of the CCTV central equipment from both the signal shop and the High Point TOC as follows:

- Use the GUI interface to select and view each camera,
- Use and the GUI interface to test the ability to control the pan-tilt-zoom and iris settings of each camera,

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- Use the GUI interface and test the ability to select and place any camera on any monitor,
- Utilizing a TRTMC workstation demonstrate the ability to select, control and view the camera images, and
- Use the image capture software to test the ability to capture video images and transport them to NCDOT via the existing EIC Server.

**(C) Traffic Signal Subsystem**

After completion of the integration of the traffic signals into the new signal system central software, conduct a minimum of a seven-day test of the traffic signal subsystem hardware and that portion of the communications network serving the traffic signal subsystem. The Engineer has the right to suspend the test to correct deficiencies and restart the test or to extend the test period by time equal to the downtime in excess of eight hours. If during that time it is determined by the Department that there are failures that are the responsibility of the Contractor, the Contractor shall make repairs or replacements to the satisfaction of the Department.

Verify communications port addressing from the traffic signal controllers.

**(D) 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 workstations, and demonstrating proper reception of video signals on the monitor and control panels.

Submit a system acceptance test procedure to the Engineer for review and approval before any tests are conducted.

Submit a system operational test plan a minimum of 60 days prior to the scheduled start of the test. The test plan will be reviewed by the Engineer, who will then either approve it or indicate changes required for approval. The Contractor shall then submit the revised test plan for review and approval. 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 replace component(s) or software module.

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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; and
  - Reports.
- Power failure recovery, auto reboot and startup of the distributed processing signal system software;
- Database access, modification, storage and retrieval;
- Remote access to the signal system software and CCTV software from the notebook computers and remote video operation facilities;
- Local area network (LAN) operations; and
- Demonstrating that all features of the CCTV central software operates as called for with all field equipment.

#### **39.4. OBSERVATION PERIOD**

##### **(A) General**

A 60-day Observation Period shall begin upon the successful completion of all installed site tests, all subsystem tests and all system tests described in the preceding subsections as well as the correction of all known deficiencies, including minor construction items and punch-list items developed by the Engineer. During this period the Department and the City shall observe equipment and software operation to determine that all components of the fiber-optic communications system operate properly and interface with the traffic signal subsystem components and CCTV subsystem components according to the requirements of the Plans and these Project Special Provisions over an extended period of time.

During the Observation Period, respond to failures of the Contractor's equipment within two hours and make repairs within eight hours. For items that pose a traffic safety hazard such as a controller failure, make repairs within four hours. If any failures affect major system components for more than 48 hours, the Department shall suspend the Observation Period beginning when the failure occurred. Resume the Observation Period after successful repair or replacement. Failures of the following types will cause the Department to terminate the

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Observation Period and restart the Observation Period from zero once the failures have been corrected:

1. System or component failures that necessitate a redesign of any component; and
2. Three or more major system component failures of like nature within any 30-day period.

Major system components include:

- Ethernet core switch, Ethernet distribution switch and Ethernet edge switches;
- The fiber-optic communications network;
- The LAN and the TOC and Signal Shop computer equipment; and
- CCTV equipment.

Begin a new 60-day Observation Period with the approval of the Engineer after the faulty equipment has been repaired or replaced and the redesigned components have been installed.

A successful 60-day Observation Period shall consist of continuous operation with no more than a total of five calendar days of non-operation due to mechanical, electrical, or other malfunctions.

The Observation Period shall be completed by the project completion date and prior to final acceptance of the project. The Observation Period shall not begin until the both the CCTV and traffic signal subsystem tests have been successfully completed. The Observation Period shall not begin without the approval of the Engineer.

#### **(B) CCTV Subsystem**

During the Observation Period, the Department and the City will observe equipment and software operation according to the requirements of the Plans and these Project Special Provisions. Verify that the TRTMC can view and control the proposed cameras.

Major subsystem components include the CCTV cameras, Ethernet switches, fiber-optic cable, CCTV monitors, network video recorder, PTZ controls, CCTV software, and CCTV cabinets.

#### **(C) Traffic Signal Subsystem**

During the Observation Period, the Department and the City will observe equipment and software operation according to the requirements of the Plans and these Project Special Provisions.

Major subsystem components include the all Ethernet switches, fiber-optic cable, controllers and conflict monitors, and cabinets.

### **39.5. MEASUREMENT AND PAYMENT**

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

### **39.6. FINAL ACCEPTANCE**

Final system acceptance is defined as the time when all work and materials described in the Plans and these Project Special Provisions have been furnished and completely installed by the



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Contractor; all parts of the work have been approved and accepted by the Engineer; and the CCTV and signal subsystems have been operated continuously and successfully for the 60-day Observation Period.

