

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

PROPOSAL

DATE AND TIME OF BID OPENING: **SEPTEMBER 18, 2018 AT 2:00 PM**

CONTRACT ID C204111
WBS 47160.3.1

FEDERAL-AID NO. STBG-0701(036)
COUNTY ALAMANCE
T.I.P. NO. U-6015
MILES 55.000
ROUTE NO.
LOCATION BURLINGTON - GRAHAM SIGNAL SYSTEM.

TYPE OF WORK COMPUTERIZED TRAFFIC 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

**PROPOSAL FOR THE CONSTRUCTION OF
CONTRACT No. C204111 IN ALAMANCE 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. C204111 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 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 2018 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. C204111 in **Alamance 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 2018* 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:

Ronald E. Davenport, Jr.

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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 **October 29, 2018**.

The completion date for this contract is **August 15, 2021**.

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 **the following roads** during the following time restrictions:

DAY AND TIME RESTRICTIONS**I-40 / I-85 (including any associated Ramp and/or Loop)****Monday thru Sunday****6:00 A.M. to 7:00 P.M.****Any Street Citywide within the City of Burlington and the City of Graham****Monday thru Friday****7:00 A.M. to 9:00 A.M. and 4:00 P.M. to 6:30 P.M.**

(Unless prior approval is given to vary from this schedule at least one (1) week in advance from the NCDOT and the City of Burlington)

In addition, the Contractor shall not close or narrow a lane of traffic on **Any Road (unless prior approval is given to vary from this schedule at least one (1) week in advance from the NCDOT and the City of Burlington)**, 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, HOLIDAY WEEKEND & SPECIAL EVENT LANE CLOSURE RESTRICTIONS

1. For **any 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 A.M.** December 31st and **7:00 P.M.** January 2nd. If New Year's Day is on a Friday, Saturday, Sunday or Monday, then until **7:00 P.M.** the following Tuesday.

3. For **Easter**, between the hours of **6:00 A.M.** Thursday and **7:00 P.M.** Monday.
4. For **Memorial Day**, between the hours of **6:00 A.M.** Friday and **7:00 P.M.** Tuesday.
5. For **Independence Day**, between the hours of **6:00 A.M.** the day before Independence Day and **7:00 P.M.** the day after Independence Day.

If **Independence Day** is on a Friday, Saturday, Sunday or Monday, then between the hours of **6:00 A.M.** the Thursday before Independence Day and **7:00 P.M.** the Tuesday after Independence Day.

6. For **Labor Day**, between the hours of **6:00 A.M.** Friday and **7:00 P.M.** Tuesday.
7. For **Thanksgiving Day**, between the hours of **6:00 A.M.** Tuesday and **7:00 P.M.** Monday.
8. For **Christmas**, between the hours of **6:00 A.M.** the Friday before the week of Christmas Day and **7:00 P.M.** the following Tuesday after the week of Christmas Day.
9. For **weekends during the holiday shopping period at Alamance Crossing and University Commons between the weekend of Thanksgiving and the weekend of Christmas**, between the hours of **9:00 A.M.** and **9:00 P.M.** on both **Saturday** and **Sunday**. (This note only applies to University Drive, Boone Station Drive and Huffman Mill Road.)
10. For **Burlington Royals home games** occurring at Burlington Athletic Stadium, between **four (4) hours before** the start of each game and **four (4) hours after** the end of each game. (This note only applies to the portions of Graham Street, Beaumont Avenue and West Hanover Road that are adjacent to and/or approaching the stadium.)
11. For **arrival and dismissal hours within a half (1/2) mile of any school on any school day**. (Coordinate with an affected school concerning operational hours and school days. As a minimum, do not close or narrow a lane of traffic, or close a sidewalk and/or pedestrian crossing during hours posted on school speed zone signs (when present).)
12. For **any planned Special Event** (as shown on the City of Burlington Parks and Recreation Department's Special Event Calendar) with the **Downtown Central Business District of Burlington**, between **one (1) hour before** the start of each event and **one (1) hour after** the end of each event. (This note includes the closure of sidewalks and/or pedestrian crossings.)

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 **One Thousand Dollars (\$ 1000.00)** per hour.

INTERMEDIATE CONTRACT TIME NUMBER 2 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 stop traffic on **Any Road** during the following time restrictions:

DAY AND TIME RESTRICTIONS

**Monday thru Sunday
5:00 A.M. to 11:00 P.M.**

The maximum allowable time for installing cable across road is **ten (10)** minutes for **Any Road**. 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 **Two Hundred Fifty Dollars (\$ 250.00)** per fifteen **(15)** minute time period.

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 *2018 Standard Specifications*):

| Line # | Description |
|---------------|---|
| 61 — | Controllers With Cabinet (2070LX, 332) |
| 62 — | Controllers With Cabinet (2070LX, 336S) |

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 2018 Standard Specifications).

| Line # | Description |
|---------------|-----------------------------|
| 14-16 | Long-Life Pavement Markings |

SCHEDULE OF ESTIMATED COMPLETION PROGRESS:

(7-15-08)(Rev. 6-19-18)

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:

| | <u>Fiscal Year</u> | <u>Progress (% of Dollar Value)</u> |
|------|---------------------------|--|
| 2019 | (7/01/18 - 6/30/19) | 34% of Total Amount Bid |
| 2020 | (7/01/19 - 6/30/20) | 40% of Total Amount Bid |
| 2021 | (7/01/20 - 6/30/21) | 24% of Total Amount Bid |
| 2022 | (7/01/21 - 6/30/22) | 2% of Total Amount Bid |

The Contractor shall also furnish his own progress schedule in accordance with Article 108-2 of the 2018 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. 1-17-17)

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.

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.
<https://connect.ncdot.gov/business/Turnpike/Documents/Form%20DBE-IS%20Subcontractor%20Payment%20Information.pdf>

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 **0.0** %

- (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:// www.ebs.nc.gov/VendorDirectory/default.html](https://www.ebs.nc.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®.

- (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 10:00 a.m. 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 10:00 a.m. 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 10:00 a.m. 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 10:00 a.m. 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 10:00 a.m. on 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 10:00 a.m. on the next official state business day. If the contractor cannot send the information electronically, then one complete set and 5 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 (2nd and 3rd 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 Opportunity and Work Force Development Unit at BOWD@ncdot.gov 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 Contractual Services 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. The prime contractor must give the DBE firm 5 days to respond to the prime contractor's notice of termination and advise the prime contractor and the Department of the reasons, if any, why the firm objects to the proposed termination of its subcontract and why the Department should not approve the action.

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.

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

Failure to Meet Contract Requirements

Failure to meet contract requirements in accordance with Subarticle 102-15(J) of the *2018 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.

CARGO PREFERENCE ACT:

(2-16-16)

Privately owned United States-flag commercial vessels transporting cargoes are subject to the Cargo Preference Act (CPA) of 1954 requirements and regulations found in 46 CFR 381.7. Contractors are directed to clause (b) of 46 CFR 381.7 as follows:

(b) Contractor and Subcontractor Clauses. "Use of United States-flag vessels: The contractor agrees-

" (1) To utilize privately owned United States-flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material, or commodities pursuant to this contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels.

(2) To furnish within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States a legible copy of a rated, 'on-board' commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (b) (1) of this section to both the Contracting Officer (through the prime contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20590.

(3) To insert the substance of the provisions of this clause in all subcontracts issued pursuant to this contract."

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.

COOPERATION BETWEEN CONTRACTORS:

(7-1-95)

105-7

SP1 G133

The Contractor's attention is directed to Article 105-7 of the *2018 Standard Specifications*.

I-5954 (C204025 - I-40/85 East of NC-54 in Graham) is anticipated to begin during the 2019 Construction Season and is located adjacent to this project.

I-5956 (C204026 - I-40/85 West of University Drive in Burlington) is currently under construction and is located adjacent to this project.

The Contractor on this project shall cooperate with the Contractor working within or adjacent to the limits of this project to the extent that the work can be carried out to the best advantage of all concerned.

PROJECT SPECIAL PROVISIONS**ROADWAY****BURNING RESTRICTIONS:**

(7-1-95)

200, 210, 215

SP2 R05

Open burning is not permitted on any portion of the right-of-way limits established for this project. Do not burn the clearing, grubbing or demolition debris designated for disposal and generated from the project at locations within the project limits, off the project limits or at any waste or borrow sites in this county. Dispose of the clearing, grubbing and demolition debris by means other than burning, according to state or local rules and regulations.

FOUNDATIONS AND ANCHOR ROD ASSEMBLIES FOR METAL POLES:

(1-17-12) (Rev. 1-16-18)

9, 14, 17

SP9 R05

Description

Foundations for metal poles include foundations for signals, cameras, overhead and dynamic message signs (DMS) and high mount and light standards supported by metal poles or upright trusses. Foundations consist of footings with pedestals and drilled piers with or without grade beams or wings. Anchor rod assemblies consist of anchor rods (also called anchor bolts) with nuts and washers on the exposed ends of rods and nuts and a plate or washers on the other ends of rods embedded in the foundation.

Construct concrete foundations with the required resistances and dimensions and install anchor rod assemblies in accordance with the contract and accepted submittals. Construct drilled piers consisting of cast-in-place reinforced concrete cylindrical sections in excavated holes. Provide temporary casings or polymer slurry as needed to stabilize drilled pier excavations. Use a prequalified Drilled Pier Contractor to construct drilled piers for metal poles. Define “excavation” and “hole” as a drilled pier excavation and “pier” as a drilled pier.

This provision does not apply to foundations for signal pedestals; see Section 1743 of the *2018 Standard Specifications* and 2018 Roadway Standard Drawing No. 1743.01.

Materials

Refer to the *2018 Standard Specifications*.

| Item | Section |
|--------------------------|----------------|
| Conduit | 1091-3 |
| Grout, Type 2 | 1003 |
| Polymer Slurry | 411-2(B)(2) |
| Portland Cement Concrete | 1000 |
| Reinforcing Steel | 1070 |
| Rollers and Chairs | 411-2(C) |
| Temporary Casings | 411-2(A) |

Provide Type 3 material certifications in accordance with Article 106-3 of the *2018 Standard Specifications* for conduit, rollers, chairs and anchor rod assemblies. Store steel materials on blocking at least 12" above the ground and protect it at all times from damage; and when placing in the work make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials. Load, transport, unload and store foundation and anchor rod assembly materials so materials are kept clean and free of damage. Bent, damaged or defective materials will be rejected.

Use conduit type in accordance with the contract. Use Class A concrete for footings and pedestals, Class Drilled Pier concrete for drilled piers and Class AA concrete for grade beams and wings including portions of drilled piers above bottom of wings elevations. Corrugated temporary casings may be accepted at the discretion of the Engineer. A list of approved polymer slurry products is available from:

connect.ncdot.gov/resources/Geological/Pages/Products.aspx

Provide anchor rod assemblies in accordance with the contract consisting of the following:

- (A) Straight anchor rods,
- (B) Heavy hex top and leveling nuts and flat washers on exposed ends of rods, and
- (C) Nuts and either flat plates or washers on the other ends of anchor rods embedded in foundations.

Do not use lock washers. Use steel anchor rods, nuts and washers that meet ASTM F1554 for Grade 55 rods and Grade A nuts. Use steel plates and washers embedded in concrete with a thickness of at least 1/4". Galvanize anchor rods and exposed nuts and washers in accordance with Article 1076-4 of the *2018 Standard Specifications*. It is not necessary to galvanize nuts, plates and washers embedded in concrete.

Construction Methods

Install the required size and number of conduits in foundations in accordance with the plans and accepted submittals. Construct top of piers, footings, pedestals, grade beams and wings flat, level and within 1" of elevations shown in the plans or approved by the Engineer. Provide an Ordinary Surface finish in accordance with Subarticle 825-6(B) of the *2018 Standard Specifications* for portions of foundations exposed above finished grade. Do not remove anchor bolt templates or pedestal or grade beam forms or erect metal poles or upright trusses onto foundations until concrete attains a compressive strength of at least 3,000 psi.

- (A) Drilled Piers

Before starting drilled pier construction, hold a predrill meeting to discuss the installation, monitoring and inspection of the drilled piers. Schedule this meeting after the Drilled Pier Contractor has mobilized to the site. The Resident or Division Traffic Engineer, Contractor and Drilled Pier Contractor Superintendent will attend this predrill meeting.

Do not excavate holes, install piles or allow equipment wheel loads or vibrations within 20 ft of completed piers until 16 hours after Drilled Pier concrete reaches initial set.

Check for correct drilled pier alignment and location before beginning drilling. Check plumbness of holes frequently during drilling.

Construct drilled piers with the minimum required diameters shown in the plans. Install piers with tip elevations no higher than shown in the plans or approved by the Engineer.

Excavate holes with equipment of the sizes required to construct drilled piers. Depending on the subsurface conditions encountered, drilling through rock and boulders may be required. Do not use blasting for drilled pier excavations.

Contain and dispose of drilling spoils and waste concrete as directed and in accordance with Section 802 of the *2018 Standard Specifications*. Drilling spoils consist of all materials and fluids removed from excavations.

If unstable, caving or sloughing materials are anticipated or encountered, stabilize holes with temporary casings and/or polymer slurry. Do not use telescoping temporary casings. If it becomes necessary to replace a temporary casing during drilling, backfill the excavation, insert a larger casing around the casing to be replaced or stabilize the excavation with polymer slurry before removing the temporary casing.

If temporary casings become stuck or the Contractor proposes leaving casings in place, temporary casings should be installed against undisturbed material. Unless otherwise approved, do not leave temporary casings in place for mast arm poles and cantilever signs. The Engineer will determine if casings may remain in place. If the Contractor proposes leaving temporary casings in place, do not begin drilling until a casing installation method is approved.

Use polymer slurry and additives to stabilize holes in accordance with the slurry manufacturer's recommendations. Provide mixing water and equipment suitable for polymer slurry. Maintain the required slurry properties at all times except for sand content.

Define a "sample set" as slurry samples collected from mid-height and within 2 ft of the bottom of holes. Take sample sets from excavations to test polymer slurry immediately after filling holes with slurry, at least every 4 hours thereafter and immediately before placing concrete. Do not place Drilled Pier concrete until both slurry samples from an excavation meet the required polymer slurry properties. If any slurry test results do not meet the requirements, the Engineer may suspend drilling until both samples from a sample set meet the required polymer slurry properties.

Remove soft and loose material from bottom of holes using augers to the satisfaction of the Engineer. Assemble rebar cages and place cages and Drilled Pier concrete in accordance with Subarticle 411-4(E) of the *2018 Standard Specifications* except for the following:

- (1) Inspections for tip resistance and bottom cleanliness are not required,
- (2) Temporary casings may remain in place if approved, and

- (3) Concrete placement may be paused near the top of pier elevations for anchor rod assembly installation and conduit placement or
- (4) If applicable, concrete placement may be stopped at bottom of grade beam or wings elevations for grade beam or wing construction.

If wet placement of concrete is anticipated or encountered, do not place Drilled Pier concrete until a concrete placement procedure is approved. If applicable, temporary casings and fluids may be removed when concrete placement is paused or stopped in accordance with the exceptions above provided holes are stable. Remove contaminated concrete from exposed Drilled Pier concrete after removing casings and fluids. If holes are unstable, do not remove temporary casings until a procedure for placing anchor rod assemblies and conduit or constructing grade beams or wings is approved.

Use collars to extend drilled piers above finished grade. Remove collars after Drilled Pier concrete sets and round top edges of piers.

If drilled piers are questionable, pile integrity testing (PIT) and further investigation may be required in accordance with Article 411-5 of the *2018 Standard Specifications*. A drilled pier will be considered defective in accordance with Subarticle 411-5(D) of the *2018 Standard Specifications* and drilled pier acceptance is based in part on the criteria in Article 411-6 of the *2018 Standard Specifications* except for the top of pier tolerances in Subarticle 411-6(C) of the *2018 Standard Specifications*.

If a drilled pier is under further investigation, do not grout core holes, backfill around the pier or perform any work on the drilled pier until the Engineer accepts the pier. If the drilled pier is accepted, dewater and grout core holes and backfill around the pier with approved material to finished grade. If the Engineer determines a pier is unacceptable, remediation is required in accordance with Article 411-6 of the *2018 Standard Specifications*. No extension of completion date or time will be allowed for remediation of unacceptable drilled piers or post repair testing.

Permanently embed a plate in or mark top of piers with the pier diameter and depth, size and number of vertical reinforcing bars and the minimum compressive strength of the concrete mix at 28 days.

(B) Footings, Pedestals, Grade Beams and Wings

Excavate as necessary for footings, grade beams and wings in accordance with the plans, accepted submittals and Section 410 of the *2018 Standard Specifications*. If unstable, caving or sloughing materials are anticipated or encountered, shore foundation excavations as needed with an approved method. Notify the Engineer when foundation excavation is complete. Do not place concrete or reinforcing steel until excavation dimensions and foundation material are approved.

Construct cast-in-place reinforced concrete footings, pedestals, grade beams and wings with the dimensions shown in the plans and in accordance with Section 825 of the *2018 Standard Specifications*. Use forms to construct portions of pedestals and grade beams protruding above finished grade. Provide a chamfer with a 3/4" horizontal width

for pedestal and grade beam edges exposed above finished grade. Place concrete against undisturbed soil or backfill and fill in accordance with Article 410-8 of the *2018 Standard Specifications*. Proper compaction around footings and wings is critical for foundations to resist uplift and torsion forces.

(C) Anchor Rod Assemblies

Size anchor rods for design and the required projection above top of foundations. Determine required anchor rod projections from nut, washer and base plate thicknesses, the protrusion of 3 to 5 anchor rod threads above top nuts after tightening and the distance of one nut thickness between top of foundations and bottom of leveling nuts.

Protect anchor rod threads from damage during storage and installation of anchor rod assemblies. Before placing anchor rods in foundations, turn nuts onto and off rods past leveling nut locations. Turn nuts with the effort of one workman using an ordinary wrench without a cheater bar. Report any thread damage to the Engineer that requires extra effort to turn nuts.

Arrange anchor rods symmetrically about center of base plate locations as shown in the plans. Set anchor rod elevations based on required projections above top of foundations. Securely brace and hold rods in the correct position, orientation and alignment with a steel template. Do not weld to reinforcing steel, temporary casings or anchor rods.

Install top and leveling (bottom) nuts, washers and the base plate for each anchor rod assembly in accordance with the following procedure:

- (1) Turn leveling nuts onto anchor rods to a distance of one nut thickness between the top of foundation and bottom of leveling nuts. Place washers over anchor rods on top of leveling nuts.
- (2) Determine if nuts are level using a flat rigid template on top of washers. If necessary, lower leveling nuts to level the template in all directions or if applicable, lower nuts to tilt the template so the metal pole or upright truss will lean as shown in the plans. If leveling nuts and washers are not in full contact with the template, replace washers with galvanized beveled washers.
- (3) Verify the distance between the foundation and leveling nuts is no more than one nut thickness.
- (4) Place base plate with metal pole or upright truss over anchor rods on top of washers. High mount luminaires may be attached before erecting metal poles but do not attach cables, mast arms or trusses to metal poles or upright trusses at this time.
- (5) Place washers over anchor rods on top of base plate. Lubricate top nut bearing surfaces and exposed anchor rod threads above washers with beeswax, paraffin or other approved lubricant.
- (6) Turn top nuts onto anchor rods. If nuts are not in full contact with washers or washers are not in full contact with the base plate, replace washers with galvanized beveled washers.
- (7) Tighten top nuts to snug-tight with the full effort of one workman using a 12" wrench. Do not tighten any nut all at once. Turn top nuts in increments. Follow a star pattern cycling through each nut at least twice.

- (8) Repeat (7) for leveling nuts.
- (9) Replace washers above and below the base plate with galvanized beveled washers if the slope of any base plate face exceeds 1:20 (5%), any washer is not in firm contact with the base plate or any nut is not in firm contact with a washer. If any washers are replaced, repeat (7) and (8).
- (10) With top and leveling nuts snug-tight, mark each top nut on a corner at the intersection of 2 flats and a corresponding reference mark on the base plate. Mark top nuts and base plate with ink or paint that is not water-soluble. Use the turn-of-nut method for pretensioning. Do not pretension any nut all at once. Turn top nuts in increments for a total turn that meets the following nut rotation requirements:

| NUT ROTATION REQUIREMENTS (Turn-of-Nut Pretensioning Method) | |
|---|--------------------|
| Anchor Rod Diameter, inch | Requirement |
| $\leq 1 \frac{1}{2}$ | 1/3 turn (2 flats) |
| $> 1 \frac{1}{2}$ | 1/6 turn (1 flat) |

Follow a star pattern cycling through each top nut at least twice.

- (11) Ensure nuts, washers and base plate are in firm contact with each other for each anchor rod. Cables, mast arms and trusses may now be attached to metal poles and upright trusses.
- (12) Between 4 and 14 days after pretensioning top nuts, use a torque wrench calibrated within the last 12 months to check nuts in the presence of the Engineer. Completely erect mast arm poles and cantilever signs and attach any hardware before checking top nuts for these structures. Check that top nuts meet the following torque requirements:

| TORQUE REQUIREMENTS | |
|----------------------------------|---------------------------|
| Anchor Rod Diameter, inch | Requirement, ft-lb |
| 7/8 | 180 |
| 1 | 270 |
| 1 1/8 | 380 |
| 1 1/4 | 420 |
| $\geq 1 \frac{1}{2}$ | 600 |

If necessary, retighten top nuts in the presence of the Engineer with a calibrated torque wrench to within ± 10 ft-lb of the required torque. Do not overtighten top nuts.

- (13) Do not grout under base plate.

Measurement and Payment

Foundations and anchor rod assemblies for metal poles and upright trusses will be measured and paid for elsewhere in the contract.

No payment will be made for temporary casings that remain in drilled pier excavations. No payment will be made for PIT. No payment will be made for further investigation of defective piers. Further investigation of piers that are not defective will be paid as extra work in accordance with Article 104-7 of the *2018 Standard Specifications*. No payment will be made for remediation of unacceptable drilled piers or post repair testing.

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(D) of the *2018 Standard Specifications*.

STANDARD SPECIAL PROVISION

ERRATA

(2-12-18)

Z-4

Revise the *2018 Standard Specifications* as follows:

Division 7

Page 7-27, line 4, Article 725-1 MEASUREMENT AND PAYMENT, replace article number “725-1” with “724-4”.

Page 7-28, line 10, Article 725-1 MEASUREMENT AND PAYMENT, replace article number “725-1” with “725-3”.

Division 8

Page 8-23, lines 3, 6, 11 and 13, Section 836, SLUICE GATE, replace article number “8366” with “836”.

Division 10

Page 10-69, Table 1046-1 WIRE DIAMETER, rename RECYCLED PLASTIC AND COMPOSITE OFFSET BLOCK PROPERTIES

Page 10-162, line 1, Article 1080-50 PAINT FOR VERTICAL MARKERS, replace article number “1080-50” with “1080-10”.

Page 10-162, line 5, Article 1080-61 EPOXY RESIN FOR REINFORCING STEEL, replace article number “1080-61” with “1080-11”.

Page 10-162, line 22, Article 1080-72 ABRASIVE MATERIALS FOR BLAST CLEANING STEEL, replace article number “1080-72” with “1080-12”.

Page 10-163, line 25, Article 1080-83 FIELD PERFORMANCE AND SERVICES, replace article number “1080-83” with “1080-13”.

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

(3-18-03) (Rev. 12-20-16)

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, 919-707-3730, or <http://www.ncagr.gov/plantindustry/> 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, emerald ash borer, or other noxious weeds.

STANDARD SPECIAL PROVISION**TITLE VI AND NONDISCRIMINATION:**

(6-28-77)(Rev 6/19/2018)

Z-6

Revise the *2018 Standard Specifications* as follows:

Replace Article 103-4(B) with the following:

The North Carolina Department of Transportation is committed to carrying out the U.S. Department of Transportation's policy of ensuring nondiscrimination in the award and administration of contracts.

The provisions of this section related to United States Department of Transportation (US DOT) Order 1050.2A, Title 49 Code of Federal Regulations (CFR) part 21, 23 United States Code (U.S.C.) 140 and 23 CFR part 200 (or 49 CFR 303, 49 U.S.C. 5332 or 49 U.S.C. 47123) are applicable to all North Carolina Department of Transportation (NCDOT) contracts and to all related subcontracts, material supply, engineering, architectural and other service contracts, regardless of dollar amount. Any Federal provision that is specifically required not specifically set forth is hereby incorporated by reference.

(1) **Title VI Assurances (USDOT Order 1050.2A, Appendix A)**

During the performance of this contract, the contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "contractor") agrees as follows:

(a) Compliance with Regulations

The contractor (hereinafter includes consultants) shall comply with the Acts and the Regulations relative to Nondiscrimination in Federally-assisted programs of the U.S. Department of Transportation, Federal Highway Administration (FHWA), as they may be amended from time to time, which are herein incorporated by reference and made a part of this contract.

(b) Nondiscrimination

The contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The contractor shall not participate directly or indirectly in the discrimination prohibited by the Acts and the Regulations, including employment practices when the contract covers any activity, project, or program set forth in Appendix B of 49 CFR Part 21.

(c) Solicitations for Subcontractors, Including Procurements of Materials and Equipment

In all solicitations, either by competitive bidding, or negotiation made by the contractor for work to be performed under a subcontract, including procurements of materials, or leases of equipment, each potential subcontractor or supplier shall be notified by the contractor of the contractor's obligations under this contract and the Acts and the Regulations relative to Nondiscrimination on the grounds of race, color, or national origin.

(d) Information and Reports

The contractor shall provide all information and reports required by the Acts, the Regulations, and directives issued pursuant thereto and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the Recipient or the FHWA to be pertinent to ascertain compliance with such Acts,

Regulations, and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish the information, the contractor shall so certify to the Recipient or the FHWA, as appropriate, and shall set forth what efforts it has made to obtain the information.

(e) Sanctions for Noncompliance:

In the event of a contractor's noncompliance with the Non-discrimination provisions of this contract, the Recipient will impose such contract sanctions as it and/or the FHWA may determine to be appropriate, including, but not limited to:

- (i) Withholding payments to the contractor under the contract until the contractor complies; and/or
- (ii) Cancelling, terminating, or suspending a contract, in whole or in part.

(f) Incorporation of Provisions

The contractor shall include the provisions of paragraphs (a) through (f) in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Acts, the Regulations and directives issued pursuant thereto. The contractor shall take action with respect to any subcontract or procurement as the Recipient or the FHWA may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if the contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, the contractor may request the Recipient to enter into any litigation to protect the interests of the Recipient. In addition, the contractor may request the United States to enter into the litigation to protect the interests of the United States.

(2) **Title VI Nondiscrimination Program (23 CFR 200.5(p))**

The North Carolina Department of Transportation (NCDOT) has assured the USDOT that, as a condition to receiving federal financial assistance, NCDOT will comply with Title VI of the Civil Rights Act of 1964 and all requirements imposed by Title 49 CFR part 21 and related nondiscrimination authorities to ensure that no person shall, on the ground of race, color, national origin, limited English proficiency, sex, age, or disability (including religion/creed or income-level, where applicable), be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any programs, activities, or services conducted or funded by NCDOT. Contractors and other organizations under contract or agreement with NCDOT must also comply with Title VI and related authorities, therefore:

(a) During the performance of this contract or agreement, contractors (e.g., subcontractors, consultants, vendors, prime contractors) are responsible for complying with NCDOT's Title VI Program. Contractors are not required to prepare or submit Title VI Programs. To comply with this section, the prime contractor shall:

1. Post NCDOT's Notice of Nondiscrimination and the Contractor's own Equal Employment Opportunity (EEO) Policy in conspicuous locations accessible to all employees, applicants and subcontractors on the jobsite.
2. Physically incorporate the required Title VI clauses into all subcontracts on federally-assisted and state-funded NCDOT projects, and ensure inclusion by subcontractors into all lower-tier subcontracts.
3. Required Solicitation Language. The Contractor shall include the following notification in all solicitations for bids and requests for work or material, regardless of funding source:

“The North Carolina Department of Transportation, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 U.S.C. §§

2000d to 2000d-4) and the Regulations, hereby notifies all bidders that it will affirmatively ensure that any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award. In accordance with other related nondiscrimination authorities, bidders and contractors will also not be discriminated against on the grounds of sex, age, disability, low-income level, creed/religion, or limited English proficiency in consideration for an award.”

4. Physically incorporate the FHWA-1273, in its entirety, into all subcontracts and subsequent lower tier subcontracts on Federal-aid highway construction contracts only.
 5. Provide language assistance services (i.e., written translation and oral interpretation), free of charge, to LEP employees and applicants. Contact NCDOT OCR for further assistance, if needed.
 6. For assistance with these Title VI requirements, contact the NCDOT Title VI Nondiscrimination Program at 1-800-522-0453.
- (b) Subrecipients (e.g. cities, counties, LGAs, planning organizations) may be required to prepare and submit a Title VI Plan to NCDOT, including Title VI Assurances and/or agreements. Subrecipients must also ensure compliance by their contractors and subrecipients with Title VI. (23 CFR 200.9(b)(7))
- (c) If reviewed or investigated by NCDOT, the contractor or subrecipient agrees to take affirmative action to correct any deficiencies found within a reasonable time period, not to exceed 90 calendar days, unless additional time is granted by NCDOT. (23 CFR 200.9(b)(15))
- (d) The Contractor is responsible for notifying subcontractors of NCDOT’s External Discrimination Complaints Process.
1. Applicability
Title VI and related laws protect participants and beneficiaries (e.g., members of the public and contractors) from discrimination by NCDOT employees, subrecipients and contractors, regardless of funding source.
 2. Eligibility
Any person—or class of persons—who believes he/she has been subjected to discrimination based on race, color, national origin, Limited English Proficiency (LEP), sex, age, or disability (and religion in the context of employment, aviation, or transit) may file a written complaint. The law also prohibits intimidation or retaliation of any sort.
 3. Time Limits and Filing Options
Complaints may be filed by the affected individual(s) or a representative and must be filed no later than 180 calendar days after the following:
 - (i) The date of the alleged act of discrimination; or
 - (ii) The date when the person(s) became aware of the alleged discrimination; or
 - (iii) Where there has been a continuing course of conduct, the date on which that conduct was discontinued or the latest instance of the conduct.Title VI and related discrimination complaints may be submitted to the following entities:

- North Carolina Department of Transportation, Office of Civil Rights, Title VI Program, 1511 Mail Service Center, Raleigh, NC 27699-1511; toll free 1-800-522-0453
 - Federal Highway Administration, North Carolina Division Office, 310 New Bern Avenue, Suite 410, Raleigh, NC 27601, 919-747-7010
 - US Department of Transportation, Departmental Office of Civil Rights, External Civil Rights Programs Division, 1200 New Jersey Avenue, SE, Washington, DC 20590; 202-366-4070
4. Format for Complaints
Complaints must be in writing and signed by the complainant(s) or a representative, and include the complainant's name, address, and telephone number. Complaints received by fax or e-mail will be acknowledged and processed. Allegations received by telephone will be reduced to writing and provided to the complainant for confirmation or revision before processing. Complaints will be accepted in other languages, including Braille.
5. Discrimination Complaint Form
Contact NCDOT Civil Rights to receive a full copy of the Discrimination Complaint Form and procedures.
6. Complaint Basis
Allegations must be based on issues involving race, color, national origin (LEP), sex, age, disability, or religion (in the context of employment, aviation or transit). "Basis" refers to the complainant's membership in a protected group category.

**TABLE 103-1
COMPLAINT BASIS**

| Protected Categories | Definition | Examples | Applicable Nondiscrimination Authorities |
|--|--|--|--|
| Race and Ethnicity | An individual belonging to one of the accepted racial groups; or the perception, based usually on physical characteristics that a person is a member of a racial group | Black/African American, Hispanic/Latino, Asian, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, White | Title VI of the Civil Rights Act of 1964; 49 CFR Part 21; 23 CFR 200; 49 U.S.C. 5332(b); 49 U.S.C. 47123. (<i>Executive Order 13166</i>) |
| Color | Color of skin, including shade of skin within a racial group | Black, White, brown, yellow, etc. | |
| National Origin (<i>Limited English Proficiency</i>) | Place of birth. Citizenship is not a factor. (<i>Discrimination based on language or a person's accent is also covered</i>) | Mexican, Cuban, Japanese, Vietnamese, Chinese | |
| Sex | Gender. The sex of an individual. <i>Note: Sex under this program does not include sexual orientation.</i> | Women and Men | 1973 Federal-Aid Highway Act; 49 U.S.C. 5332(b); 49 U.S.C. 47123. |
| Age | Persons of any age | 21-year-old person | Age Discrimination Act of 1975 49 U.S.C. 5332(b); 49 U.S.C. 47123. |
| Disability | Physical or mental impairment, permanent or temporary, or perceived. | Blind, alcoholic, para-amputee, epileptic, diabetic, arthritic | Section 504 of the Rehabilitation Act of 1973; Americans with Disabilities Act of 1990 |

| | | | |
|--|---|---|--|
| <p>Religion (in the context of employment) <i>(Religion/ Creed in all aspects of any aviation or transit-related construction)</i></p> | <p>An individual belonging to a religious group; or the perception, based on distinguishable characteristics that a person is a member of a religious group. In practice, actions taken as a result of the moral and ethical beliefs as to what is right and wrong, which are sincerely held with the strength of traditional religious views. Note: Does not have to be associated with a recognized religious group or church; if an individual sincerely holds to the belief, it is a protected religious practice.</p> | <p>Muslim, Christian, Sikh, Hindu, etc.</p> | <p>Title VII of the Civil Rights Act of 1964; 23 CFR 230; FHWA-1273 Required Contract Provisions. (49 U.S.C. 5332(b); 49 U.S.C. 47123)</p> |
|--|---|---|--|

(3) Pertinent Nondiscrimination Authorities

During the performance of this contract, the contractor, for itself, its assignees, and successors in interest agrees to comply with the following non-discrimination statutes and authorities, including, but not limited to:

- (a) Title VI of the Civil Rights Act of 1964 (42 U.S.C. § 2000d et seq., 78 stat. 252), (prohibits discrimination on the basis of race, color, national origin); and 49 CFR Part 21.
- (b) The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (42 U.S.C. § 4601), (prohibits unfair treatment of persons displaced or whose property has been acquired because of Federal or Federal-aid programs and projects);
- (c) Federal-Aid Highway Act of 1973, (23 U.S.C. § 324 et seq.), (prohibits discrimination on the basis of sex);
- (d) Section 504 of the Rehabilitation Act of 1973, (29 U.S.C. § 794 et seq.), as amended, (prohibits discrimination on the basis of disability) and 49 CFR Part 27;
- (e) The Age Discrimination Act of 1975, as amended, (42 U.S.C. § 6101 et seq.), (prohibits discrimination on the basis of age);
- (f) Airport and Airway Improvement Act of 1982, (49 USC § 471, Section 47123), as amended, (prohibits discrimination based on race, creed, color, national origin, or sex);
- (g) The Civil Rights Restoration Act of 1987, (PL 100-209), (Broadened the scope, coverage and applicability of Title VI of the Civil Rights Act of 1964, The Age Discrimination Act of 1975 and Section 504 of the Rehabilitation Act of 1973, by expanding the definition of the terms "programs or activities" to include all of the programs or activities of the Federal-aid recipients, sub-recipients and contractors, whether such programs or activities are Federally funded or not);
- (h) Titles II and III of the Americans with Disabilities Act, which prohibit discrimination on the basis of disability in the operation of public entities, public and private transportation systems, places of public accommodation, and certain testing entities (42 U.S.C. §§ 12131-12189) as implemented by Department of Transportation regulations at 49 C.F.R. parts 37 and 38;
- (i) The Federal Aviation Administration's Nondiscrimination statute (49 U.S.C. § 47123) (prohibits discrimination on the basis of race, color, national origin, and sex);
- (j) Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which ensures Nondiscrimination against minority populations by discouraging programs, policies, and activities with

disproportionately high and adverse human health or environmental effects on minority and low-income populations;

- (k) Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency, and resulting agency guidance, national origin discrimination includes discrimination because of Limited English proficiency (LEP). To ensure compliance with Title VI, you must take reasonable steps to ensure that LEP persons have meaningful access to your programs (70 Fed. Reg. at 74087 to 74100);
 - (l) Title IX of the Education Amendments of 1972, as amended, which prohibits you from discriminating because of sex in education programs or activities (20 U.S.C. 1681 et seq).
 - (m) Title VII of the Civil Rights Act of 1964 (42 U.S.C. § 2000e et seq., Pub. L. 88-352), (prohibits employment discrimination on the basis of race, color, religion, sex, or national origin).
- (4) **Additional Title VI Assurances**

***The following Title VI Assurances (Appendices B, C and D) shall apply, as applicable*

- (a) Clauses for Deeds Transferring United States Property (1050.2A, Appendix B)
The following clauses will be included in deeds effecting or recording the transfer of real property, structures, or improvements thereon, or granting interest therein from the United States pursuant to the provisions of Assurance 4.

NOW, THEREFORE, the U.S. Department of Transportation as authorized by law and upon the condition that the North Carolina Department of Transportation (NCDOT) will accept title to the lands and maintain the project constructed thereon in accordance with the North Carolina General Assembly, the Regulations for the Administration of the Federal-Aid Highway Program, and the policies and procedures prescribed by the Federal Highway Administration of the U.S. Department of Transportation in accordance and in compliance with all requirements imposed by Title 49, Code of Federal Regulations, U.S. Department of Transportation, Subtitle A, Office of the Secretary, Part 21, Nondiscrimination in Federally-assisted programs of the U.S. Department of Transportation pertaining to and effectuating the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252; 42 U.S.C. § 2000d to 2000d-4), does hereby remise, release, quitclaim and convey unto the NCDOT all the right, title and interest of the U.S. Department of Transportation in and to said lands described in Exhibit A attached hereto and made a part hereof.

(HABENDUM CLAUSE)

TO HAVE AND TO HOLD said lands and interests therein unto the North Carolina Department of Transportation (NCDOT) and its successors forever, subject, however, to the covenants, conditions, restrictions and reservations herein contained as follows, which will remain in effect for the period during which the real property or structures are used for a purpose for which Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits and will be binding on the NCDOT, its successors and assigns.

The NCDOT, in consideration of the conveyance of said lands and interests in lands, does hereby covenant and agree as a covenant running with the land for itself, its successors and assigns, that (1) no person will on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination with regard to any facility located wholly or in part on, over, or under such lands hereby conveyed [,] [and]* (2) that the NCDOT will use the lands and interests in lands and interests in lands so conveyed, in compliance with all requirements imposed by or pursuant to Title 49, Code of Federal Regulations, U.S. Department of Transportation, Subtitle A, Office of the Secretary, Part 21, Non-discrimination in Federally-assisted programs of the U.S. Department of Transportation, Effectuation of Title VI of the Civil Rights Act of 1964, and as said Regulations and Acts may be amended [, and (3) that in the event of breach of any of the above-mentioned nondiscrimination conditions, the Department will have a right to enter or re-enter said lands and facilities on said land, and that above described land and facilities will thereon revert to and vest in and become the absolute property of the U.S. Department of Transportation and its assigns as such interest existed prior to this instruction].*

(*Reverter clause and related language to be used only when it is determined that such a clause is necessary in order to make clear the purpose of Title VI.)

(b) Clauses for Transfer of Real Property Acquired or Improved Under the Activity, Facility, or Program (1050.2A, Appendix C)

The following clauses will be included in deeds, licenses, leases, permits, or similar instruments entered into by the North Carolina Department of Transportation (NCDOT) pursuant to the provisions of Assurance 7(a):

1. The (grantee, lessee, permittee, etc. as appropriate) for himself/herself, his/her heirs, personal representatives, successors in interest, and assigns, as a part of the consideration hereof, does hereby covenant and agree [in the case of deeds and leases add "as a covenant running with the land"] that:
 - (i.) In the event facilities are constructed, maintained, or otherwise operated on the property described in this (deed, license, lease, permit, etc.) for a purpose for which a U.S. Department of Transportation activity, facility, or program is extended or for another purpose involving the provision of similar services or benefits, the (grantee, licensee, lessee, permittee, etc.) will maintain and operate such facilities and services in compliance with all requirements imposed by the Acts and Regulations (as may be amended) such that no person on the grounds of race, color, or national origin, will be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination in the use of said facilities.
2. With respect to licenses, leases, permits, etc., in the event of breach of any of the above Nondiscrimination covenants, the NCDOT will have the right to terminate the (lease, license, permit, etc.) and to enter, re-enter, and repossess said lands and facilities thereon, and hold the same as if the (lease, license, permit, etc.) had never been made or issued. *
3. With respect to a deed, in the event of breach of any of the above Nondiscrimination covenants, the NCDOT will have the right to enter or re-enter the lands and facilities thereon, and the above described lands and facilities will there upon revert to and vest in and become the absolute property of the NCDOT and its assigns. *

- (*Reverter clause and related language to be used only when it is determined that such a clause is necessary to make clear the purpose of Title VI.)
- (c) Clauses for Construction/Use/Access to Real Property Acquired Under the Activity, Facility or Program (1050.2A, Appendix D)

The following clauses will be included in deeds, licenses, permits, or similar instruments/ agreements entered into by the North Carolina Department of Transportation (NCDOT) pursuant to the provisions of Assurance 7(b):

1. The (grantee, licensee, permittee, etc., as appropriate) for himself/herself, his/her heirs, personal representatives, successors in interest, and assigns, as a part of the consideration hereof, does hereby covenant and agree (in the case of deeds and leases add, "as a covenant running with the land") that (1) no person on the ground of race, color, or national origin, will be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination in the use of said facilities, (2) that in the construction of any improvements on, over, or under such land, and the furnishing of services thereon, no person on the ground of race, color, or national origin, will be excluded from participation in, denied the benefits of, or otherwise be subjected to discrimination, (3) that the (grantee, licensee, lessee, permittee, etc.) will use the premises in compliance with all other requirements imposed by or pursuant to the Acts and Regulations, as amended, set forth in this Assurance.
2. With respect to (licenses, leases, permits, etc.), in the event of breach of any of the above Non-discrimination covenants, the NCDOT will have the right to terminate the (license, permit, etc., as appropriate) and to enter or re-enter and repossess said land and the facilities thereon, and hold the same as if said (license, permit, etc., as appropriate) had never been made or issued. *
3. With respect to deeds, in the event of breach of any of the above Nondiscrimination covenants, the NCDOT will there upon revert to and vest in and become the absolute property of the NCDOT and its assigns. *

(*Reverter clause and related language to be used only when it is determined that such a clause is necessary to make clear the purpose of Title VI.)