Final acceptance shall not occur until:

- All field demonstration, installed site, system, and operational tests have been satisfactorily completed;
- All punch-list discrepancies have been rectified;
- All documentation has been delivered and accepted; and
- All required training has been completed.

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
<b>ROADWAY ITEMS</b>						
0001	0000100000-N	800	MOBILIZATION	Lump Sum	L.S.	
0002	2591000000-E	848	4" CONCRETE SIDEWALK	1,740	SY	
0003	4405000000-E	1110	WORK ZONE SIGNS (PORTABLE)	840	SF	
0004	4410000000-E	1110	WORK ZONE SIGNS (BARRICADE MOUNTED)	72	SF	
0005	4415000000-N	1115	FLASHING ARROW BOARD	3	EA	
0006	4420000000-N	1120	PORTABLE CHANGEABLE MESSAGE SIGN	3	EA	
0007	4430000000-N	1130	DRUMS	150	EA	
0008	4435000000-N	1135	CONES	150	EA	
0009	4445000000-E	1145	BARRICADES (TYPE III)	50	LF	
0010	4450000000-N	1150	FLAGGER	400	HR	
0011	4480000000-N	1165	TMA	3	EA	
0012	4510000000-N	SP	LAW ENFORCEMENT	450	HR	
0013	4516000000-N	1180	SKINNY DRUM	100	EA	
0014	4725000000-E	1205	THERMOPLASTIC PAVEMENT MARKING SYMBOL (90 MILS)	217	EA	
0015	4870000000-E	1205	REMOVAL OF PAVEMENT MARKING LINES (24")	120	LF	
0016	4875000000-N	1205	REMOVAL OF PAVEMENT MARKING SYMBOLS & CHARACTERS	10	EA	
0017	7048500000-E	1705	PEDESTRIAN SIGNAL HEAD (16", 1 SECTION W/COUNTDOWN)	144	EA	
0018	7060000000-E	1705	SIGNAL CABLE	69,120	LF	
0019	7120000000-E	1705	VEHICLE SIGNAL HEAD (12", 3 SECTION)	105	EA	

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0020	7132000000-E	1705	VEHICLE SIGNAL HEAD (12", 4 SECTION)	70 EA		
0021	7144000000-E	1705	VEHICLE SIGNAL HEAD (12", 5 SECTION)	15 EA		
0022	7252000000-E	1710	MESSENGER CABLE (1/4")	70,630 LF		
0023	7279000000-E	1715	TRACER WIRE	117,412 LF		
0024	7301000000-E	1715	DIRECTIONAL DRILL (***** (2, 2")	24,775 LF		
0025	7312000000-N	1716	JUNCTION BOX (***** (OVER-SIZED)	295 EA		
0026	7312000000-N	1716	JUNCTION BOX (***** (SPECIAL-SIZED)	89 EA		
0027	7324000000-N	1716	JUNCTION BOX (STANDARD SIZE)	13 EA		
0028	7372000000-N	1721	GUY ASSEMBLY	336 EA		
0029	7408000000-E	1722	1" RISER WITH WEATHERHEAD	39 EA		
0030	7420000000-E	1722	2" RISER WITH WEATHERHEAD	39 EA		
0031	7430000000-N	1722	HEAT SHRINK TUBING RETROFIT KIT	119 EA		
0032	7432000000-E	1722	2" RISER WITH HEAT SHRINK TUBING	194 EA		
0033	7444000000-E	1725	INDUCTIVE LOOP SAWCUT	1,755 LF		
0034	7516000000-E	1730	COMMUNICATIONS CABLE (**FIBER) (24)	250,300 LF		
0035	7516000000-E	1730	COMMUNICATIONS CABLE (**FIBER) (36)	187,270 LF		
0036	7528000000-E	1730	DROP CABLE	60,057 LF		
0037	7540000000-N	1731	SPLICE ENCLOSURE	219 EA		