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 for 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

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.
- The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.
 - The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.
10. **Assurance Required by 49 CFR 26.13(b):**
- The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.
 - 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.
- The records kept by the contractor shall document the following:
 - The number and work hours of minority and non-minority group members and women employed in each work classification on the project;
 - The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and
 - The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;
 - 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

- 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 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 to 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 NC180101 01/05/2018 NC101

Z-101

Date: January 5, 2018

General Decision Number: NC180101 01/05/2018 NC101

Superseded General Decision Numbers: NC20170101

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: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.35 for calendar year 2018 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was 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 \$10.35 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract for calendar year 2018. The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2) – (60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number
0

Publication Date
01/05/2018

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 |
| Telecommunications Technician | 15.19 | 1.25 |
| IRONWORKER | 13.30 | |
| LABORER | | |
| Asphalt Raker and Spreader | 12.78 | |

| | Rates | Fringes |
|---|-------|---------|
| 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 |
| PAINTER | | |
| Bridge | 23.77 | |
| POWER EQUIPMENT OPERATORS | | |
| 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 | |
| TRUCK DRIVER | | |
| GVWR of 26,000 Lbs or Less | 11.45 | |
| GVWR of 26,000 Lbs or Greater | 13.57 | .03 |

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

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a

family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

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

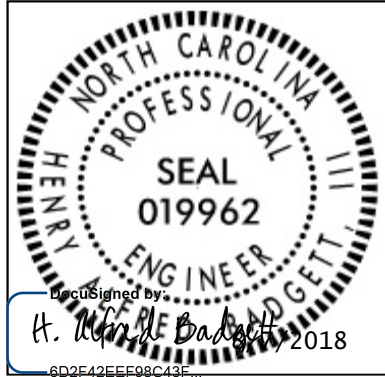
4.) All decisions by the Administrative Review Board are final.

END OF GENERAL DECISION

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Alamance County



PROJECT SPECIAL PROVISIONS
Burlington-Graham Computerized Signal System

N.C. Project No. U-6015 (WBS # 47160.1.1)
F.A. Project No. STBG-0701 (036)

Based On
NCDOT ITS and Signals Project Special Provisions
Version 18.1

Document not considered final unless all signatures completed.

Prepared by:

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 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 construct a new computerized traffic signal system in the Cities of Burlington and Graham, North Carolina. Work will be primarily comprised of a new fiber optic communications system, field equipment upgrades, upgrading the existing city-wide centrally managed distributed processing traffic control system, enhancement of the City of Burlington Traffic Control Center (TCC), and the upgrade and expansion of the existing video monitoring system. This project includes:

- Signal display upgrades at selected locations and replacement of existing controllers and cabinets with new Model 2070LX controllers housed in Model 332 or 336S cabinets for 206 signalized intersections;
- Replacement and expansion of single-mode fiber-optic communications cable and one wireless serial communications system and fiber-optic transceivers with a new Ethernet-based, fault-tolerant, single-mode fiber-optic communications comprised of approximately 55 roadway miles of fiber-optic cable, with one wireless communications link to one CCTV camera;
- Upgrading and expanding the existing video monitoring system by replacing 13 existing analog CCTV cameras and their encoders with new digital Internet Protocol (IP) equipment, adding 27 new digital camera locations (40 total locations), and modifying the existing central video equipment and database; and
- Replacing the existing signal system software and central computers with new distributed processing software, new computer workstations, and servers.
- Replace video monitor wall and supporting equipment.

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 and Ethernet edge switches;

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- 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 pedestrian signals at one location;
- 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;
- Install new metal CCTV poles, or new wood CCTV poles, or new joint use CCTV / traffic signal poles at designated locations;
- Modify existing electrical services and install new electrical services and associated grounding;
- Furnish and install new servers, workstations, video wall and associated support equipment;
- 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.

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 into the new Burlington-Graham Signal System. These concurrent projects include but may not be limited to the following:

- NCDOT Projects:
 - U-5752, US 70 (South Church Street): St. Marks Church Road intersection improvements,
 - U-5843, US 70 (North Church Street): SR 1817 (Graham-Hopedale Road) intersection improvements,
 - U-5844, NC 62: SR 1430 (Ramada Road) to US 70 (Church Street) Widen to multi-lanes,
 - U-6010, US 70 (South Church Street): SR 1226 / SR 1311 (University Drive) intersection improvements, includes widening of US 70 to maintain consistent cross-section with project U-5752 improvements,
 - U-6011, US 70 (South Church Street): SR 1158 (Huffman Mill Road) intersection improvements,
 - U-6019, US 70 (South Church Street): Tarleton Avenue to Fifth Street in Burlington, widen and construct center turn lane,

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- 47771, NC 54 (East Harden Street): Widen and improve right turn taper, radius and signal upgrade at the intersection of NC 54 and SR 1945 (Riverbend Road)
- 07-0263 - SR 1716 (N. Graham, begin 2018/2019-Hopedale Road) at SR 1343 (Martin Street) – Future signal
- 7.1001SM 07-1258 – US 70 (South Church Street): at Wade Coble Drive / Hillier Drive – Future signal
- SR 1149 (Huffman Mill Road) at Hospital Entrance – Future signal
- Grand Oaks Boulevard at Hospital Entrance – Future signal
- US 70 (Church Street) at Edgewood Avenue/Edgewood Village Access, Future signal
- US 70 (Church Street) at Ashley Woods Drive – Future signal

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.

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 2018, 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 Burlington’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*;
- Project Special Provisions shall govern over Standard Special Provisions, Plans, *Standard Specifications*, Supplemental Specifications and *Roadway Standard Drawings*.

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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.

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.

2018 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.

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.

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

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 Engineer. 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 Engineer at no additional cost.

Make software/firmware upgrades that are developed to correct operating characteristics available to the Engineer 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

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

G. 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 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.

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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.

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 Burlington-Graham 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.

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. Remove and replace an entire panel of sidewalk (from joint to joint), not partial panels. 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 Burlington's Streets Superintendent at 336-222-5066 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 City of Burlington's Streets Supt. 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

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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.

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.

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. City Permits

Obtain City Permits for Utility Cuts and Temporary Lane, Street, and Sidewalk Closures, prior to beginning any work inside the City Limits, if required.

E. 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.

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

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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. Coordinate with the Division Traffic Signal Supervisor (336-690-6780).

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.

G. 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 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.

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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 Burlington and Graham city 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®-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.

H. 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.

I. Removal of Existing Equipment and Material

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

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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; 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. Return all other Department-owned and City-owned equipment and material as follows:

- Return Department-owned equipment removed between 7:30 a.m. and 2:30 p.m., Monday through Thursday, to a site determined by the NCDOT Division 7 Deputy Division Traffic Engineer. Contact the Division 7 Deputy Division Traffic Engineer at (336) 487-0175 in advance of each delivery to schedule a mutually agreed upon 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 of Burlington Signal Shop located at 234 East Summit Avenue in Burlington (27215), or at a time mutually agreed to by the Contractor, the Engineer and the City. Contact Dean Coble of the City at (336) 222-5079 in advance of each delivery to schedule a mutually agreed upon day and time for delivery of removed materials and equipment.

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.

J. 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.

K. 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 2070LX equipment. Coordinate timing work with Department staff and 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 Department staff and 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 Department and City will provide existing intersection and system timing parameters (cycle, split and offset) and available custom graphics. Department and 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 Department-furnished and City-furnished timing data to ASC/3™-formatted data and for loading all timing data into the controllers and conflict monitors. Submit the converted data files for review and approval by the Department and the City at least two weeks (10 business days) prior to scheduled implementation. The Department and 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.

L. 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®-approved, underground splice connectors or in condulets using heat shrink tubing. Splice signal cable inside equipment cabinets, cabinet base extenders/adapters, and terminal splice boxes at nickel-plated brass, recessed-screw, barrier-type terminal blocks or using heat shrink tubing. 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.

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Install all wire and cable with necessary hardware including, but not limited to shoulder eyebolts, washers, nuts, thimble eyelets, three-bolt clamps, J-hooks, split bolt connectors, grounding clamps, and lashing material.

M. 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 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.

N. 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.

O. Traffic Signal Activation

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

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P. 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) and North Carolina Railroad Company (NCR) 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 NCRR 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."

Cable crossings include the following locations:

| Plan Sheet | Location | Railroad Company |
|------------|--|------------------|
| CRP-6.025 | RR Overpass at Fisher Street near NC 87-100 (W. Webb Avenue) / Crossing # 722 815V | NS / NCR |
| CRP-6.131 | RR Overpass at NC 87 (W. Webb Avenue) near Flora Avenue / Crossing # 722 811T | NS / NCR |
| CRP-6.142 | At-Grade Crossing across Elmira Street near NC 87-100 (W. Webb Avenue) / Crossing # 722 814N | NS / NCR |
| CRP-6.185 | At-Grade Crossing across S. Graham-Hopedale / Washington Street near Longest Street/ Crossing # 735 448C | NS / NCR |

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,

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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.

Norfolk Southern Corporation:

<http://www.nscorp.com/content/nscorp/en/real-estate/norfolk-southern-services/wire-pipeline-fiber-optic-projects.html>

North Carolina Railroad Company:

<http://www.ncrr.com/corridor-access/best-practices-for-utilities/> **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. U-6015 in the Cities of Burlington and Graham and Alamance County, North Carolina.

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Provide 72 hours advance notice to 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 10 working days advanced written notice to NCRP in order that flagging service can be arranged and provided. Do not undertake any work within the NCRP 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 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

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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 regarding 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 details 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 cables,
5. Installation of drop cables into risers with existing fiber-optic cable,
6. Reel-to-reel splice locations,
7. Transitioning the City's existing city-wide signal system over to the new signal system software, changing out the controllers and switching from the existing serial fiber-optic and radio communications system to a new Ethernet-based fiber-optic, communications system.
8. Removal of existing fiber-optic communications cable, where Plans or Engineer require, 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 an existing underground conduit or existing riser where there is no spare conduit/riser to facilitate installation of new cable before removing the existing cable; and
10. How to coordinate with others at the time new cabinets are set to make the necessary signal changes at the TCC to get the controller online.

Submit a Migration Plan to the Engineer for Department review and approval prior to beginning any migration from the existing signal system and communications system to the new

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signal system and new Ethernet communications system. Submit the Migration Plan 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

Notify the City Traffic Engineer at (336) 570-6516 at least two weeks prior to the commencement of work on a particular existing 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 that the time-base coordination plans are installed in all of the intersection controllers within the control zone. Place in time-base coordination only those signals within an existing communications channel that are actively being migrated to the Ethernet communications system. Ensure that the time-base coordination plans from existing controllers are transferred to the replacement controllers at those same locations.

Notify the Regional ITS Engineer at (336) 315-7080 at least two weeks prior to the commencement of any fiber-optic cable splicing or pulling in existing conduits along I-85.

Notify the City of Burlington IT Operations Manager at (336) 222-5044 at least 10 working days prior to the commencement of any work involving fiber-optic cable along City of Burlington IT cable routes.

All replacement or disconnection of existing City of Burlington IT fiber-optic cable shall occur only on weekends after Friday night at 8 PM and must be complete by Monday at 5 AM. Failure to comply or to complete within the time limits will result **in liquidated damages of \$1,500 per 24-hour period or any portion thereof.**

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 the use of time-base 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 approved by the Engineer in advance of the initial disconnection from system communications.

Verify time-base coordination in 2070LX 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 2070LX 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-base coordination is in use and make any corrections necessary to maintain proper coordination. In the event coordinated timing plan changes are needed, the Contractor shall implement them at the direction of the Contractor. 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 TCC is interrupted (i.e., while signals are offline).

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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.**

Group the work by the proposed communications rings, allowing intersection migration to take place in discrete segments as described in these Project Special Provisions. For one-way streets within proposed rings, start at the most upstream intersection and work downstream without skipping intersections.

Perform as much of the necessary “make ready” work as possible within a proposed Ethernet communications ring to be migrated 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, electrical service modifications, etc.

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

Interrupt communications, replace cabinets and controllers, and migrate signals from the existing communications channel to the new Ethernet communications network as follows:

- Begin the process of replacing cabinets and controllers. Prior to installing each new cabinet and controller, configure and install the Ethernet edge switch in the cabinet and program or otherwise verify that time-base coordination is properly programmed. See “Backup Intersection Operation” subsection in the “Signal System Software” section of these Project Special Provisions for further details.
- 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.
- Upon successful testing, integrate into the new central system software under Ethernet communications.

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.

Complete the work of migrating all the signals in one Ethernet communications ring before moving to the next ring. Exceptions to the requirements in this section must be approved by the Engineer.

Once migration begins on a given communications ring, continue migrating signals along that ring until all communications 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.

Once all signal migration within a proposed communications ring is complete, establish or otherwise verify that time-base coordination is properly programmed on all existing controllers in the ring. Disconnect and remove existing communications cable where designated in the Plans.

Upon successful testing, integrate the communications ring and all devices connected to that ring into the central system software under Ethernet communications.

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

As each Ethernet ring is completed and lit, test communications to each Ethernet edge switch in that ring 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 TCC and existing signal controllers still connected to the existing communications cable is reestablished and working correctly.

C. Staging Concept

The existing communications infrastructure is a city-wide signal system comprising most of the traffic signals in the Cities of Burlington and Graham and all of the existing cameras. There is one location with a spread spectrum radio link for communications.

The sequence described below is designed to minimize the downtime between the old and new systems and maintain the connection to the various rings and controllers. The Contractor may elect to perform the major steps identified for each ring in a sequence different than proposed below for each ring; 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 Engineer.

Prior to the initiation of the first step of migration in each ring, follow the steps described below.

Stage 1, Field Infrastructure:

The construction of the field infrastructure shall begin before the TCC modifications. Begin “make-ready” work at the Burlington TCC and the routes listed in Stage 2 below.

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 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.) shall 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.

The general approach to follow for all Rings except 8 and 9 shall follow the steps listed below. For Rings 8 and 9, see the requirements in Stage 2.

1. Step 1

The Department 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. If this work cannot be completed within 120 days, notify the Engineer 20 calendar days in advance to allow the Department to request an extension of the permit.

2. Step 2

Begin construction of the trunk cables along the major routes described below. 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.

3. Step 3

Construct the branch cables to the arterials off the trunk fiber-optic routes and non-redundant routes 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 each traffic signal controller cabinet. 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 change-out.

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 transferring communications from the old fiber-optic network to the new fiber-optic network. See the preceding subsection 1.4(B) "General Requirements" for further details. Exceptions to the requirements in this section must be approved by the Engineer. Notify the City of Burlington Signal System Supervisor Dean Coble at (336) 222-5079 at least two weeks prior to the commencement of work on a particular existing communications channel to ensure that time-base coordination will be operating and effective during the time of communications interruption. As each Ethernet ring 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 communication channel and work towards the TCC. Group the work by the existing communication channels, allowing intersection migration to take place in discrete packages. The boundaries of the existing closed-loop systems are documented in the "System Boundaries and Control Sections Technical Memorandum (Task 7.1)", dated January 2018, a copy of which may be obtained from the Engineer upon request.

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

After the controllers are replaced, additional database work must be performed. Revise the offset references when NEMA controllers are replaced with 2070s. The NEMA controllers use offsets referenced to the end of the coordinated phase green. The 2070s with ASC/3 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 6

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

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

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Ensure controller cabinet change-outs adhere to all requirements listed in Subsections 1.3(A) “General” and 1.3(H) “Utility Services” 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 TCC, are reestablished, if they were interrupted, and are working correctly.

7. Step 7

Conduct system testing, acceptance and burn in period.

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 2, Core Trunk Fiber-Optic Cable 1:

Begin and complete the “make-ready” work in the Public Works Building of the City of Burlington before installation of the primary trunk cable listed below. Begin and complete the communications construction and integration along the routes listed below. Begin construction of the larger trunk cables along the major routes described below that carry multiple rings. For those routes with overhead cable, overlash the new fiber-optic cable to the existing fiber-optic cable or lash it to new messenger cable as shown on the plans. For the underground routes, install the new cable in spare ducts, where available, or inside the same conduit as the existing fiber-optic cable where there is no available, accessible spare conduit. The use of the existing occupied conduit may require the removal of the existing cable first. Provide cable storage for subsequent and future splices where called for in the Plans. Begin construction of field infrastructure (i.e., messenger cable, risers, underground conduits, junction boxes, foundation modifications, CCTV poles/cameras/cabinets, fiber-optic communications cable).

Construct the larger primary trunk fiber-optic cables along:

- 48 Strands
 - NC 54 (Chapel Hill Road)
 - NC 54 (West Harden Street) – NC 54 Chapel Hill Road) to South Maple Avenue
 - NC 62 (Alamance Road) – I-85 to S. Mebane Street
 - S. Mebane Street – NC 62 (Alamance Road) to Summit Avenue
 - Maple Street – NC 54 (West Harden Street) to West Pine Street
 - Marshall Street – Pine Street to NC 54 (East Harden Street)
 - Pine Street – S. Maple Street to Marshall Street
 - Summit Avenue – south of TCC (2 cables)
- 36 Strands
 - Albright Avenue
 - East Davis Street
 - Holt Street – North of N. Main Street
 - Ireland Street
 - Kirkpatrick Road
 - Maple Avenue – US 70 (N. Church Street) to S. Lexington Avenue
 - Marshall Street – NC 54 (East Harden Street) to Albright Avenue
 - N. Main Street (Burlington) – Holt Street to US 70 (N. Church Street)
 - North Main Street (Graham)

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- NC 87 (East Webb Avenue)
- South Graham-Hopedale Road
- S. Lexington Avenue
- S. Mebane Street – E. Davis Street to NC 87 (East Webb Avenue)
- Summit Avenue – North of TCC (2 cables)
- University Drive – South of US of (Church Street)
- US 70 (Burlington Road)
- US 70 (S. Church Street) – University Drive to US 70 (N. Fisher St.)
- US 70 (N. Church Street) – Holt Street to Ireland Street
- US 70 (N. Church Street) – N. Main Street to Graham-Hopedale Road
- US 70 (N. Fisher Street)
- US 70 (S. Fisher Street)
- 24 Strands
 - Grand Oaks Blvd.
 - Huffman Mill Road – north of Bones Station Road
 - South Maple Street – North of East Pine Street
 - South Mebane Street – Huffman Mill Road to NC 62 (Alamance Road)
 - Summit Avenue
- 12 Strands
 - East Davis Street
 - Mebane Street – East of Summit Avenue (concurrent with Summit Avenue)
 - North Main Street (Burlington)
 - South Worth Street
 - Anthony Street
 - Briarcliff Road
 - East Front Street
 - East Parker Street
 - Hermitage Road
 - Holt Street – South of US 70 (N. Church Street)
 - Mebane Street – West of E. Davis Street
 - Rauhut Street
 - Saddle Club Road
 - St. Marks Church Road
 - US 70 (N. Church Street) – Ireland Street to N. Fisher Street

Begin constructing the 48, 36, and certain 24 and 12 strand cables first to provide communications to the TCC.

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

Interrupt communications, replace cabinets and controllers, install new CCTV where applicable, and migrate signals from the existing system to the new communications network. If the communications conversion in the subject ring interrupts the communication in another ring, the Contractor must re-establish communication continuity in the adjacent ring before any work can continue. As each new cabinet and controller are installed, establish Ethernet connectivity from the Ethernet edge switch to the Ethernet core switch, and re-establish communication to all signals still connected to the existing fiber-optic network.

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

Complete the work of migrating all the signals and cameras in one ring before moving to the next ring. Complete the intersection migrations in a ring within the number of workdays equal to no more than the number of signalized intersections in the ring. The Engineer must approve exceptions to the requirements in this section.

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

Complete field infrastructure construction for all of Rings 6-11 to the new communications system and integrate these rings and controllers into the new central software using new servers at the TCC.

For Rings 8 and 9 complete the cabinet and controller changeouts prior to replacing the drop cables. After changing out the cabinets and controllers, restore communications on the existing communications channels. After the cabinet and controllers have been replaced, over one weekend after the Friday PM peak traffic period, disconnect the existing trunk cable and its drop cables and remove the trunk and drop cables. Pull in new trunk cable and drop cables, and establish communications on Rings 8 and 9. Accomplish this work before the Monday morning peak traffic period.

Stage 3, Core Trunk Fiber-Optic Cable:

Continue installation of the trunk cables and field infrastructure on the secondary routes by constructing the trunk fiber-optic cables along:

- 12 Strands
 - Graham Street
 - West Hanover Road
 - West Parker Street

Complete field infrastructure construction for all of Rings 3 and 4 to the new communications system and integrate these rings and controllers into the new central software using new servers at the TCC.

Stage 4, Core Trunk Fiber-Optic Cable:

Continue installation of the trunk cables and field infrastructure on the secondary routes by constructing the trunk fiber-optic cables along:

- 24 Strands
 - University Drive – North of US 70 (Church Street)
- 12 Strands
 - St. Marks Church Road (north section)

Complete field infrastructure construction for all of Rings 14 and 15 to the new communications system and integrate these rings and controllers into the new central software using new servers at the TCC.

Stage 5, Core Trunk Fiber-Optic Cable:

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Continue installation of the trunk cables and field infrastructure on the secondary routes by constructing the trunk fiber-optic cables along:

- 24 Strands
 - Boone Station Drive
 - NC 62 (Alamance Road) - Grand Oaks Blvd. to S. Mebane Street
- 12 Strands
 - Delaney Drive
 - Forestdale Drive
 - Huffman Mill Road – south of Boones Station Road
 - St. Marks Church Road (south section)

Complete field infrastructure construction for all of Rings 16-20 to the new communications system and integrate these rings and controllers into the new central software using new servers at the TCC.

Stage 6, Core Trunk Fiber-Optic Cable:

Continue installation of the trunk cables and field infrastructure on the secondary routes by constructing the trunk fiber-optic cables along:

- 24 Strands
 - Maple Avenue – South of I-85
 - Moore Street
 - NC 49 (East Elm Street)
 - NC 54 (East Harden Street)
 - South Main Street (Graham)
 - US 70 (N. Church Street) – East of Graham-Hopedale Road
- 12 Strands
 - Beaumont Avenue
 - Jimmie Kerr Road
 - North Graham-Hopedale Road

Complete field infrastructure construction for all of Rings 1, 2 and 5 to the new communications system and integrate these rings and controllers into the new central software using new servers at the TCC.

Stage 7, Core Trunk Fiber-Optic Cable:

Continue installation of the trunk cables and field infrastructure on the secondary routes by constructing the trunk fiber-optic cables along:

- 24 Strands
 - NC 87 (West Webb Avenue)
 - Trollinger Street
 - West Davis Street
 - West Front Street – East of West Davis Street
- 12 Strands
 - Edgewood Avenue
 - Flora Avenue
 - Tarleton Avenue – North of West Front Street
 - West Front Street – West of West Davis Street

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- University Drive – West of Flora Avenue

Complete field infrastructure construction for all of Rings 12 and 13 to the new communications system and integrate these rings and controllers into the new central software using new servers at the TCC.

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:

Pay Item

Pay Unit

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. 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.

C. 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.

D. Temporary Lane Closures

1. General

Operate all equipment and personnel within the designated work area during lane closures. Do not impede or stop traffic to perform 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 vehicle warning lights as described in Article 1101-5 of the *Standard Specifications*.

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 and provide law enforcement or other adequate traffic control measure to direct traffic through the intersection before 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.

E. Traffic Stoppage

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

F. 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 contact 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 work zone 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*.

G. 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.

H. Pedestrian Access

Maintain pedestrian access at all times as shown in the TMP. When existing pedestrian facilities are disrupted, closed or relocated, provide temporary facilities that are detectable and include accessibility features consistent with the features present in the existing pedestrian facility. The work zone supervisor is responsible for the implementation of the TMP, and installation and maintenance of the pedestrian devices. The work zone shall be inspected weekly

or as directed by the Engineer. When pedestrian movement through or around a work zone 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 comparable. Do not have any abrupt changes in grade or terrain that could cause a tripping hazard or could be a barrier to wheelchair use. Provide 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.

3.3. MATERIALS

A. Work Zone Traffic Control Devices

Refer to Division 10 of the *Standard Specifications*.

Furnish a Type 3 material certification in accordance with Article 106-3 of the *Standard Specifications* for all new temporary control devices and a Type 7 material certification for all used temporary traffic control devices at least 72 hours before use.

B. Work Zone Signs

Refer to Division 10 of the *Standard Specifications*:

| Item | Section |
|-------------------------|---------|
| 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*:

| Item | Section |
|-----------------------|---------|
| Flashing Arrow Boards | 1089-6 |

Use arrow boards listed 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.

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D. Portable Changeable Message SignsRefer to Division 10 of the *Standard Specifications*:

| Item | Section |
|-----------------------------------|----------------|
| Portable Changeable Message Signs | 1089-7 |

Use portable changeable message signs listed 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. DrumsRefer to Division 10 of the *Standard Specifications*:

| Item | Section |
|-------------|----------------|
| Drums | 1089-5 |

Provide drums listed on the NCDOT Approved Products List.

F. ConesRefer to Division 10 of the *Standard Specifications*:

| Item | Section |
|-------------|----------------|
| Cones | 1089-4 |

Provide cones listed on the NCDOT Approved Products List.

G. BarricadesRefer to Division 10 of the *Standard Specifications*:

| Item | Section |
|-------------|----------------|
| Barricades | 1089-3 |

Provide barricades that meet NCHRP 350 for Category II traffic control devices and listed on the NCDOT Approved Products List.

H. FlaggersRefer to Division 10 of the *Standard Specifications*:

| Item | Section |
|-------------|----------------|
| Flaggers | 1089-10 |

I. Truck Mounted AttenuatorsRefer to Division 10 of the *Standard Specifications*:

| Item | Section |
|----------------------------------|----------------|
| Truck Mounted Impact Attenuators | 1089-9 |

Use chassis mounted or trailer mounted 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*:

| Item | Section |
|--------------|----------------|
| Skinny Drums | 1089-5 |

Provide skinny drums listed on the NCDOT Approved Products List.

3.4. CONSTRUCTION METHODS

A. Work Zone Traffic Control Devices

Ensure all traffic control devices are 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.

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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 arrow board.

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 display time for each phase shall be at least 2 seconds, and the sum of the display times for both 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 twice when 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 Article 1089-7(D). Periodically change the controller password to deter unauthorized programming. Using two levels of password security is recommended such that operators at one level may only change message sequences displayed using preprogrammed sequences and operators at a higher level may create and store messages or message sequences.

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. Periodically clean or replace the sign face panels and associated solar panels.

E. Drums

Use the same type of retroreflective 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 a tire ballasting method, use approved manufacturer's tires and place the tires flush with the ground.

Immediately replace and dispose of any drum, ballast or reflective sheeting that are torn, crushed, discolored or otherwise damaged.

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Use retroreflective adhesive sheeting on all cones used between dusk and dawn. Use the same type of retroreflective 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. Do not use cones for 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 retroreflective 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.

G. Barricades

Install Type III barricades of sufficient length to close the entire roadway. Reposition the devices as necessary to completely close the roadway to traffic at the end of the workday.

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. All flaggers shall be qualified by an NCDOT approved training agency in the set-up and techniques of safely and competently performing a flagging operation. For a complete listing of approved training agencies, 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.

U-6015**ITS-52****Alamance County****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 TMAs that meet the crash test requirements of *Standard Specifications* Subarticle 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 Roadway Standard Drawings. TMA trailer lighting systems shall be activated in the flash mode while deployed.

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 or replaced by using approved methods.

J. Skinny Drums

Use the same type of retroreflective 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.

Immediately replace and dispose of any skinny drum, ballast or retroreflective 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 for night work operations or allow 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.

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Use a law enforcement officer(s) when an existing traffic signal must be taken out of operation 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.

3.5. MAINTENANCE AND INSPECTION

Submit a proposed traffic control device maintenance schedule and checklist for approval before construction. Perform continuous maintenance and daily scheduled inspections of temporary traffic control devices. Review and maintain all traffic handling measures to ensure that adequate provisions are in place for public and workers' safety.

Maintenance activities include cleaning, repair or replacement and prompt disposal of temporary traffic control devices that are damaged, torn, crushed, discolored, displaced or deteriorated beyond effectiveness.

Replace work zone traffic control devices deemed unacceptable according to the guidelines set forth in the American Traffic Safety Service Association's (ATSSA) Quality Guidelines for Work Zone Traffic Control Devices

If the name and telephone number of the agency, Contractor or supplier is shown on the non-retroreflective surface of channelizing devices, use letters and numbers that are non-reflective and not over 2 inches in height.

3.6. FAILURE TO MAINTAIN TRAFFIC CONTROL

Failure to maintain temporary traffic control measures or temporary 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 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 incidental to the measurement of the quantity of signs.

Work zone signs (portable) will be measured and paid 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 incidental to the measurement of the quantity of signs.

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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 arrow boards 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 will be incidental to the work of this.

Portable changeable message sign will be measured and paid as the maximum number of portable changeable message signs acceptably placed and in operation, at any one time during the life of the project.

Relocation, replacement, repair and maintenance of portable changeable message signs will be incidental to the work of this section.

Drums will be measured and paid as the maximum number of drums acceptably placed and in use at any one time during the life of the project. Relocation, repair, replacement, maintenance or disposal of drums, ballast or reflective sheeting will be incidental to the work of this section.

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, maintenance or disposal of cones will be incidental to the work of this section.

Barricades (Type III) will be measured and paid 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, maintenance or disposal of barricades will be incidental to the work of this section.

Flagger (day) will be measured and paid as the actual number of days that each flagger is used for lane closures. Flagging conducted for the convenience of the Contractor's operations is not compensated. 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 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 as the maximum 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, maintenance or disposal of skinny drums will be incidental to the work of this section.

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Law enforcement will be measured and paid as the actual number of hours that each law enforcement officer provides 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 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 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 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:

| Pay Item | Pay Unit |
|-------------------------------------|-----------------|
| Work Zone Signs (Barricade Mounted) | Square Foot |
| Work Zone Signs (Portable) | Square Foot |
| Flashing Arrow Board | Each |
| Portable Changeable Message Sign | Each |
| Drums | Each |
| Cones | Each |
| Barricades (Type III) | Linear Foot |
| Flagger | Day |
| TMA | Each |
| Skinny Drum | Each |
| Law Enforcement | Hour |

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4. PAVEMENT MARKINGS

4.1. DESCRIPTION

Furnish and install thermoplastic pavement markings and remove pavement markings in accordance with the traffic signal plans.

4.2. MATERIALS

A. General

Refer to and fully comply with Section 1087 of the *Standard Specifications*.

B. Material Qualification

Use pavement markings that are on the Department's Approved Products List or are traffic qualified by the Signing and Delineation Unit.

C. Performance

Poor performance of pavement marking material at any site, whether or not related to a specific contract may be grounds for nonacceptance 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 and Highly Reflective Media Dispensing Equipment

Apply glass beads and highly reflective media to the surface of pavement long line markings using an automatic high pressurized bead and media dispenser or a pressurized mechanical feed, attached to the marking equipment. Hand liner type equipment is exempt from this requirement. Locate the bead and media applicator at the proper distance behind the application of pavement marking material to provide the proper amount of retroreflectivity. Equip the bead and media applicator with an

automatic cut-off control synchronized with the cut-off control of the marking material.

Spread the beads and reflective media 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.

Apply heated-in-place thermoplastic only when ambient air temperature and pavement surface temperature is 40°F and rising.

E. Time Limitations for Replacement

| TIME LIMIT FOR REPLACEMENT | | |
|--|--|---|
| Facility Type | Marking Type | Replacement Deadline |
| 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 day 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.

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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. 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 of 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, before 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.

Surface preparation and removal of bridge laitance shall be considered incidental to the installation of pavement marking with the exception of curing compound removal.

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

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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 traffic signal 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.

Install pavement marking lines that are straight or have uniform curvature and conform with the tangents, curves, and transitions as specified in the traffic signal 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, stop bars and symbols that require multiple passes of the application equipment such that there are no gaps separating the application passes.

Install symbols so that they conform to the sizes and shapes shown in the traffic signal 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-1952F) are within the tolerance limits of the color chips listed below:

White: Color 17886
Yellow: Color 13538
Black: Color 37038

(2) Highly Reflective Media Application

“Drop-on” is the method where glass beads and highly reflective media 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 and media dispensing for stop bars may be accomplished by gravitational methods.

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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 minimum retroreflective values for a 30-day period beginning upon the Engineer's acceptance of all markings on the project. Guarantee retroreflectivity 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*.

Maintain responsibility for debonding and color of the pavement markings during a 12-month observation period beginning upon the satisfactory completion and acceptance by the Engineer of all pavement marking work required in the traffic signal plans. Guarantee the markings under the payment and performance bond in accordance with Article 105-17 of the *Standard Specifications*.

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 and symbols including removal for long life marking preparation. This work does not include removal of removable tape pavement markings.

Remove pavement marking lines 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.

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Do not use high pressure water blasting on asphalt.

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 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 is 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 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

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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.

Handliner 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.

Apply drop-on beads and/or highly reflective media uniformly to the surface of the molten thermoplastic material so the beads and highly reflective media are partially embedded and at a rate recommended by the manufacturer to obtain the minimum reflectance values. For highly reflective markings, a double drop system consisting of glass beads and highly reflective media is required. Produce in place markings with 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.

| REFLECTOMETER REQUIREMENTS FOR THERMOPLASTIC | | |
|---|--------------|----------------------------|
| Item | Color | Reflectivity |
| Standard Glass Beads | White | 375 mcd/lux/m ² |
| | Yellow | 250 mcd/lux/m ² |
| Highly Reflective Media | White | 800 mcd/lux/m ² |
| | Yellow | 600 mcd/lux/m ² |

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 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.

| THICKNESS REQUIREMENT | |
|-----------------------|--|
| Thickness | Location |
| 120 mils | Center lines, skip lines, transverse bands, mini-skip lines and crosswalk lines. |
| 90 mils | Yield line symbols. |

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 12-month pavement markings 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

Thermoplastic Pavement Marking Lines will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily placed 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 markings satisfactorily placed.

Thermoplastic 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.

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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.

Premarking will be incidental to other items in the contract. Unless directed by the Engineer, there will be no direct payment for interim paint. No direct payment will be made for black paint or tape.

The Contractor may choose to use heated-in-place thermoplastic symbols and transverse lines instead of molten thermoplastics pavement markings at no additional cost to the Department.

Replacement of pavement markings that prematurely deteriorated, failed to adhere to the pavement, lacked reflectorization or were otherwise unsatisfactory during the life of the project or during the 12-month pavement markings observation period as determined by the Engineer will be at no cost to the Department.

Payment will be made under:

| Pay Item | Pay Unit |
|--|-----------------|
| Thermoplastic Pavement Marking Lines, ___", ___ mils | Linear Foot |
| Thermoplastic Pavement Marking Symbol, ___ mils | Each |
| Removal of Pavement Marking Lines, ___" | Linear Foot |

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Furnish and install vehicle and pedestrian LED signal heads, visors, interconnecting brackets, wire entrance fittings, mounting assemblies, signal cable, lashing wire, pedestrian pushbuttons (and associated lead-in cable), pedestrian signal signs, 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 and pedestrian signal head housings and end caps from die-cast aluminum. Provide visor mounting screws, door latches, and hinge pins fabricated from stainless steel. Provide interior screws, fasteners, and metal parts fabricated from stainless steel.

Fabricate tunnel and traditional visors from sheet aluminum.

Paint all surfaces inside and outside of signal housings and doors. Paint outside surfaces of tunnel and traditional visors, wire outlet bodies, wire entrance fitting brackets and end caps when supplied as components of 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, rigid vehicle signal head mounting brackets for mast arm attachments, messenger cable hanger components or balance adjuster components.

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 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. 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.

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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,
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, and
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 new 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 10 inches in length for 12-inch vehicle signal heads.

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

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

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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 messenger cable hanger components, wire outlet bodies and balance adjuster components from stainless steel or malleable iron galvanized in accordance with ASTM A153 (Class A) or ASTM A123. Provide serrated rings made of aluminum. Provide messenger cable hangers with U-bolt clamps. Fabricate washers, screws, hex-head bolts and associated nuts, clevis pins, cotter pins, U-bolt clamps and nuts 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 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.

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 QPL.

Provide the manufacturer's model number and the product number (assigned by the Department) for each module that appears on the 2018 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

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– Light Emitting Diode (LED) Circular Signal Supplement” dated June 27, 2005 (hereafter referred to as VTCSH Circular Supplement) and other requirements stated in this specification.

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

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

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.

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 QPL.

Provide the manufacturer’s model number and the product number (assigned by the Department) for each module that appears on the 2018 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:

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

For yellow arrow signal modules, provide modules tested under the procedures outlined in the VTCSH Arrow Supplement to insure power required at 77° F is 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. Pedestrian Signal Heads:

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

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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.

Provide 16-inch pedestrian signal heads with traditional three-sided, rectangular visors, 6 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 R10-3E signs with mounting hardware that comply with the MUTCD in effect on the date of advertisement.

Design the LED pedestrian traffic signal modules (hereafter referred to as modules) for installation into standard pedestrian traffic signal sections that do not contain the incandescent signal section reflector, lens, eggcrate visor, gasket, or socket. Provide modules that consist of an assembly that uses LEDs as the light source in lieu of an incandescent lamp. Use LEDs that are 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.

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Provide modules which have the solid hand/walking man overlay on the left and the countdown on the right. All makes and models of LED modules purchased for use on this project shall appear on the current NCDOT Traffic Signal QPL.

Provide the manufacturer's model number and the product number (assigned by the Department) for each module that appears on the 2018 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:

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

Note: Use a wattmeter having an accuracy of $\pm 1\%$ 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.

Ensure the countdown display begins normal operation upon the completion of the preemption sequence and no more than one pedestrian clearance cycle.

D. Signal Cable

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

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

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

E. Louvers:

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

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Provide louvers made from sheet aluminum. Paint the louvers alkyd urea black synthetic baked enamel with a minimum gloss reflectance and meeting the requirements of MIL-E-10169, "Enamel Heat Resisting, Instrument Black."

Ensure that the louvers have a 0-degree horizontal viewing angle. Provide a minimum of 5 vanes.

5.3. CONSTRUCTION METHODS

A. General

Comply with *Roadway Standard Drawing* No. 1705.02 when installing signal heads.

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.

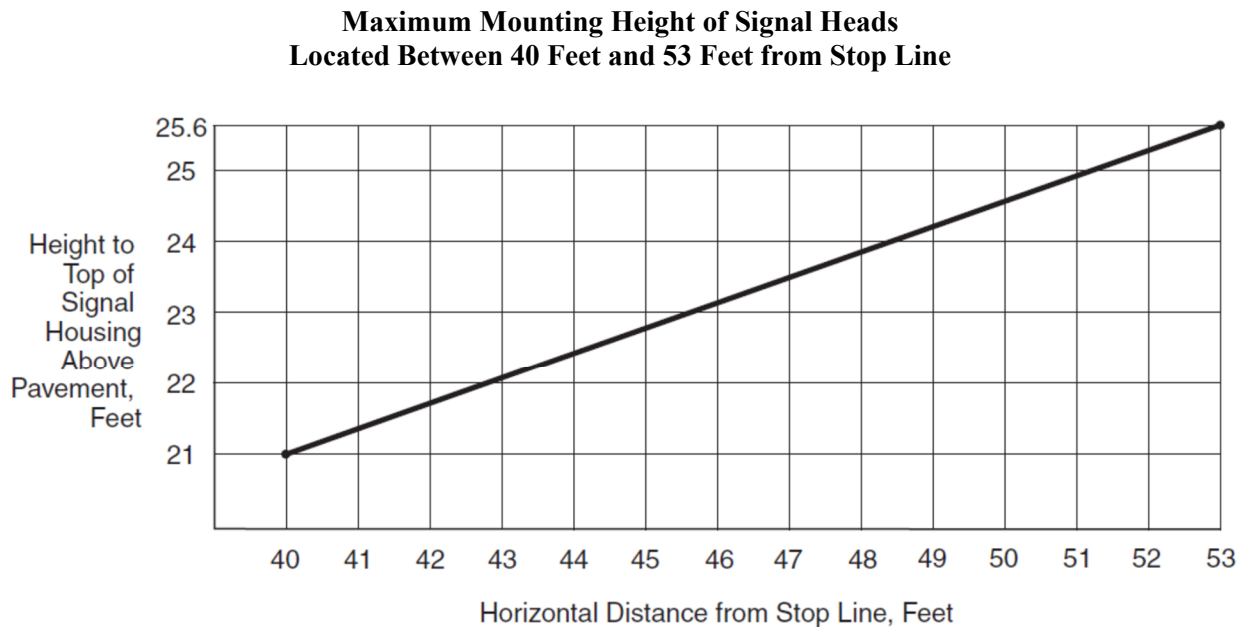
When new signal heads are placed into operation, immediately bag and remove signals heads that are not to be reused.

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.



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.

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:

- 1) 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.
- 2) 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.

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.

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.

Comply with *Roadway Standard Drawing* No. 1705.04 when installing pedestrian pushbuttons on Type I or Type II pedestals.

Mount the pushbutton at a minimum height of 3.5 feet but no higher than 4.0 feet above the adjacent pedestrian travel way.

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 feet or more than 10 feet above sidewalk level. Position and adjust the heads to provide maximum visibility at the beginning of the controlled crosswalk.

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D. Louvers

Attach the louvers to the visors using stainless steel hardware. Position the signal head to give the viewing angle as shown in the plans.

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.

Louver will be measured and paid as the actual number of signal sections for which louvers have been 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 incidental to furnishing and installing vehicle and pedestrian signal heads.

Signal cable will be measured and paid 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 incidental to furnishing and installing signal cable.

Payment will be made under:

| Pay Item | Pay Unit |
|---|-----------------|
| Vehicle Signal Head (12", 3 Section) | Each |
| Vehicle Signal Head (12", 4 Section) | Each |
| Vehicle Signal Head (12", 5 Section) | Each |
| Pedestrian Signal Head (16", 1 Section w/Countdown) | Each |
| Louver | Each |
| Signal Cable | Linear Foot |

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6. BACKPLATES

6.1. DESCRIPTION

Furnish and install backplates for vehicle signal heads with all necessary hardware.

6.2. MATERIALS

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

Comply with ITE standard Vehicle Traffic Control Signal Heads. Provide backplates specific to the manufacturer of the vehicle signal heads. Provide stainless steel fasteners and hardware for attachment to signal head. Provide backplates that extend at least 5 inches from the vehicle signal head outline. Ensure the backplate fills in the gaps between cluster-mounted vehicle signal sections (5-section vehicle signal heads). A 1/4-inch maximum gap between vehicle signal head and backplate, as viewed from the front, will be allowed.

Fabricate metallic backplates for vehicle signal heads from sheet aluminum at least 0.05 inch thick. Provide backplates painted an alkyd urea black synthetic baking enamel with minimum gloss reflectance that meets Federal Specification MIL-E-10169, Instrument Black.

Provide polycarbonate or vacuum formed ABS plastic backplates that are black on both the front and back sides with a consistent color throughout the entire piece for each backplate. Provide backplates that contain UV inhibitors and stabilizers for protection against UV degradation. Provide backplates that have a minimum tensile stress at yield of 5,300 psi at 73°F and meet UL Standard 94. Ensure polycarbonate backplates have a minimum thickness of 0.100 inch with one side dull black and the other side semi-gloss black. Ensure vacuum formed ABS plastic backplates have a minimum thickness of 0.125 inch with a hair cell finish on the front side and a smooth finish on the back side.

6.3. CONSTRUCTION METHODS

Install backplates for vehicle signal heads so as not to interfere with the function of all door hinges, signal section latches and mounting hardware. Do not bend or deform backplates during installation. Gooseneck fittings may be installed in reverse to accommodate backplates. Use stainless steel fasteners for attaching backplates to signal sections.

6.4. MEASUREMENT AND PAYMENT

Backplates will be measured and paid in units of each, furnished, installed and accepted. No measurement will be made for different sizes, type or reflective taping of backplates.

Payment will be made under:

| Pay Item | Pay Unit |
|-----------------|-----------------|
| Backplate | Each |

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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 irreversible compression connectors.

Adjust existing messenger cable attachments heights.

7.2. MATERIALS**A. General**

Furnish material, equipment and hardware under this section that is 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 thimble eyelets.