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0038	7552000000-N	1731	INTERCONNECT CENTER	243	EA	
0039	7566000000-N	1733	DELINEATOR MARKER	66	EA	
0040	7575142200-N	SP	NEW ELECTRICAL SERVICE	111	EA	
0041	7575160000-E	1734	REMOVE EXISTING COMMUNICATIONS CABLE	95,400	LF	
0042	7575180000-N	1735	CABLE TRANSFER	12	EA	
0043	7636000000-N	1745	SIGN FOR SIGNALS	51	EA	
0044	7684000000-N	1750	SIGNAL CABINET FOUNDATION	38	EA	
0045	7686000000-N	1752	CONDUIT ENTRANCE INTO EXISTING FOUNDATION	92	EA	
0046	7687000000-N	1752	MODIFY FOUNDATION FOR CONTROLLER CABINET	118	EA	
0047	7696000000-N	1751	CONTROLLER WITH CABINET (*****) (2070E, 332, BASE MOUNTED)	214	EA	
0048	7696000000-N	1751	CONTROLLER WITH CABINET (*****) (2070E, 336S, POLE MOUNTED)	4	EA	
0049	7708000000-N	1751	DETECTOR CARD (*****) (MODEL 222)	1,193	EA	
0050	7901000000-N	1753	CABINET BASE EXTENDER	144	EA	
0051	7901010000-N	1753	CABINET BASE ADAPTER	23	EA	
0052	7980000000-N	SP	GENERIC SIGNAL ITEM 1" RISER WITH HEAT SHRINK TUBING	7	EA	
0053	7980000000-N	SP	GENERIC SIGNAL ITEM 5/8" X 10' GROUNDING ELECTRODE	400	EA	
0054	7980000000-N	SP	GENERIC SIGNAL ITEM AUXILIARY OUTPUT FILE	125	EA	

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0055	7980000000-N	SP	GENERIC SIGNAL ITEM CARD CAGE	2 EA		
0056	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CABINET (336A, BUILDING MOUNT)	5 EA		
0057	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CABINET (336A, POLE MOUNT)	20 EA		
0058	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CABINET (NEMA 4, 2-WAY SIDE-OF-POLE MOUNT)	1 EA		
0059	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CABINET (NEMA 4, POLE MOUNT)	16 EA		
0060	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CABINET DISCONNECT	2 EA		
0061	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CABINET FOUNDATION	1 EA		
0062	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CABINET(336A, BASE MOUNT)	1 EA		
0063	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV CAMERA ASSEMBLY	46 EA		
0064	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV TEST CABINET (336A)	1 EA		
0065	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV WOOD POLE (55')	13 EA		
0066	7980000000-N	SP	GENERIC SIGNAL ITEM CCTV WOOD POLE (70')	3 EA		
0067	7980000000-N	SP	GENERIC SIGNAL ITEM COMMUNICATIONS RACK (SIGNAL SHOP)	1 EA		
0068	7980000000-N	SP	GENERIC SIGNAL ITEM COMMUNICATIONS RACK (TOC)	3 EA		
0069	7980000000-N	SP	GENERIC SIGNAL ITEM COMPUTER WORKSTATION	5 EA		

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0070	7980000000-N	SP	GENERIC SIGNAL ITEM DIGITAL DISPLAY MONITOR (23")	25 EA		
0071	7980000000-N	SP	GENERIC SIGNAL ITEM DIGITAL HARDWARE VIDEO DECODER	17 EA		
0072	7980000000-N	SP	GENERIC SIGNAL ITEM DIGITAL HARDWARE VIDEO ENCODER	8 EA		
0073	7980000000-N	SP	GENERIC SIGNAL ITEM EMERGENCY GENERATOR TRANSFER SWITCH	25 EA		
0074	7980000000-N	SP	GENERIC SIGNAL ITEM ETHERNET CORE SWITCH	1 EA		
0075	7980000000-N	SP	GENERIC SIGNAL ITEM ETHERNET DISTRIBUTION SWITCH	1 EA		
0076	7980000000-N	SP	GENERIC SIGNAL ITEM ETHERNET EDGE SWITCH	260 EA		
0077	7980000000-N	SP	GENERIC SIGNAL ITEM FIREWALL	1 EA		
0078	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH 2018 ENHANCED CONFLICT MONITOR	11 EA		
0079	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH 2070E CONTROLLER	11 EA		
0080	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH 332 CABINET	11 EA		
0081	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH 336S CABINET	1 EA		
0082	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH CCTV CABINET (336A)	1 EA		
0083	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH CCTV CABINET (NEMA 4)	1 EA		
0084	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH CCTV CAMERA ASSMEBLY	2 EA		
0085	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH CONFLICT MONITOR TESTER	1 EA		