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 article 1091-2, "Wire and Cable", 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

7.3. 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

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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 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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Adjust existing messenger cable to achieve proper signal head clearance over roadway where directed by the plans. Refer to section 5.3.B of these project special provisions for proper signal head clearance.

7.4. MEASUREMENT AND PAYMENT

Messenger cable (_____) will be measured and paid 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, J-hooks, eye nuts, split bolt connectors, metal pole clamps, and stainless-steel banding hardware as these will be incidental to furnishing and installing messenger cable. Bonding to an existing pole grounding system will be incidental to furnishing and installing messenger cable.

No measurement will be made for adjusting existing messenger cables as these will be incidental to furnishing and installing signal heads.

Ground rods installed as part of pole grounding systems will be measured and paid for in accordance with the "Electrical Service" section of these Project Special Provisions. No measurement will be made for furnishing and installing #6 AWG solid bare copper wire, messenger bonding clamps, hot-dipped galvanized wire staples, and irreversible compression connections as part of pole grounding systems as such work is incidental to furnishing and installing the wood poles, messenger cable and grounding electrodes.

Payment will be made under:

| Pay Item | Pay Unit |
|------------------------|-----------------|
| Messenger Cable (1/4") | Linear Foot |
| Messenger Cable (3/8") | Linear Foot |

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8. UNDERGROUND CONDUIT

8.1. DESCRIPTION

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

8.2. MATERIALS

A. General

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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| HDPE CONDUIT SIZE | |
|---------------------------|-------------------|
| Conduit Trade Size | Furnish |
| 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.

| RESIN PROPERTIES | | |
|--|--|---------------------------------------|
| Property | Requirement | Test Method |
| Density | 0.940 - 0.947g/cm ³ | 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.

| CONDUIT COLORS | | |
|--|------------------------------|---------------------------|
| Conduit Contents | Preferred Solid Color | Alternate |
| 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.

8.3. CONSTRUCTION METHODS

A. General

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

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 or Cat 6 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 downtown Burlington and Graham.

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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

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

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completion, restore surface to like-original condition within five consecutive calendar days of occurrence of damage. Remove all rock and debris from backfill material. Remove excess material from site and compact area according to Article 300-7 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.

5. 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.

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6. 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 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.

For the following structures, the minimum clearance requirements are:

| MINIMUM CLEARANCE REQUIREMENTS FOR STRUCTURES | |
|--|---|
| Man-made Structure | Minimum Clearance Requirement |
| Bridge foundation | 5' horizontal & 4' vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10' horizontal should be no deeper than 8') |
| Drainage pipes 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 |

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.

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.

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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 rights-of-way 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 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.

8.4. MEASUREMENT AND PAYMENT

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

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 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 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 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

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inside the existing conduits as such work will be 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 incidental to conduit installation. No measurement will be made of removing, stockpiling and resetting existing granite curb as such work will be 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 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 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 incidental to furnishing and installing underground conduit.

Payment will be made under:

| Pay Item | Pay Unit |
|-----------------------------|-----------------|
| Tracer Wire | Linear Foot |
| Underground Conduit (1)(1") | Linear Foot |
| Underground Conduit (1)(2") | Linear Foot |
| Underground Conduit (2)(2") | Linear Foot |
| Directional Drill (1)(2") | Linear Foot |
| Directional Drill (2)(2") | Linear Foot |

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9. JUNCTION BOXES

9.1. DESCRIPTION

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

9.2. 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 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 (see NCDOT *Roadway Standard Drawing* No. 1716.01 for additional details):

- For standard size junction boxes that contain traffic signal cable and loop lead-in cable, provide covers with the standard *TRAFFIC SIGNAL* logo;
- For standard size junction boxes that house electrical service conductors, provide covers with the standard *ELECTRIC* logo; and
- For oversized and special-sized junction boxes, provide covers with the following standard logo/imprint: *NCDOT* (line 1) *FIBER* (line 2) *OPTIC* (line 3).

Provide at least two 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.

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C. Junction Box Sizes

Provide junction boxes and covers of the following sizes as called for in the Plans:

| Junction Box Size | Minimum Inside Dimensions |
|-------------------|---------------------------|
| 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) |

9.3. 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 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 feet 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

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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. 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 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) |

9.4. MEASUREMENT AND PAYMENT

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

No measurement will be made of covers for new junction boxes, washed stone, removal of existing junction boxes and grounding systems as these will be 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 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.

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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.

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 incidental to furnishing and installing junction boxes.

Payment will be made under:

| Pay Item | Pay Unit |
|---------------------------------------|-----------------|
| Junction Box (Standard Size) | Each |
| Junction Box (Over-Sized, Heavy Duty) | Each |
| Junction Box (Special-Sized) | Each |

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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.

10.2. 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 to accommodate all cables.

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. 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.

10.3. 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-cabling 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-cabling 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 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

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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.

10.4. 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 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 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 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 through new risers and conduits and connecting them to the new controller cabinet will be incidental to furnishing and installing terminal splice cabinets.

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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 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 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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11. WOOD POLES**11.1. DESCRIPTION**

Furnish and install poles, grounding systems and all necessary hardware.

11.2. MATERIALS**A. General**

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

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. Wood Poles for Aerial Cable Routes and Electric Service

Unless otherwise specified in the Plans, furnish Class 4 wood poles that have a minimum length of 40 feet and are of a sufficient length to maintain the minimum required clearances above the roadway, obstructions, and affected railroad tracks.

C. Wood Poles for CCTV Cameras

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 CCTV camera mounting heights of up to 37 feet above the ground at the base of the pole, furnish CCTV wood poles that are at least 50 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.

D. Wood Poles for Traffic Signals

Unless otherwise specified in the Plans, furnish Class 3 wood poles that have a minimum length of 40 feet and are of a sufficient length to maintain the minimum required clearances above the roadway, obstructions, and affected railroad tracks.

11.3. 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. If the Plans do not specify an exact location and there are no other poles along the side of the road where the pole is to be 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:

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| Speed Limit | Desirable Minimum Setback Distance | | | |
|-------------|--|---|---|---|
| | From Face of Curb in Curb & Gutter Section | From Edge of Travel Way in Shoulder Section (No Curb) | Within Intersection Radii from Face of Curb | Within Intersection Radii from Edge of Pavement |
| ≤ 25 mph | 8 feet | 10 feet | 7 feet | 10 feet |
| 30-35 mph | 10 feet | 12 feet | 7 feet | 10 feet |
| 40 mph | 12 feet | 14 feet | 7 feet | 10 feet |
| 45-50 mph | 16 feet | 18 feet | 7 feet | 10 feet |
| ≥55 mph | 22 feet | 22 feet | 7 feet | 10 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 poles for signals and aerial cable routes at manufacturer's recommended depth or at a depth equal to 10% of the pole length plus 2 feet, whichever is greater but at a minimum depth of 5 feet. 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.

For all other new Department or City-owned poles, install a grounding system consisting of #6 AWG solid bare copper wire that is mechanically crimped using an irreversible compression tool with die to a single ground rod installed at base of pole or to the electrical service grounding electrode system located within 10 feet of the pole. Install ground wire so as to minimize damage from vandalism and environmental exposures. Install ground wire up pole to a point adjacent to the uppermost span. Use hot-dipped galvanized 1.5" wire staples to secure ground wire to pole, spacing the staples along the ground 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.

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11.4. MEASUREMENT AND PAYMENT

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

CCTV wood pole will be measured and paid for as the actual number of CCTV wood poles of furnished, installed and accepted regardless of length.

Ground rods installed as part of pole grounding systems will be measured and paid for in accordance with the “Electrical Service” section of these Project Special Provisions. No measurement will be made for furnishing and installing #6 AWG solid bare copper wire, messenger bonding clamps, hot-dipped galvanized wire staples, and compression connections as part of pole grounding systems as such work is incidental to furnishing and installing the wood poles, messenger cable and grounding electrodes.

Payment will be made under:

| Pay Item | Pay Unit |
|-----------------|-----------------|
| Wood Pole | Each |
| CCTV Wood Pole | Each |

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12. GUY ASSEMBLIES

12.1. DESCRIPTION

Furnish and install guy assemblies with all necessary hardware.

12.2. MATERIALS

Furnish material, equipment and hardware under this section that is 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 instead 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.

12.3. CONSTRUCTION METHODS

A. General

Comply with *Roadway Standard Drawing* 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.

12.4. 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 incidental to furnishing and installing guy assemblies.

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Payment will be made under:

Pay Item

Pay Unit

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, galvanized pole attachment fittings, stainless steel banding hardware, grounding and all necessary hardware.

13.2. MATERIALS

Furnish material, equipment and hardware 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 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 or 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 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 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 1.25" 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., 1.25" and 2") of rigid galvanized conduit used for fiber-optic communications cable risers on this project.

13.3. 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 or heat shrink tubing 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 or heat shrink tubing on existing risers as specified.

Use separate ½-inch riser with weatherhead for pedestrian pushbutton.

Use separate 1-inch riser with weatherhead for the following:

- Pedestrian signals;
- Electrical service; and
- Cat. 6 Ethernet cable routed to a CCTV camera from a CCTV or traffic signal cabinet.

Use separate 2-inch risers with weatherheads for signal cables (bundled). Use separate 2-inch risers for lead-in cables. Install condulets on all risers for lead-in cable, railroad preemption interconnection cables and signal pedestals.

Use a separate riser with heat shrink tubing for fiber-optic communications cables. For pole-mounted cabinets only, use 1.25-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 1.25-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 1.25-inch conduit have a 7.25-inch radius and equal horizontal and vertical legs (i.e., offsets) that measure approximately 10.75 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 1.25-inch, 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 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.

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Use 2-inch risers with heat shrink tubing for coaxial cable for radio antennas as called for in the Plans.

For all other locations, use 2-inch risers with heat shrink tubing for fiber-optic communications cable. Install risers with heat shrink tubing so that cable can be installed without violating its minimum bending radius of the fiber-optic cable. Install fiber-optic cable so it does not share a riser with any other cable type, except where shown on plans to share with Cat 6 Ethernet cable.

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

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 approve 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.

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 these Project Special Provisions.

13.4. MEASUREMENT AND PAYMENT

 " Riser with will be measured and paid as the actual number of risers of each type and size furnished, installed and accepted.

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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, conduit nipples, conduit locknuts and sealing locknuts, pole attachment fittings, weep hole-drilling and zinc-rich touch-up paint as these will be 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 incidental to installing the new riser. No measurement will be made of core-drilling a conduit entrance through a cabinet base adapter or cabinet base extender for attachment of a riser where required as such work will be incidental to furnishing and installing the new riser.

Ground rods (grounding electrodes) installed as part of pole grounding systems will be measured and paid for in accordance with the "Electrical Service" section of these Project Special Provisions. No measurement will be made for furnishing and installing #6 AWG solid bare copper wire, messenger bonding clamps, hot-dipped galvanized wire staples, and irreversible compression connections as part of pole grounding systems as such work will be incidental to furnishing and installing the wood poles, messenger cable, risers and grounding electrodes.

No measurement will be made for bonding risers to pole ground. Bonding existing risers will be incidental to installing fiber optic cable through the riser. Bonding new risers will be incidental to installing the 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 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 incidental to furnishing and installing the pole-mounted cabinet.

No measurement will be made of risers with weatherheads furnished and installed as part of new electrical services as they will be incidental to furnishing and installing new electrical services (see "Electrical Service" section of these Project Special Provisions).

Heat shrink tubing 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 incidental to furnishing and installing heat shrink tubing retrofit kits.

Payment will be made under:

| Pay Item | Pay Unit |
|-----------------------------|-----------------|
| 1/2" Riser with Weatherhead | Each |

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Pay Item

Pay Unit

1" Riser with Weatherhead

Each

2" Riser with Weatherhead

Each

1.25" Riser with Heat Shrink Tubing

Each

2" Riser with Heat Shrink Tubing

Each

Heat Shrink Tubing Kit

Each

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14. INDUCTIVE DETECTION LOOPS

14.1. DESCRIPTION

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

14.2. MATERIALS

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

A. Loop Sealant

Provide the Engineer 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 D2655. 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"

C. Conduit

Comply with the "Underground Conduit" section of these Project Special Provisions for PVC conduit.

14.3. CONSTRUCTION METHODS

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

Notify Engineer one week before installing inductive detection loops.

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

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. Ensure conduit maintains a minimum 30 inches of cover from the edge of pavement structure to the junction box. Do not sawcut through 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

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included on form. The form is located on the Department's website at <https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx> .

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.

14.4. MEASUREMENT AND PAYMENT

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

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

Payment will be made under:

Pay Item

Pay Unit

Inductive Loop Sawcut

Linear Foot

U-6015**ITS-114****Alamance County****15. LEAD-IN CABLE****15.1. DESCRIPTION**

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.

15.2. 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.

15.3. CONSTRUCTION METHODS

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

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15.4. MEASUREMENT AND PAYMENT

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

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

Payment will be made under:

| Pay Item | Pay Unit |
|----------------------|-----------------|
| Lead-in Cable (14-2) | Linear Foot |

U-6015**ITS-116****Alamance County****16. FIBER-OPTIC CABLE****16.1. 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, junction box markers, lashing wire and all necessary hardware.

16.2. 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

For all cables except for cables specified to plenum-rated, furnish single-mode fiber-optic communications cable that is pre-approved on the Department's QPL. Furnish fiber-optic cable that is all-dielectric and gel-free.

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 drop cables, provide exactly 12 fibers per buffer tube in all cables regardless of the total number of fibers the cables contain. Except for drop cables which may be provided with either 6 fibers or 12 fibers per buffer tube, 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

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tubes to the central member without crushing the buffer tubes. Ensure that binding 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 twelve individual fibers. 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 pigtails and LC connectors already attached or field install the pigtails and connectors. For field installed connectors, provide cabinet-mounted interconnect centers that are pre-equipped with factory-preassembled connector panels, SMFO pigtails with LC connectors and splice trays; then fusion splice all drop cable fibers to the SMFO pigtails.

Ensure attenuation loss for complete drop cable does not exceed a mean value of 1.5 dB.

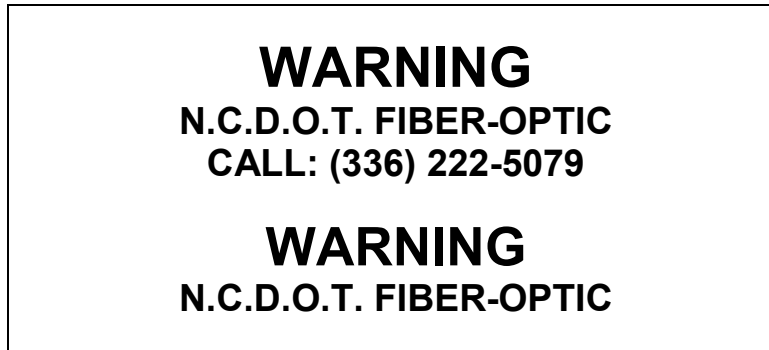
D. Communications Cable Identification Markers

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

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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 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.

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16.3. 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 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 pigtailed 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 (1.25-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. Aerial Installation

Install one communications cable identification marker on the signal system communications cable within 36 inches of the attachment point on each pole 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 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.

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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 any other 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.

C. 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.

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.

For pulling cable through junction boxes, 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.

In a junction box where no splice enclosure is required, store 30 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 30 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.

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.

In locations shown in the Plans, disconnect and remove the existing fiber-optic cable with the new fiber-optic cable attached. In some locations there is an existing City of Burlington IT Department fiber-optic cable in an adjacent inner duct or in the same conduit. Exercise extreme care not to damage the IT cable. Comply with the migration plan for scheduling and coordination.

D. Indoor Installation

Install fiber-optic drop cable in Electric Metal Tubing (EMT) conduit between the TCC server room and the signal shop using cable pulling lubricants recommended by the fiber-optic cable manufacturer as shown on the Plans. 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 TCC after terminating the cables in the rack-mounted splice centers housed therein.

E. City of Burlington IT Department Fiber-Optic Cable

As shown in the Plans, some existing City of Burlington IT fiber-optic cable will be replaced or extended.

At locations where City of Burlington IT cable must be removed in order to allow new signals communications fiber to be installed, remove and replace with no less than the existing size cable. Upon installation, splice the new fiber-optic cable to the existing fiber-optic cable. Comply with the migration plan for scheduling and coordination.

At locations shown in the Plans, existing aerial signal system and City of Burlington IT fiber-optic cable must be removed due to utility adjustments. Back pull the City of Burlington IT cable and coil and store cable at a pole. This cable will be reconnected by the City of Burlington

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IT Dept. Inform the City of Burlington IT Department 10 working days in advance of disconnecting The City of Burlington IT cable.

At locations shown below and in the Plans, City of Burlington IT fiber-optic cable will be installed that does not replace existing cable. Cap and seal the fiber-optic cable upon completion. This cable will be connected by the City of Burlington IT Dept.

| Route | Location | Type of Construction | Description |
|------------------------------------|---|-----------------------------|---|
| US 70 (Burlington Rd./ Church St.) | Springwood Church Rd. to St. Marks Church Rd. | Overhead | Install new 24-strand fiber-optic IT cable with new 36-strand ITS cable. Cap and seal IT cable at each end. |
| NC 62 (Rauhut St.) | US 70 (N. Fisher St.) to Sharpe Rd. | Overhead | Install new 24-strand fiber-optic IT cable with new 12-strand ITS cable. Cap and seal IT cable at each end. |
| East Davis Street. | S. Lexington Ave. to City Hall | Underground | Install new 12-strand fiber-optic IT cable and splice to existing cable from City Hall |

F. 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 30 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 30 feet of drop cable and 30 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 the first six fibers (i.e., fibers 1-6) by fusion splicing them to factory-assembled SMFO pigtails with LC connectors and connecting the pigtails to the connector panel in the rack-mounted interconnect center. Label all connectors, pigtails 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 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 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.

G. 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.

16.4. MEASUREMENT AND PAYMENT

Communications cable (___-fiber) will be measured and paid as the actual linear feet of fiber-optic cable of each fiber count furnished, installed, and accepted 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 12 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 incidental to the installation of fiber-optic cable and drop cables.

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No measurement will be made of removing existing cables from existing risers as such removals will be incidental to furnishing and installing the fiber-optic cables and drop cables.

When replacing fiber-optic cable or drop cables, no measurement will be made of removing cables from existing conduits as such removals will be incidental to furnishing and installing the fiber-optic cables and drop cables.

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 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 incidental to installation of new fiber-optic 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 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:

| Pay Item | Pay Unit |
|---------------------------------|-----------------|
| Communications Cable (12-Fiber) | Linear Foot |
| Communications Cable (24-Fiber) | Linear Foot |
| Communications Cable (36-Fiber) | Linear Foot |
| Communications Cable (48-Fiber) | Linear Foot |
| Drop Cable | Linear Foot |
| Aerial Cable Protector | Linear Foot |

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17. BACK PULL FIBER OPTIC CABLE

17.1. DESCRIPTION

Back pull and store or back pull and reinstall existing communications cable.

17.2. CONSTRUCTION

During project construction where instructed to back pull existing aerial sections of fiber optic communications cable, unlash the cable from the messenger cable, and back pull the cable to a point where it can be stored or re-routed as shown on the plans. If instructed, remove and discard the existing messenger cable and pole mounting hardware once the cable is safely out of harm's way.

During project construction where instructed to back pull existing underground sections of fiber-optic communications cable, back pull the cable to a point where it can be stored or re-routed as shown on the plans. If instructed, remove abandoned junction boxes and backfill with a suitable material to match the existing grade. Leave abandoned conduits in place unless otherwise noted.

Where instructed, re-pull the fiber-optic cable back along messenger cable or through conduit systems.

17.3. MEASUREMENT AND PAYMENT

Back pull fiber-optic cable will be paid for as the actual linear feet of fiber-optic cable back pulled and either stored or back pulled and rerouted. Payment is for the actual linear feet of cable back pulled.

No payment will be made for removing messenger cable and pole mounting hardware or removing junction boxes and back filling to match the surrounding grade as these items of work will be incidental to back pulling the fiber optic cable.

Payment will be made under:

Pay Item

Back Pull Fiber-Optic Cable

Pay Unit

Linear Foot

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18. FIBER-OPTIC SPLICE CENTERS

18.1. 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.

18.2. 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 pigtails with each interconnect center. Provide pigtails that are a maximum of 6 feet in length with factory-assembled LC connectors on one end. Ensure SMFO pigtails 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 three 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. Ensure the splice enclosures are provided with correct number of ports for the splices in these Plans. 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.

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 pigtails for terminating new fibers on the connector panel of an existing interconnect center. Provide pigtails that are a maximum of 6 feet in length with factory-assembled LC connectors on one end. Ensure SMFO pigtails meet the operating characteristics of the SMFO cable with which it is to be coupled. 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.

18.3. 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 Traffic Signal 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.

Do not install aerial splice enclosures and storage guides over roadways or driveways.

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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. Huffman Mill Road Hub Cabinet

Install rack mounted interconnect centers for the proposed fiber-optic communications cable at the existing Huffman Mill Road Type 333 hub cabinet. Install the interconnect centers in the left rack of the cabinet below the other interconnect centers. Cross connect the existing and proposed interconnect centers as shown in the Plans.

G. 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

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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.

18.4. 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% 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 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 incidental to modifying the existing splice.

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 incidental to furnishing and installing fiber-optic interconnect centers and splice enclosures, and modifying existing splices.

No measurement will be made for disconnect fiber-optic drop cables from existing interconnect centers and temporarily storing the existing cable in existing equipment cabinets, removal of existing splice centers, including existing interconnect centers and splice enclosures, as such work will be incidental to furnishing and installing fiber-optic interconnect centers and splice enclosures.

Payment will be made under:

| Pay Item | Pay Unit |
|------------------------|-----------------|
| Interconnect Center | Each |
| Splice Enclosure | Each |
| Modify Existing Splice | Each |

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19. DELINEATOR MARKERS**19.1. DESCRIPTION**

Furnish and install delineator markers (tubular marker posts) with all necessary hardware and adhesives to warn of buried fiber-optic communications cable.

19.2. MATERIALS

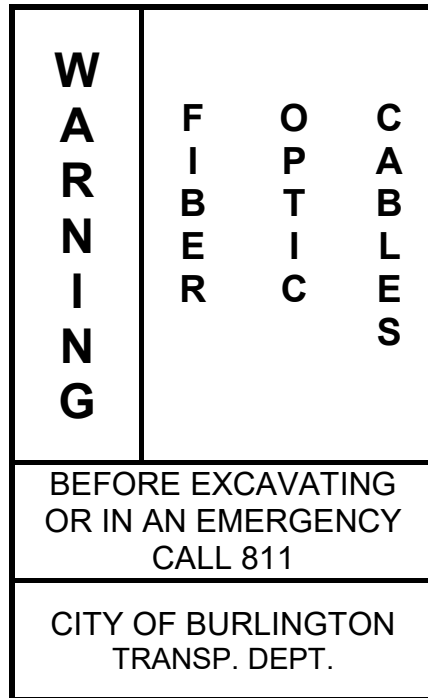
Furnish material, equipment, and hardware under this section that is pre-approved on the ITS and Signals QPL.

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.

For fiber-optic cable along I-85, provide text, including Department 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:

| | |
|--|--|
| W A R N I N G | F I B E R O P T I C C A B L E S |
| BEFORE EXCAVATING OR IN AN EMERGENCY CALL (336) 315-7080 | |
| NORTH CAROLINA DEPARTMENT OF TRANSPORTATION | |

For all other fiber-optic cable, provide text, including City of Burlington 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:



19.3. CONSTRUCTION METHODS

A. Delineator Markers in Historic Districts

Obtain the Engineer’s approval before installing any delineator 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.

19.4. 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.

Payment will be made under:

| Pay Item | Pay Unit |
|-------------------|-----------------|
| Delineator Marker | Each |

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20. REMOVE EXISTING COMMUNICATIONS CABLE

20.1. DESCRIPTION

Remove existing communications cable. Remove existing communications cable splice boxes/cabinets, hub cabinets, cabinet foundations, associated risers and in-ground junction boxes as designated in the Plans.

20.2. 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.

20.3. 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.

B. 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).

C. 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:

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.

20.4. 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 incidental to the removal of existing communications cable.

No measurement will be made for removing cable that is being replaced and the removed cable is used to pull the replacement cable. No additional measurement will be made for multiple communications cables being removed from the same underground conduit or same pole. No

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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 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 incidental to installation of new fiber-optic communications cable.

Payment will be made under:

Pay Item

Remove Existing Communications Cable

Pay Unit

Linear Foot

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21. CABLE TRANSFERS

21.1. DESCRIPTION

Remove and reinstall existing communications cable for pole relocations.

21.2. 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.

21.3. 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:

| Pay Item | Pay Unit |
|-----------------|-----------------|
| Cable Transfer | Each |

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22. PEDESTALS

22.1. DESCRIPTION

Furnish and install pedestrian pushbutton posts for pedestrian pushbuttons as shown in the plans. Furnish assembly with foundation, grounding system and all necessary hardware as shown in the Roadway Standard Drawings. Provide a pedestal assembly that meets AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals in effect on the date of project advertisement. Unless otherwise required by the plans, install pedestrian pushbutton posts on 10 FHWA-approved breakaway support or anchor systems.

Furnish and install screw-in helical foundation as an alternative to the standard reinforced concrete foundation for supporting Type I Pedestals.

22.2. MATERIALS

Furnish material, equipment, and hardware under this section that is pre-approved on the ITS and Signals QPL.

Furnish pedestal assemblies with foundations that conform to the latest edition of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* in effect on the date of project advertisement. Refer to *Roadway Standard Drawings* No. 1743 for structural design specifications.

Refer to Articles 1091-6, "Grounding Electrodes" and 1091-2, "Wire and Cable" of the *Standard Specifications*.

A. Pedestal Shaft

Furnish pedestal shafts fabricated from either aluminum or galvanized steel pipe with a uniform pipe outer diameter of 4.5" and of the lengths specified for the type of pedestal shown on *Roadway Standard Drawing* No. 1743.

Furnish shafts constructed from schedule 40 extruded aluminum pipe that conforms to Aluminum Association Alloy -6061T6 with a tensile strength of 30 KSI and a minimum wall thickness of 0.237". Aluminum conduit will not develop the necessary strength required and is not allowed. Thread and deburr in accordance with American National Standard Pipe Threads, NPT (ANSI B2.1). Finish the exterior with a rough surface texture consisting of a uniform grain pattern that is perpendicular to the axis of the pipe along the full pipe length. Unless otherwise specified, do not use galvanized steel pipe.

B. Transformer Bases

Furnish transformer bases for each type of pedestal shown on *Roadway Standard Drawings* No. 1743 fabricated from aluminum that meets Aluminum Association Alloy 356 or equivalent, and that are designed to break upon impact in accordance with AASHTO requirements. Submit FHWA certification for each type of transformer base that reflects compliance with NCHRP 350. For use in grounding and bonding, provide a 0.5" minimum diameter, coarse thread hole cast into transformer base located inside base and oriented for easy access.

Provide a minimum access opening for all transformer bases of 8" x 8" with an access door that is attached with a 1/4" x 3/4" long stainless-steel vandal proof screw to secure access door.

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Provide overall base dimensions of 15" (l) x 13 3/4" (w) x 13 3/4" (d) for square bases and 14" (l) x 16 1/2" (w) x 16 1/2" (d) for octagonal bases. Provide a threaded opening at the top of the base to receive a 4" NPT pipe shaft. Include a set screw prep and 3/8 inch-16 x 1-inch stainless-steel set screw to secure the pedestal post to the pedestal base. Fabricate the bottom of the transformer base with 4 equally spaced holes or slots for a 12" bolt circle to secure the entire assembly to the concrete foundation.

C. Anchor Bolts

For each pedestal, provide 4 anchor bolts in accordance with ASTM F1554, Grade 55, of the size and length specified in *Roadway Standard Drawings* No. 1743. Provide anchor bolts with coarse threads meeting the bolt/thread criteria specified by AISC. Provide threads for a minimum length of 4" on each end of the bolt. All thread anchor rods may be used. Ensure anchor bolts are hot-dipped galvanized in accordance with ASTM.

For each anchor bolt:

(1) Provide three heavy hex nuts; one at the top, and two at the bottom (embedded end) of the anchor bolt. Provide hex nuts with coarse threads that match the anchor bolt thread requirements above. Provide hex nuts that meet the requirements of ASTM A563 Grade DH, ASTM A194, Grade 2H or equivalent. Galvanize all heavy hex nuts in accordance with ASTM A153.

(2) Provide one standard size washer that meets the requirements of ASTM F436 for use between the two heavy hex nuts on the embedded end of the anchor bolt. Galvanize in accordance with ASTM A153.

(3) Provide one extra thick, oversized washer for use over the slotted opening of the pedestal base. Fabricate washer to meet the chemical, physical, and heat treating requirements of ASTM F436. Fabricate the washer to the diameter and thickness needed. Galvanize fabricated washer in accordance with ASTM A153. Heat treat to the same requirements as F436 (i.e. 26 to 45 HRC).

For a 3/4-inch diameter anchor bolt mounted in a 1 1/2" slotted opening, the dimensional requirements for an extra thick, oversized washer are as follows:

- (a) The minimum Outside Diameter (OD) required is 2 3/4"
- (b) The hole Inside Diameter (ID) = Nominal Bolt Diameter + 1/16" = 0.812"
- (c) The minimum washer thickness required is 3/8"

If anchor bolts less than 3/4 inch in diameter are proposed for use to anchor pedestal bases, provide a washer calculation to ensure the washer thickness is adequate. To account for any pedestal manufacturing differences, verify the actual slotted opening width of the pedestal base anchoring points, and include it in the calculation. Anchor bolts that are less than 1/2 inch in diameter may not be used as they are not structurally adequate to support the pedestal and may inhibit the performance of the breakaway base.

The fabrication process for thick washers makes the washer slightly tapered (i.e. the top OD and the bottom OD are not the same). Install thick washers with the larger diameter face down against the pedestal base casting.

Do not use standard washers over the slotted opening of the pedestal base. Do not substitute or stack thin washers to achieve the required thickness specified or required.

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In addition to the submittal requirements of Section 1098-1(B), provide Mill Certifications, Galvanization Certifications, and Heat Treating Certifications for all anchor bolts, fabricated washers, and structural hardware.

D. Pedestal Cap

Furnish a 4-1/2" outside diameter slip fit domed pedestal top cap for each pedestal assembly designed to fit over the outside of the pedestal shaft. Fabricate the cap from aluminum that meets Aluminum Association Alloy 356. Ensure the cap provides 3 equally spaced stainless-steel set screw fasteners to secure the cap to the pedestal shaft.

E. Pole Flange Base for 4 1/2" Pipe

Furnish a flange base with cover). Flange bases are non-breakaway supports that are to be used with a breakaway bolt system for AASHTO compliance for breakaway structures. Provide aluminum or steel flange bases with a minimum 7.5" diameter bolt circle. Ensure bases are either continuously welded to shafts or threaded to receive shafts. Each base should be designed to accommodate either three or four 1/2" bolts equally spaced on the bolt circle to receive breakaway anchors. Provide NPT threads on the internal opening of the flange base through the full length of the flange base with locking set screws at the top of the base to receive a 4" NPT pipe shaft.

Fabricate aluminum flange bases that meet Aluminum Association Alloy 356 requirements for architectural bases. Fabricate steel flange bases that meet ASTM A36.

F. Breakaway Anchors

Furnish single or double neck omnidirectional breakaway anchor bolt coupling systems. Use breakaway anchors that are FHWA certified to be compliant with NCHRP Report 350 as an alternative to transformer bases. Use with non-breakaway pole flange bases. Use 1/2" diameter bolts for pushbutton posts. Fabricate from steel with a minimum yield strength of 55 KSI. Galvanize in accordance with ASTM A153. Do not use breakaway anchors in conjunction with breakaway transformer bases.

G. Foundation

Install pedestal foundations of the type and size shown on *Roadway Standard Drawings* No. 1743.04. Furnish Class A minimum concrete that conforms to Article 1000-4. Provide reinforcing steel that conforms to the applicable parts of Section 1070 of the *Standard Specifications*.

H. Screw-In Helical Foundation Anchor Assembly

Furnish and install screw-in helical foundation as an alternative to the standard reinforced concrete foundation specified in these project special provisions.

Fabricate pipe assembly consisting of a 4-inch diameter x 56-inch long pipe, single helical blade and square fixed attachment plate. Furnish pipe in accordance with ASTM A-53 ERW Grade B and include a 2-inch x 3-inch cable opening in the pipe at 18 inches below the attachment plate. Furnish steel attachment plate and helical blade in accordance with ASTM A-36. Include four slotted mounting holes in the attachment plate to fit bolt circles ranging from 7 3/4 inches to 14 3/4 inches diameter. Furnish additional 3/4-inch keyholes at slotted holes to permit anchor bolt installation and replacement from top surface. Include combination bolt-head

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retainer and dirt scrapers at the attachment plate underside to allow for a level or flush-mount plate installation with respect to the finished grade. Galvanize pipe assembly components in accordance with AASHTO M 111 or an approved equivalent.

Furnish four 3/4-inch 10NC x 3-inch square head anchor bolts to meet the requirements of ASTM 325. Provide four 3/4-inch plain flat galvanized washers, four 3/16-inch-thick galvanized plate washers and four 3/4-inch galvanized hex nuts. Galvanize in accordance with AASHTO M 111 or an approved equivalent.

22.3. CONSTRUCTION METHODS

A. Type I Pedestrian Pushbutton Post

Install pushbutton post for mounting pedestrian pushbutton (refer to “Signal Head” section of these Project Special Provisions).

Install underground conduit for pushbutton lead-in cable in the pushbutton post’s foundation.

Attach or anchor pushbutton post to the top of foundation via a breakaway support in a vertical plumb orientation. Ensure post is of sufficient length to accommodate the pushbutton, accessible pedestrian signals and any associated pedestrian informational signing at the mounting heights shown in the plans or *Roadway Standard Drawings* No. 1705 and 1743.

B. Screw-In Helical Foundation Anchor Assembly

Advance or mechanically screw foundation into soil until top of attachment plate is level with finished grade. Slide the anchor bolt heads through the keyhole openings and under the attachment plate with threads pointing up. Bolt the pedestal base to the foundation attachment plate.

For further construction methods, see manufacturer’s installation drawings.

22.4. MEASUREMENT AND PAYMENT

Type I post with foundation will be measured and paid as the actual number of pedestrian pushbutton posts furnished, installed and accepted.

No measurement will be made for pedestal foundations, pedestal screw-in helical foundations, grounding systems and any peripheral pedestal mounting hardware as these are incidental to furnishing and installing pedestals.

Payment will be made under:

| Pay Item | Pay Unit |
|-----------------------------|-----------------|
| Type I Post with Foundation | Each |

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23. SIGNS INSTALLED FOR SIGNALS

23.1. DESCRIPTION

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

23.2. 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 Article 903-3, Ground Mounted Sign Supports of the *Standard Specifications*.

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

23.3. CONSTRUCTION METHODS

Install signs with applicable 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 Article 903-3, Ground Mounted Sign 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.

23.4. 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:

| Pay Item | Pay Unit |
|------------------|----------|
| Sign for Signals | Each |

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24. EQUIPMENT CABINET FOUNDATIONS

24.1. DESCRIPTION

Furnish and install foundations for base-mounted equipment cabinets and all necessary hardware.

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

24.2. 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.

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.

24.3. CONSTRUCTION METHODS

Comply with Section 825, "Incidental Concrete Construction", of the *Standard Specifications*.

Refer to Section 1 of these Project Special Provisions for requirements concerning construction within historic districts.

When using poured concrete foundations and preformed cabinet pads, use procedures, equipment and hardware as follows:

- Locate new cabinets so as not to obstruct sight distance of vehicles turning on red or create any ADA violations or pedestrian conflicts.

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- Obtain approval for final cabinet foundation locations before pouring concrete base or installing a preformed cabinet base.
- Do not install foundations over uncompacted fill or muck.
- Hand-tamp soil before placing concrete or preformed cabinet base and ensure ground is level.
- Maintain 12 inches minimum from service pole to closest point on foundation unless otherwise approved.
- 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 and chamfered edges.
- 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*. 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 unpaved area was not grassed, replace the original ground cover in kind as directed by the Engineer.

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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.

24.4. MEASUREMENT AND PAYMENT

Signal cabinet foundation will be measured and paid as the actual number of equipment 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 incidental to furnishing and installing 4" concrete sidewalk.

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 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 incidental to furnishing and installing signal cabinet foundations.

Payment will be made under:

Pay Item

Signal Cabinet Foundation
4" Concrete Sidewalk

Pay Unit

Each
Square Yard

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25. MODIFY CABINET FOUNDATIONS**25.1. 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.

25.2. MATERIALS

Comply with the provisions of "Equipment Cabinet Foundations" section of these Project Special Provisions.

25.3. CONSTRUCTION METHODS**A. General**

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

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. 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 bus.

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.

Drill holes approximately 6 inches deep on 12-inch centers into the existing foundation. Clean holes with compressed air just before 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:

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| Foundation Extension | Length of Dowel |
|----------------------|-----------------|
| >16" | 24" |
| >6" and ≤16" | 17" |
| =6" | 14" |

Use concrete to install the maintenance technician pad.

Form the sides of the modified foundation to a minimum depth of 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 if necessary 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:

1. Remove the existing cabinet foundation and replace it with a new preformed cabinet pad in the same location.
2. Overlay the existing cabinet foundation with a new preformed cabinet pad.
3. 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.

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. Install new controller

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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 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.

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.

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25.4. 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:

| Pay Item | Pay Unit |
|---|-----------------|
| Conduit Entrance into Existing Foundation | Each |
| Modify Foundation for Controller Cabinet | Each |

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26. CONTROLLERS WITH CABINETS

26.1. 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.

26.2. MATERIALS - GENERAL

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL.

26.3. MATERIALS – TYPE 2070LX CONTROLLERS

Furnish Model 2070LX controllers that conform to CALTRANS *Transportation Electrical Equipment Specifications* (TEES) (dated March 12, 2009, plus Errata 1 dated January 21, 2010 and Errata 2 dated December 5, 2014) except as required herein.

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. **The 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 2070LX controllers with the Linux operating system kernel 2.6.18 or higher and device drivers, composed of the unit chassis and at a minimum the following modules and assemblies:

- MODEL 2070-1C, CPU Module, Single Board, with 8Mb Datakey (blue in color)
- 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 2070-4A, Power Supply Module, 10 AMP

Provide all updates to the Linux operating system software released up through final acceptance of the project at no additional cost to the Department.

Provide Model 2070LX controllers that are capable of properly running the Department's ASC/3 local controller software and that are capable of operating properly within an Ethernet communications system.

26.4. 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.

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| 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 |

26.5. 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 and base-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 and base-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 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, 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 |
| Occurrences (8x20µs waveform)..... | 100 min @ 2,000A |
| Maximum Clamp Voltage..... | Rated for equipment protected |
| Response Time..... | < 1 nanosecond |
| Maximum Capacitance..... | 1,500 pF |

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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

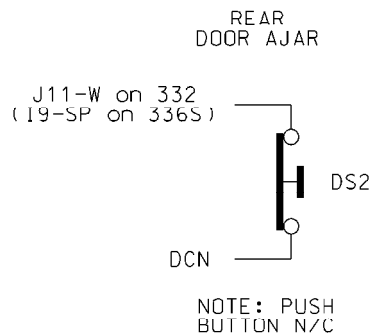
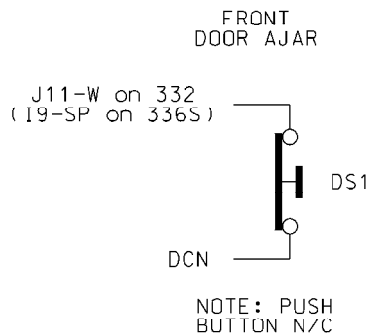
Discharge Voltage.....<200 Volts @ 1,000A

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.



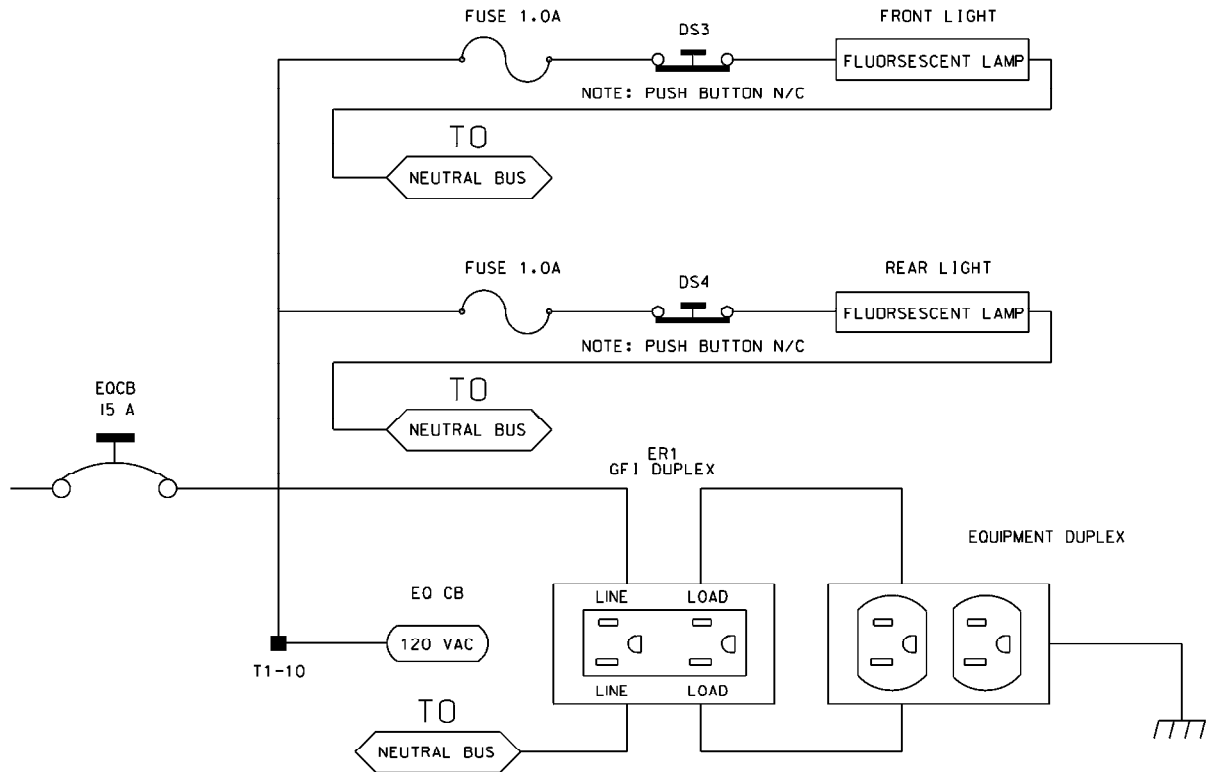
Furnish a fluorescent fixture in the rear across the top of the cabinet and another fluorescent fixture in the front across the top of the cabinet at a minimum. Ensure that the fixtures provide sufficient light to illuminate all terminals, labels, switches, and devices in the cabinet. Conveniently locate 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

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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 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:

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| 336S 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:

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

Provide 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

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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.