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0086	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH DETECTOR CARD (MODEL 222)	60 EA		
0087	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH DIGITAL HARDWARE VIDEO DECODER	1 EA		
0088	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH DIGITAL HARDWARE VIDEO ENCODER	1 EA		
0089	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH ETHERNET EDGE SWITCH	13 EA		
0090	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH FIBER-OPTIC POWER METER	1 EA		
0091	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH FIBER-OPTIC RESTORATION KIT	1 EA		
0092	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH OPTICAL LIGHT GENERATOR	1 EA		
0093	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH SPARE CABLE & CONNECTORS KIT	1 EA		
0094	7980000000-N	SP	GENERIC SIGNAL ITEM FURNISH VISUAL FAULT LOCATOR	1 EA		
0095	7980000000-N	SP	GENERIC SIGNAL ITEM GUY ASSEMBLY (AERIAL)	37 EA		
0096	7980000000-N	SP	GENERIC SIGNAL ITEM GUY ASSEMBLY (SIDEWALK)	61 EA		
0097	7980000000-N	SP	GENERIC SIGNAL ITEM INTEGRATED BASE ADAPTER (TYPE 1)	26 EA		
0098	7980000000-N	SP	GENERIC SIGNAL ITEM INTEGRATED BASE ADAPTER (TYPE 2)	3 EA		
0099	7980000000-N	SP	GENERIC SIGNAL ITEM INTEGRATED BASE ADAPTER (TYPE 3)	10 EA		

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0100	7980000000-N	SP	GENERIC SIGNAL ITEM INTEGRATED BASE ADAPTER (TYPE 4)	1 EA		
0101	7980000000-N	SP	GENERIC SIGNAL ITEM ITS SERVER	4 EA		
0102	7980000000-N	SP	GENERIC SIGNAL ITEM KVM SWITCH	1 EA		
0103	7980000000-N	SP	GENERIC SIGNAL ITEM LAPTOP COMPUTER	4 EA		
0104	7980000000-N	SP	GENERIC SIGNAL ITEM MODIFY EXISTING ELECTRICAL SERVICE	14 EA		
0105	7980000000-N	SP	GENERIC SIGNAL ITEM MODIFY EXISTING SPLICE	16 EA		
0106	7980000000-N	SP	GENERIC SIGNAL ITEM NETWORK VIDEO RECORDER	2 EA		
0107	7980000000-N	SP	GENERIC SIGNAL ITEM PTZ JOYSTICK	4 EA		
0108	7980000000-N	SP	GENERIC SIGNAL ITEM REMOVE SPLICE CABINET	19 EA		
0109	7980000000-N	SP	GENERIC SIGNAL ITEM REPLACE EXISTING JB COVER (OVER-SIZED)	16 EA		
0110	7980000000-N	SP	GENERIC SIGNAL ITEM TERMINAL SPLICE CABINET	8 EA		
0111	7980000000-N	SP	GENERIC SIGNAL ITEM TEST CONTROLLER WITH CABINET (2070E, 332)	2 EA		
0112	7980000000-N	SP	GENERIC SIGNAL ITEM UPS (SIGNAL SHOP)	1 EA		
0113	7980000000-N	SP	GENERIC SIGNAL ITEM VEHICLE SIGNAL HEAD (12", 3 SECTION WITH BI-MODAL SECTION)	47 EA		
0114	7980000000-N	SP	GENERIC SIGNAL ITEM VIDEO PROCESSING UNIT	4 EA		



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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0115	7985000000-N	SP	GENERIC SIGNAL ITEM MODIFY CCTV SOFTWARE	Lump Sum	L.S.	
0116	7985000000-N	SP	GENERIC SIGNAL ITEM NETWORK MANAGEMENT SOFTWARE	Lump Sum	L.S.	
0117	7985000000-N	SP	GENERIC SIGNAL ITEM SIGNAL SHOP MODIFICATIONS	Lump Sum	L.S.	
0118	7985000000-N	SP	GENERIC SIGNAL ITEM SIGNAL SYSTEM SOFTWARE	Lump Sum	L.S.	
0119	7985000000-N	SP	GENERIC SIGNAL ITEM SYSTEM SUPPORT SOFTWARE & DEVICES	Lump Sum	L.S.	
0120	7985000000-N	SP	GENERIC SIGNAL ITEM TOC MODIFICATIONS	Lump Sum	L.S.	
0121	7985000000-N	SP	GENERIC SIGNAL ITEM TRAINING	Lump Sum	L.S.	
0122	7990000000-E	SP	GENERIC SIGNAL ITEM AERIAL CABLE PROTECTOR	820 LF		
0123	7990000000-E	SP	GENERIC SIGNAL ITEM ETHERNET CABLE	2,676 LF		
0124	7990000000-E	SP	GENERIC SIGNAL ITEM LEAD-IN CABLE	33,910 LF		
0125	7990000000-E	SP	GENERIC SIGNAL ITEM UNDERGROUND CONDUIT (1, 2")	2,434 LF		
0126	7990000000-E	SP	GENERIC SIGNAL ITEM UNDERGROUND CONDUIT (2, 2")	27,744 LF		
0127	7991000000-E	SP	GENERIC SIGNAL ITEM BRICK PAVERS	160 SF		