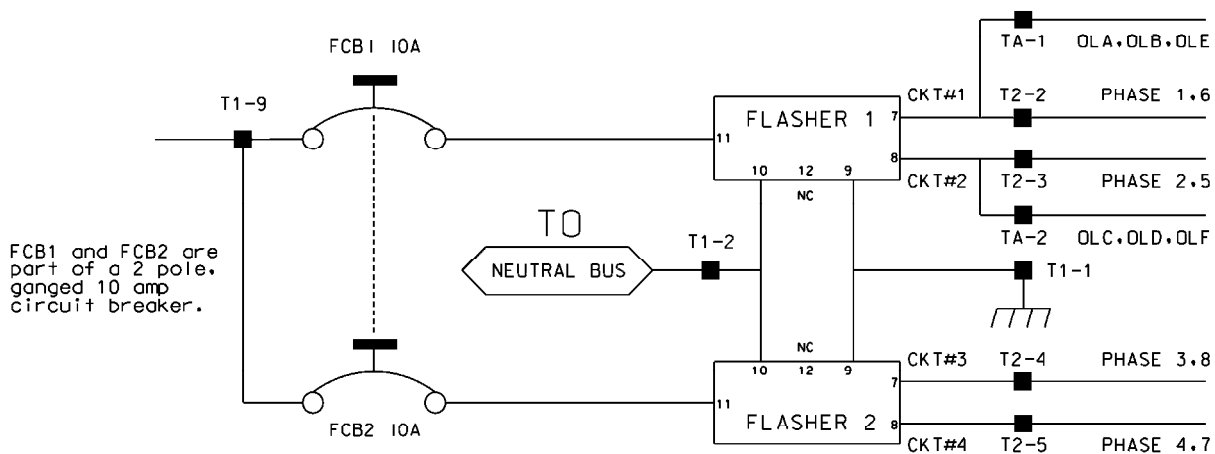
| P20 Connector | | | | | |
|---------------|----------------|---------|-----|-----------------|---------|
| PIN | FUNCTION | CONN TO | PIN | FUNCTION | CONN TO |
| 1 | Channel 15 Red | 119 | 2 | Channel 16 Red | 110 |
| 3 | Channel 14 Red | 104 | 4 | Chassis GND | 01-9 |
| 5 | Channel 13 Red | 113 | 6 | N/C | |
| 7 | Channel 12 Red | AUX 101 | 8 | Spec Function 1 | |
| 9 | Channel 10 Red | AUX 124 | 10 | Channel 11 Red | AUX 114 |
| 11 | Channel 9 Red | AUX 121 | 12 | Channel 8 Red | 107 |
| 13 | Channel 7 Red | 122 | 14 | Channel 6 Red | 134 |
| 15 | Channel 5 Red | 131 | 16 | Channel 4 Red | 101 |
| 17 | Channel 3 Red | 116 | 18 | Channel 2 Red | 128 |
| 19 | 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.



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.

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| 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.

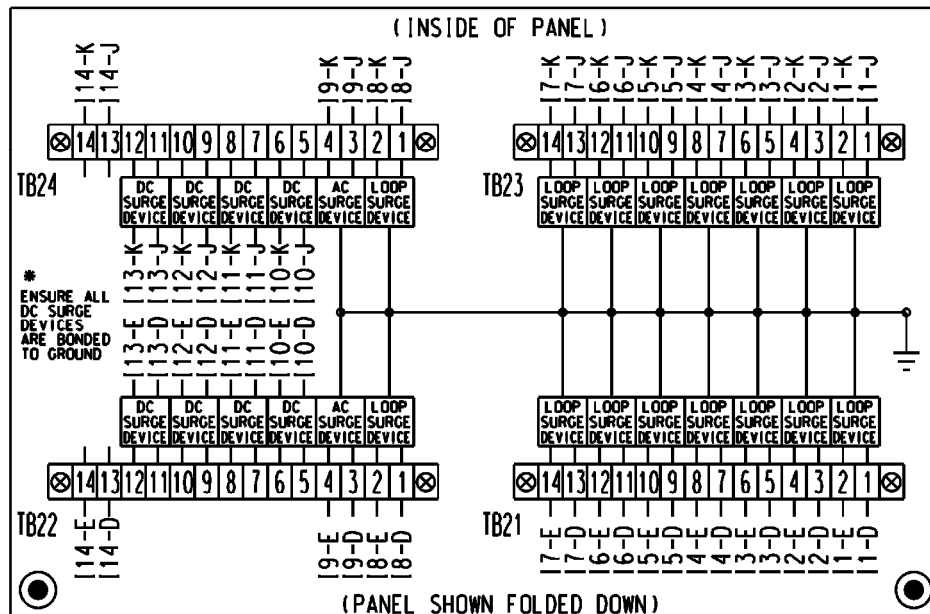
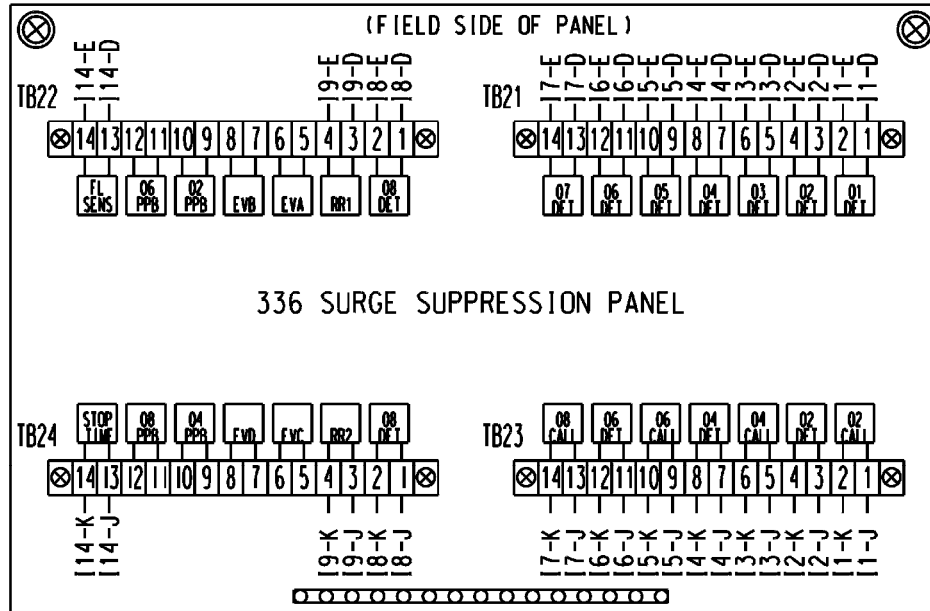
Provide front and rear doors with latching handles that allow padlocking in the closed position. Furnish 0.75-inch minimum diameter stainless steel handles with a minimum 0.5-inch shank. Place the padlocking attachment at 4.0 inches from the handle shank center to clear the lock and key. Provide an additional 4.0 inches minimum gripping length.

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 and 336S base-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

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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 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 2070LX 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 2070LX 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.

26.6. 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 an 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)

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- 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)

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.

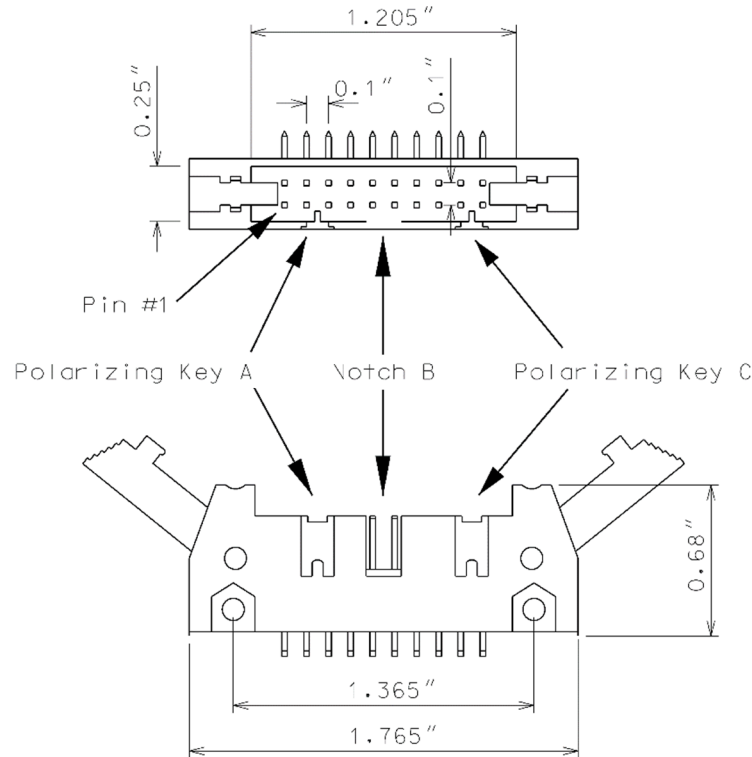
Provide a jumper that will reverse the active polarity for pin #EE (output relay common). Ensure that when the jumper is not present pin #EE (output relay common) will be considered 'Active' at a voltage greater than 70 Vrms and 'Not Active' at a voltage less than 50 Vrms (Caltrans mode). Ensure that 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 2070LX 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 2070LX 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 ± 0.1 -second accuracy). If a channel fails to detect an “on” signal at the Yellow input for a minimum of 2.7 seconds (± 0.1 second) following the detection of an “on” signal at a Green input for that channel, ensure that the monitor triggers and generates a 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

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 |

| 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

| Pin # | Function (Back Side) | Pin # | Function (Component Side) |
|--------------|-----------------------------|--------------|----------------------------------|
| 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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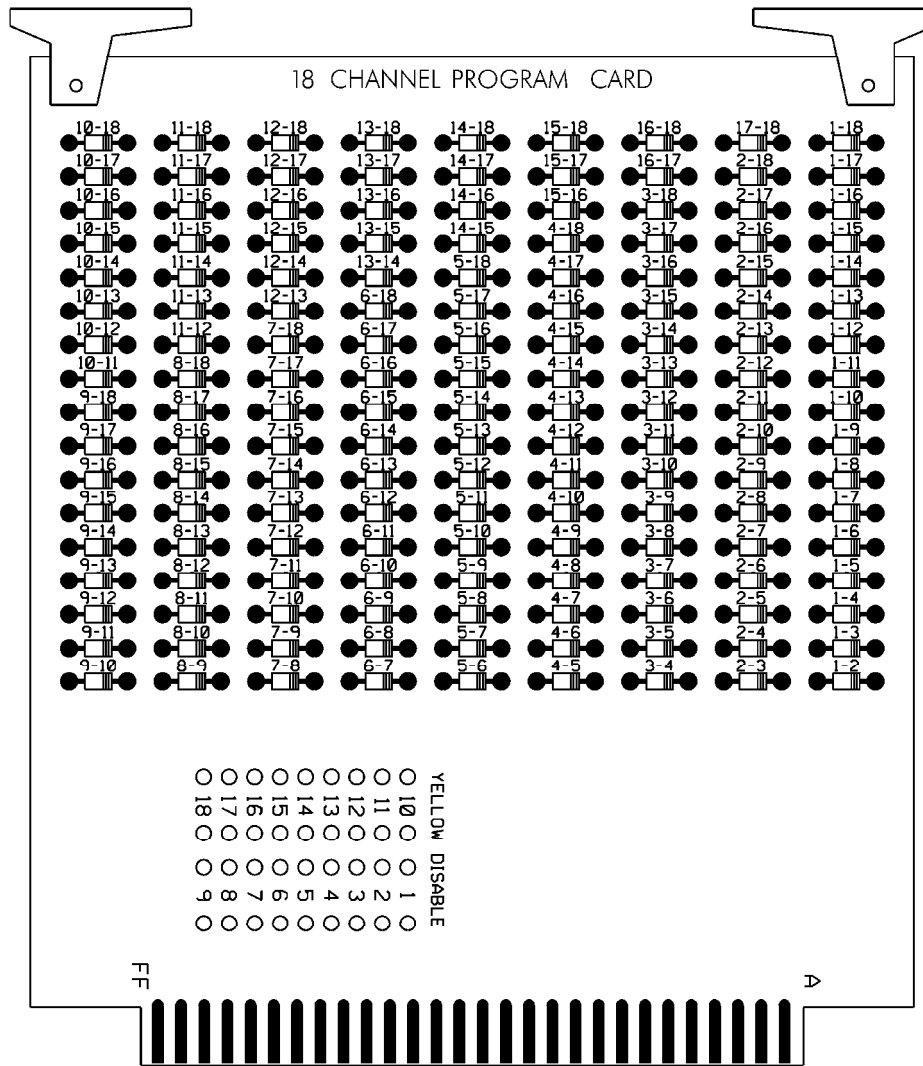
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CONFLICT PROGRAM CARD PIN ASSIGNMENTS

| Pin # | Function (Back Side) | Pin # | Function (Component Side) |
|--------------|-----------------------------|--------------|----------------------------------|
| 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



26.7. 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.

| 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 |

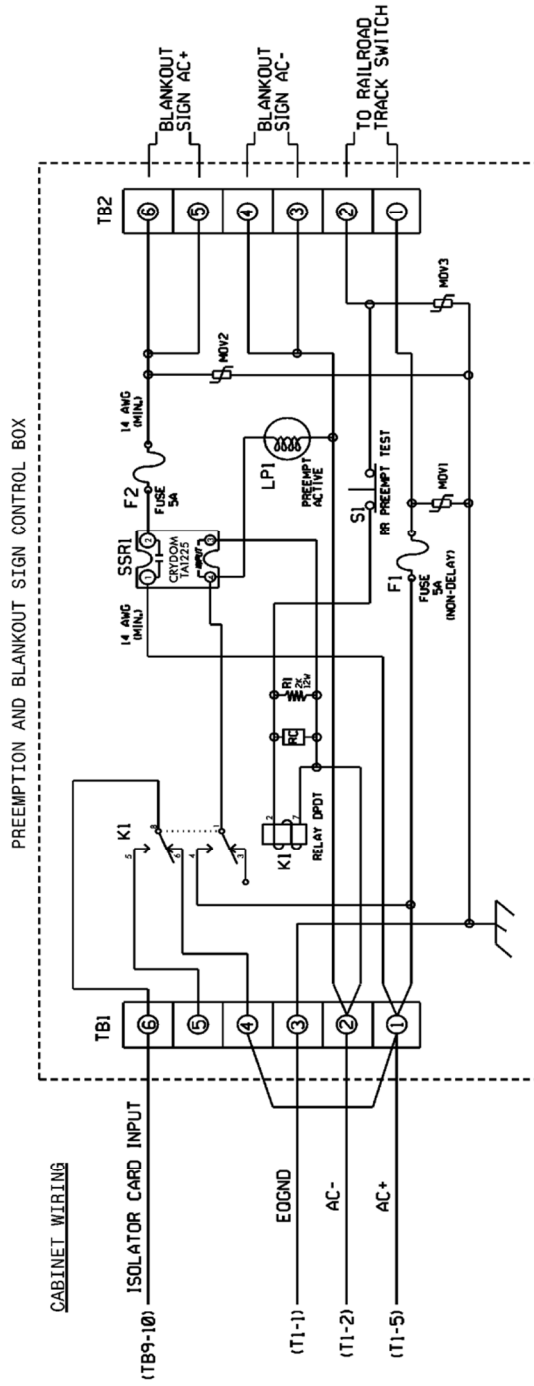
Provide resistor R1 as a 2K ohm, 12-watt, wirewound resistor with tinned terminals and attaching leads. Ensure the resistor is spaced apart from surrounding wires.

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

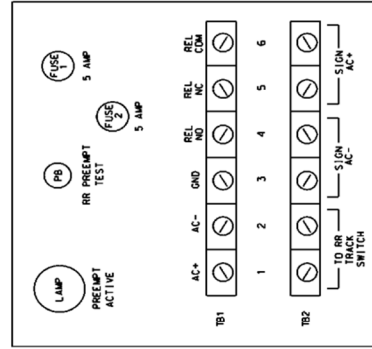


Figure 1

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26.8. 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.

26.9. 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 of 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.

Stencil the signal inventory number in 3-inch black letters on both the front and rear doors of the cabinet.

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

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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 or 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 Linux operating system software during the life of the project up through final acceptance of the project.

Once all new cables have been installed 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.

B. Electrical Service and Grounding

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.

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Install and program the Ethernet edge switches in accordance with the “Communications Hardware” section of these Project Special Provisions.

D. Workshop

Provide enclosed workshop to store, set up and test new controllers and cabinets before installation. Locate workshop within the City Limits of Burlington. 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.

E. GPS Coordinates

Provide real world coordinates for all equipment cabinets.

Comply with all requirements of the “Junction Boxes” section of these Project Special Provisions.

26.10. MEASUREMENT AND PAYMENT

Controller with cabinet (____) will be measured and paid as the actual number of each type of controllers with cabinets 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). The cost of installation of the firmware will be included in the cost of the controller installation.

Detector card (Model 222) will be measured and paid as the actual number of Model 222 detector cards furnished, installed and accepted.

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.

Ethernet edge switches will be measured and paid for in accordance with the “Communications Hardware” section of these Project Special Provisions.

No measurement will be made of conflict monitors, malfunction management units, modems and workshop as these will be incidental to furnishing and installing controllers with cabinets.

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No measurement will be made of aluminum plates furnished and installed to fill gaps between the opening of a cabinet base extender and the edge of smaller existing cabinet foundations when required as such work will be incidental to furnishing and installing controllers with cabinets.

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 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[®] spreadsheet and providing an ESRI Shapefile (.SHP file format) as such work will be incidental to installing controllers with cabinets.

Payment will be made under:

| Pay Item | Pay Unit |
|--|-----------------|
| Controller with Cabinet (2070LX, 336S) | Each |
| Controller with Cabinet (2070LX, 332) | Each |
| Detector Card (Model 222) | Each |

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27. CABINET BASE ADAPTER AND BASE EXTENDER

27.1. DESCRIPTION

Furnish and install cabinet base adapters and base extenders with all necessary hardware for 170E-family cabinets.

27.2. 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 6.7 of CALTRANS TEES. 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.

Some intersections with existing base-mounted cabinets within and near downtown Burlington currently have foundations that protrude several inches above ground and that are smaller than the base of the new Type 336S and 332 cabinets being installed. Enlarging or replacing many of these bases is infeasible due to right-of-way and other physical constraints and, as a result, they must be retained for base-mounting the new controller cabinets. Furnish an aluminum plate(s) of the same thickness as the base extender flange to fill any gap between the opening in the base extender and the edge of such existing foundation as needed.

27.3. 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.

B. Installation on Pedestal Bases Downtown

Position the new controller cabinet with its base extender attached over the existing conduit spread and in such a way as to minimize the overhang of each side of the base extender, especially on sides adjacent to sidewalk. Obtain the Engineer's approval of the cabinet's position on the foundation before anchoring the base extender to the existing foundation. Install an aluminum plate(s) of the same thickness as the base extender flange to fill any gap between the opening in the base extender and the edge of the existing foundation as needed.

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C. Existing Base Mounted CCTV Cabinets

For existing NEMA base mounted CCTV cabinets, remove the existing cabinet, install a base extender and install a Type 336A cabinet. Replace the existing feeder conductors from the electric service meter to the bus bar in the base mounted cabinets. The locations requiring this work are:

| | | |
|---------|--------|-------------------------------|
| CRP-064 | CCTV-1 | Huffman Mill Rd. & I-85 |
| CRP-014 | CCTV-2 | Huffman Mill Rd. & Church St. |
| CRP-089 | CCTV-3 | Alamance Rd. & I-85 |
| CRP-115 | CCTV-4 | Maple Ave. & I-85 |
| CRP-176 | CCTV-5 | Main St. & I-85 |
| CRP-106 | CCTV-6 | Harden St. & I-85 |
| CRP-120 | CCTV-7 | Mebane St. & Webb Ave. |
| CRP-019 | CCTV-8 | Church St. & O'Neal St. |

27.4. 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.

No measurement will be made of aluminum plates furnished and installed to fill gaps between the opening of a cabinet base extender and the edge of smaller existing cabinet foundations when required as such work will be incidental to furnishing and installing cabinet base extenders and cabinet base adapters.

No measurement will be made for replacing feeder conductors as such work will be incidental to furnishing and installing cabinet base extenders and cabinet base adapters.

Payment will be made under:

| Pay Item | Pay Unit |
|-----------------------|-----------------|
| Cabinet Base Extender | Each |
| Cabinet Base Adapter | Each |

28. ELECTRICAL SERVICE

28.1. DESCRIPTION

At locations called out in the Plans, install a new electrical service and modify an existing electrical service, including an external disconnect and meter base.

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.

Obtain the maximum available ground fault current from the utility company. Print this information on a durable label and adhere to the dead front of the disconnect.

28.2. MATERIALS

A. Electrical Service

Provide material, equipment and hardware under this section that is pre-approved on the 2018 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:

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- Listed as meeting UL Standard UL-83
- Meets ASTM B-3 and B-8 or B-787 standards.

As indicated below, provide the following:

Traffic Signal Cabinet (with or without a CCTV camera in same cabinet):

- 1 single-pole 50A breaker
- 2 spare slot/space (minimum)
- 3-wire stranded #8 AWG copper feeder conductors with THWN rating

CCTV Camera Cabinet:

- 1 single-pole 15A breaker
- 2 spare slot/space (minimum)
- 3-wire stranded #12 AWG copper feeder conductors with THWN rating

Traffic Signal Cabinet and CCTV Camera Cabinet, sharing one meter service:

- 1 single-pole 50A breaker (Signal)
- 1 single-pole 15A breaker (CCTV)
- 2 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;

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- Listed as meeting UL Standard UL-414; and
- Overhead or underground service entrance as specified.

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.

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.

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 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 irreversible compression connections for grounding system installations. Comply with the NEC, the Standard Specifications, these Project Special Provisions and the Plans.

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For new underground electrical services for CCTV camera assemblies where the Plans call for the Contractor to install underground conduit and service conductors on the line side between the new electrical service the nearby power company pole, provide service conductors between the new electrical service and the Contractor-installed riser on the power company pole of the number and size (gauge) required by the local power company. Furnish service conductors that comply with the material requirements and standards of the local power company.

28.3. 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.

For locations with new electrical service, install a 6" x 6" treated wood post a minimum of 3 feet into the ground and mount the electrical service equipment on the wood post.

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 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.

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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.

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 pole identified in the plans. 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.

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

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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.
- Install a new 15A breaker for CCTV cabinet service in a spare slot in the existing disconnect for a traffic signal controller cabinet or other ITS device cabinet to enable the CCTV cabinet to share electrical service with the adjacent traffic signal or other ITS device. 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/ITS device 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, provide an additional electrical service disconnect on CCTV poles. Route the feeder conductors from the new or shared power service disconnect to this second disconnect on the CCTV pole through new underground conduit and 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.

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 irreversible compression connectors 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

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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 Burlington 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.

28.4. 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 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 runs less than 10 feet 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 between top of riser and disconnect of an overhead electrical services assembly, feeder conductors between the disconnect and equipment cabinet, ground wire, 6" x 6" wood posts and any remaining hardware and conduit to connect the electrical service to the cabinet as they will be 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 a 50A breaker (replacing existing breaker) for electrical service to a signal cabinet, 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 incidental to modifying an existing electrical service.

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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, and PVC female adapters from the existing service point to the CCTV cabinet as such work is 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. No separate payment will be made for #4 AWG solid bare copper grounding conductors or irreversible compression connectors as they will be incidental to furnishing and installing the ground rod(s).

Service conductors installed on the line side of a new underground electrical service will be measured and paid as the actual horizontal linear feet of underground run, furnished, installed and accepted, regardless of number and size of conductors. No measurement will be made of vertical segments.

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.

No measurement will be made of combination panel with pedestal extension installed for mounting new underground electrical services as they will be incidental to furnishing and installing the 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 incidental to installation of a new electrical service.

No payment will be made for 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.

Payment will be made under:

| Pay Item | Pay Unit |
|------------------------------------|-----------------|
| New Electrical Service | Each |
| Modify Existing Electrical Service | Each |
| CCTV Cabinet Disconnect | Each |
| 5/8" x 10' Grounding Electrode | Each |
| Service Conductors | Linear Foot |

29. 2.4 GHZ ETHERNET RADIO

29.1. DESCRIPTION

Furnish and install a 2.4 GHz Ethernet radio system with all necessary hardware in accordance with the Plans and this Project Special Provision to provide video and data links as shown in the Plans. Provide a radio system with a bi-directional, full duplex communications channel between “line-of-sight” antennas operating in the 2.4 GHz unlicensed frequency band. The wireless Ethernet radio shall be a 2.4 GHz solution with an integrated panel antenna as shown in the Plans or an Engineer approved equivalent.

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

A. Standards

Provide Ethernet radios that comply with the following IEEE networking standards for Ethernet communications:

- IEEE 802.11a/b/g/n Wireless LAN,
- IEEE 802.11d Spanning Tree Protocol (STP),
- IEEE 802.11e WMM and QOS,
- IEEE 802.11h DFS and TPC,
- IEEE 802.1Q Virtual Local Area Networks (VLAN Tagging),
- IEEE 802.1w Rapid Spanning Tree Protocol,
- IEEE 802.11i Wireless Security (WPA-PSK, WPA2-PSK, WPA-EAP, WPA2-EAP, TKIP, AES-CCM, RSN),
- IEEE 802.3 10BaseT,
- IEEE 802.3ab 1000BaseT,
- IEEE 802.3af Power Over Ethernet,
- IEEE 802.3i 10 Mbps Ethernet,
- IEEE 802.3u 100 Mbps Ethernet,
- IEEE 802.3x Full Duplex and Flow Control,
- IETF RFC 5321 – Simple Mail Transfer Protocol (SMTP),
- IETF RFC 2131 – Dynamic Host Configuration Protocol for IPv4,
- IETF RFC 4330 – Simple Network Time Protocol (SNTP),
- IETF STD. 54, RFC 2328 - Open Shortest Path First (OSPF) Version 2 IPv4
- IETF RFC 5340 - Open Shortest Path First (OSPF) IPv6

B. General

Wireless Ethernet Radios at CCTV Sites

To provide an Ethernet network signal connection to other device locations, furnish and install wireless Ethernet radios in a point-to-point (P2P) configuration at the following locations:

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| No. | Location | Fiber Access Point | Ethernet Radio Configuration | Antenna Type |
|-----|--|--------------------|------------------------------|--------------|
| 1 | S. Main Street at Maple Avenue (LabCorp Bldg.) | Yes | P2P | Panel |
| 2 | S. Main Street at E. Davis Street | No | P2P | Panel |

Follow the details shown in the fiber-optic splice plans.

29.2. MATERIALS

A. Ethernet Radio

The Ethernet radio shall be 2.40 to 2.4835 GHz with a panel antenna or an Engineer approved equivalent at locations as shown in the Plans. The 2.4 GHz Ethernet radio shall enable high-speed long range outdoor point-to-point communications links and shall be suited for installations subject to harsh environments.

The wireless outdoor 2.4 GHz Ethernet radio shall include the radio, antenna, power supply, cabling and connectors and a surge protection.

Ensure the Ethernet radio meets the following minimum requirements:

Radio Specifications

- Multiple Frequency Bands: 2.40 to 2.4835 GHz Unlicensed Band
- Frequency Selection: Dynamic
- Channel Widths: 5, 10, 20 and 40 MHz
- Transmit Power: 28 dBm (600w)
- Data Rate: Maximum 300 Mbps
- Receiver Sensitivity: -96 to -74 dBm
- Wireless Modulation: Orthogonal Frequency Division Multiplexing (OFDM), BPSK, QPSK, 16QAM, 64QAM
- Operating Modes: Point-to-point
- Security/Authentication and Encryption: AES, 64- and 128-bit WEP Encryption, WPA, WPA2, TKIP, SSID broadcast enable/disable, firewall for MAC/IP/Port-based filtering, IEEE 802.1X RADIUS

Configuration and Management

- Configuration Utility: Remote SSH, SNMP, FTP
- Software Upgrades: FTP download
- Diagnostics Tools: Antenna Alignment, Bandwidth, and Frequency Usage
- Real-time Link Monitoring: Secure Management Interface - Real-time signal strength, authentication data, system uptime, data rate, channel selection

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- Electrical Power Input: POE, 120 VAC input. low voltage DC with maximum power consumption of 9W.
- Power Output: 1 Amp at 18VDC
- Mechanical Dimensions: 8.2 in x 5.9 in x 2.3 in with antenna
- Weight: Less than 5 pounds

Environmental

- Radio Operating Temperature: -45°C to 85°C. Weather protected outdoor units
- Radio Operating Humidity: 5% to 95% non-condensing

Compliance and Certification

- Regulations: FCC Part 90
- Safety: UL - Canada, USA, CE

The wireless 2.4 GHz Ethernet radio shall be capable of being configured in point-to-point, point-to-multipoint or repeater modes of operation.

B. Radio Mounting Hardware Kit

Furnish radio mounting kit to support the radio/antenna when attached to a camera mounting arm.

Ensure the antenna mounting hardware kit includes at least one 96" galvanized steel cable with a stainless-steel bolt, nut and lock washer assembly on each end. Ensure the pole base plate accepts a 1-1/2" NPT aluminum pipe, and provides a surface that is at least 6-3/4" long x 4-1/4" to provide contact with the pole. Ensure the pole base plate is designed to allow both ends of the 96" galvanized cables to be secured and tightened to the base plate. Provide a 90-degree elbow with internal threads on both ends to accommodate 1-1/2" NPT aluminum pipes. Provide a 1-1/2" x 18" long aluminum pipe threaded on both ends and a 1-1/2" x 24" aluminum pipe threaded on one end with an end cap.

C. Surge Suppression

Provide surge protection for each radio in its respective cabinet. 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 UL 497A for paired data communications.

Provide specialized surge protection devices at the supply side Ethernet data cables connections to the Ethernet radios. These connections include that comply with EIA requirements. These specialized surge protection units shall be UL listed according to the UL 497A. The minimum surge current rating for the surge protection shall be 2,000 amps for data and telecommunications.

D. Pole-Mounting Hardware

Provide all hardware and mounting brackets required to mount the radio/antennas and RF antenna warning sign (where required) on metal and wood poles as required by the Plans. Attach

antennas and signs to poles using stainless steel banding hardware and clamps. Submit catalog cuts/manufacturer's literature for banding hardware and clamps to the Engineer for approval.

29.3. CONSTRUCTION METHODS

A. General

The locations and types of antennas shown in the Plans are the recommend locations and types based upon testing and analysis performed during the design phase of the project. Site conditions may have changed since the initial tests were performed. It is ultimately the Contractor's responsibility to confirm through on-site field testing the types and locations of antennas for each wireless communications link and to provide alternate antenna types and locations if required and subject to the Engineer's approval to achieve a fully functional, reliable wireless communications system for this project.

Use Power Over Ethernet (POE) cable with a screw on weatherproof gasketed connector that also provides strain relief.

B. Site Survey

Perform a radio path site survey test before ordering and installing any equipment.

Ensure the test evaluates the Signal Strength (dBm), Fade Margin (dB), Signal-to-Noise Ratio, Data Integrity (poll test), and a complete frequency spectrum scan. Ensure the radio path site survey test is performed using the supplied brand of radio equipment and type of antenna to be deployed at each location. During the initial radio path signal strength test, it may be determined that a repeater station may be necessary to complete the intended link. Provide the test results to the Engineer for review and approval. Submit copies of the test results and color copies of the frequency spectrum scan along with an electronic copy of this information. The Engineer will approve final locations of antennas and any necessary repeater stations as well as the type of antennas used for each location. If required, install an antenna splitter cable at locations where it is determined that a dual antenna configuration is necessary to accommodate communications in multiple directions.

C. Configuration

Set up the wireless Ethernet radio for operation in accordance with the manufacturer's recommendations. Configure the radios as point-to-point. Configure them to use the frequencies found to minimize interference. Align antennas to receive the maximum signal transfer. Implement strong encryption and any other security features offered or as requested by the Engineer. Test to ensure that the radios function as intended.

D. Software

Furnish units with a Windows® compatible software program that uses a GUI (Graphical User Interface) to provide "remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer" features. Provide software approved by the Engineer that is designed to function with the approved radio. Provide configuration software that can be upgraded in the future at no additional charge to the City/Department.

Ensure the wireless Ethernet radio transceiver is configurable from a single location (i.e. either end of the radio link) via supplied software (no extra cost to the City/Department).

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E. General Requirements for Metal Pole Locations

At one of the intersections in the proposed 2.4 GHz Ethernet radio system, radio is mounted on a metal pole with a streetlight owned by Duke Energy. Coordinate all work related to the mounting of the antenna and routing of antenna cables on these metal poles with Duke Energy. Comply with Duke Energy's requirements for conducting work on these metal poles.

Be advised that unfused electrical service conductors may be present in transformer bases of the metal poles as well as routed vertically inside the pole to streetlights mounted at the top of the pole. Take care to ensure that antenna cables do not come in contact with such electrical wiring inside the transformer base and inside the pole and install non-metallic flexible conduit to shield the antenna cable from such electrical conductors. Take necessary precautions so that workers do not contact the service conductors while installing the antenna cables.

Prior to performing installing the integrated radios, thoroughly investigate each site where antennae are proposed for mounting on the Duke-owned metal poles to become familiar with the unique conditions associated with each site and to ascertain the scope of the work required at each location. Develop a site-specific work plan as needed to address unique conditions encountered at each site.

Do not create any new holes or enlarge any existing holes in the metal poles, mast arms and transformer bases.

Install the integrated radios in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the NESC) and as specified in the antenna manufacturer's recommendations. Refer to the special details in the Plans for antenna mounting and cable routing details. Secure the antenna mounting hardware to the pole and route the Ethernet cable such that no strain is placed on the RG-45 connectors. Secure the antenna to the pole using stainless steel banding hardware or a method approved by the Engineer.

F. Cabinet and Electrical Power Wiring

Provide surge protection in controller cabinets to comply with the radio manufacturer's recommendations for these protectors.

Furnish outdoor rated CAT-6 Ethernet cable to be installed between the 2.4 GHz Ethernet radios and Ethernet power injector. Provide all necessary Ethernet patch cables and ensure cables are of appropriate length.

Connect the Ethernet surge protection devices between the Ethernet power injector and the 2.4 GHz Ethernet radio. This installation technique is designed to restrict earth current transients induced within the ground or directly from the power source from entering the Ethernet radio.

Ensure that installing the Ethernet radio transceivers with a fully functional traffic signal controller does not require any field device modifications with regards to hardware or software.

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

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

Permanently label all cables entering the cabinet. Ensure the power supply for the radio system is **NOT** connected to the GFCI receptacle circuit located in the cabinet. Place a copy of all manufacturer equipment specifications and instruction and maintenance manuals in the equipment cabinet.

G. Routing of Cable for Radio Mounted on Metal Poles

Do not create any new holes in the existing metal poles and transformer bases nor enlarge any existing holes. In all cases, use the same holes through which signal cables and communications cable currently pass to feed the antenna cables into and out of the poles. Do not feed antenna cables through holes or conduits that contain electrical conductors.

Where the Plans call for routing the antenna cable from the controller cabinet to the antenna through the interior of the metal pole, install the antenna cable in a continuous non-metallic flexible conduit from the antenna cable's entry point to its exit point to shield the cable from unfused electrical conductors present inside the pole. Provide a non-intrusive means for securing the upper end of the flex conduit to the interior of the pole so that it does not drop down to the pole base.

For Camera 12 mount the radio on the camera arm and align the radio to the corresponding radio at S. Main Street and Maple Avenue. Refer to the special details in the Plans for additional cable routing and antenna mounting details.

H. Wireless Ethernet Testing

Description: The wireless Ethernet link must be tested prior to purchasing the Ethernet radios and once the wireless links are installed. The wireless testing prior to purchasing of the radios will validate the viability of each wireless link and will adjust any radio mounting locations. Following installation of the wireless network sections, acceptance testing must be conducted to demonstrate that wireless links are providing maximum throughput and that wireless network sections passing through repeater sites are providing acceptable throughput.

Tree Foliage Constraint: All wireless testing must be completed when 90% of peak tree foliage has developed or remains on the trees along a link or corridor being tested. The Engineer has final approval of the wireless testing timeframe based on this requirement.

Wireless Acceptance Testing: Test the installed and configured individual wireless links and wireless network connections. A wireless link is defined as being between two Ethernet radios. A wireless network connection may be between two Ethernet bridge radios at intersections or may pass through multiple repeaters to provide a wireless connection between Ethernet switches at adjacent intersections.

Test Procedure: Develop a wireless link and wireless network connection testing procedure that follows the RFC 2544 protocol. The procedure must be approved by the Engineer. The test procedure must determine the throughput of each individual wireless link and for each wireless network connection.

Acceptance: A wireless link and network connection will be accepted as complete when testing results demonstrate and document that each installed wireless link meets or exceeds the initial link test results, and the throughput meets or exceeds 22 Mbps 90% or the time. The wireless network connections must meet or exceed the initial test results for the worst case wireless link that composes the wireless network connection. Provide all equipment and

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personnel needed to safely conduct the test and arrange for the Engineer's representative to witness the tests.

I. Training

A factory certified representative shall provide two (2) days of local training after radios have been installed and are operational.

29.4. MEASUREMENT AND PAYMENT

2.4 GHz Ethernet radio will be measured and paid as the actual number of 2.4 GHz Ethernet radios and integrated antennas furnished, installed and accepted according to following conditions: 80% of the payment will be made upon acceptance of the installed radio system and the remaining 20% of the payment will be made following final acceptance (including completion of the 60-day Observation Period). This item includes the Ethernet cable, POE adapter, Ethernet power injector, grounding system with weatherproofing, surge protection, installation materials, configuration software, labeling, any integration between the radio and the fiber-optic network (if necessary) and warranties.

The Contractor shall be responsible for providing a complete, functional system including all necessary cables and connectors in accordance to the specifications and as specified in the Plans. All miscellaneous patch and interconnect cables shall meet the proposed equipment specification requirements and shall meet EIA/TIA telecommunications standards.

No measurement will be made of power supplies, power cords, adapters, mounting hardware, stainless steel banding hardware and clamps, connectors, cables, non-metallic flex conduit, grommets, cable ties, surge protection devices, and installation materials necessary to complete this work, including the radio path site survey test and warranties, as these will be incidental to furnishing and installing 2.4 GHz Ethernet radios. No measurement will be made for removing the existing radio equipment as it is considered incidental to the new installation.

Riser assemblies will be measured and paid for separately in accordance with the "Riser Assemblies" section of these Project Special Provisions.

Payment will be made under:

| Pay Item | Pay Unit |
|------------------------|-----------------|
| 2.4 GHz Ethernet Radio | Each |

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30. ETHERNET CABLE

30.1. 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 TCC, and the City of Burlington Transportation Department in Public Works Building. Furnish and install Ethernet patch panels for terminating Ethernet cable in the TCC.

30.2. MATERIALS

A. Ethernet Cable

Provide shielded Category 6 Ethernet outdoor-rated twisted-pair cable that complies with ANSI/TIA-568-C.2 standards for four-pair shielded twisted copper for Ethernet communications. The cable shall meet all 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: 1-250 MHz
- Impedance: 100 ohms
- Return Loss: 19.8 dB
- Attenuation: 32.8 dB @ 250 MHz
- Near End Crosstalk (NEXT): 38.3 dB @ 250 MHz
- Power Sum NEXT: 36.3dB @ 250 MHz
- ELFNEXT: 19.8 dB @ 250 MHz
- Delay Skew: 45 ns
- Return Loss: 18.3 dB @ 250 MHz
- Capacitance: 15 pF/ft.

Furnish Ethernet cable meeting the following physical requirements:

- Jacket: PVC, UV resistant
- Jacket Color: Black
- Insulation: Polyolefin
- Core: Gel-filled or flooded core
- Binder: Clear mylar with 100% coverage
- Shield: Aluminum/mylar-polyester tape with 100% coverage
- Drain Wire: 24 AWG tinned copper
- Conductors: Solid copper
- Conductor Color Codes: White-Blue/Blue, White-Orange/Orange, White-Green/Green, White-Brown/Brown
- Conductor size: 23 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.).

B. Cable Management

Wire and cable must provide integrated features to enhance cable management. Integrated cable management features shall include:

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- Ascending Descending Sequential Foot Markings: The cable shall provide ascending/descending sequential foot markings printed on the cable jacket. The foot markings shall be used to determine the exact length of cable runs and/or determine the amount of cable remaining in/on a box or reel.
- Alphanumeric Cable Labeling Coding System: The cable shall provide alphanumeric cable labeling coding system printed on the cable jacket. The printed coding system shall include the following alphanumeric characters to allow cable identification without the need for separate adhesive-style labels: A, B, C, D, E, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. The coding system shall allow easy cable labeling using a standard waterproof marker for: identification of devices, device addresses, zone/circuit cable numbers, etc.
- Cable Colors: The cable shall be available with different color stripes and solid jacket colors. The cable coloring may be used with the alphanumeric cable labeling system to further enhance cable identification to maximize field productivity during system installation and/or maintenance and service.
- Integral Rip Cords: Cables 18 AWG and larger shall include an integral rip cord to provide for easier field stripping of the cable jacket.

Utilize pre-lubricated cable treated with a lubricant to increase cable pulling productivity and efficiency and to decrease the risk of cable damage due to excessive pulling strengths. A non-staining lubricant shall be applied to coat the full length of the cable during the manufacturing process. The lubricant shall produce a low coefficient of friction on the cable jacket material that reduces pulling friction by up to 70%. The lubricant shall continue to reduce friction after it has dried; remaining as a slippery film that retains lubricity for months after use. The cable lubricant shall comply with the physical and performance requirements of Telcordia Standard, TR-NWT-002811, and Generic Requirements for Cable Placing Lubricants. The lubricant shall not contain solvents nor have a flash point.

Furnish color coded cables to denote the type of connection between devices. The colors shall be:

- TCC and City of Burlington Transportation Department:
 - ITS Servers and firewall - Blue
 - Video Servers and Video Processor Units – Yellow
 - Workstations and UPS – Gray
 - Test Cabinets - Green
- Exterior Cable - Black
- Field Device Cabinets:
 - Traffic Signal Controllers – Blue
 - Conflict Monitors - Red
 - CCTV Cameras – Black
 - Laptop - Gray

C. 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.

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Furnish Fast Ethernet patch cords meeting the following physical requirements:

- Minimum of five (5)-foot length,
- Category 6,
- 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-C.2, Additional Transmission Performance Specifications for 4-pair 100 Ω Category 6 Cabling.
- Specified frequency range: 1-250 MHz
- Impedance: 100 ohms
- Return Loss: 19.8 dB
- Attenuation: 32.8 dB @ 250 MHz
- Near End Crosstalk (NEXT): 38.3 dB @ 250 MHz
- Power Sum NEXT: 36.3dB @ 250 MHz
- ELFNEXT: 19.8 dB @ 250 MHz
- Delay Skew: 45 ns
- Return Loss: 18.3 dB @ 250 MHz
- Capacitance: 15 pF/ft.

E. 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 cables whenever possible. Provide factory pre-connectorized Ethernet cables for all cables that are less than or equal to 12 feet in length.

30.3. CONSTRUCTION METHODS**A. General**

Install color-coded Category 6 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.).

D. Underground Installation

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.

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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. Above-Ceiling Installation

Install Ethernet cable in the TCC all in cable hangers as shown in the Plans using the above described pulling methods. The installation of the cable tray in the TCC is included in this project. See the Building Modifications Section of these Project Special Provisions

F. Ethernet Patch Cords

Install Ethernet patch cords between Ethernet patch panels and devices and network interface box and devices.

30.4. 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 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 incidental to furnishing and installing the equipment that they connect.

Payment will be made under:

Pay Item

Ethernet Cable

Pay Unit

Linear Foot

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31. CCTV METAL POLES

31.1. DESCRIPTION

Furnish and install CCTV metal poles, drilled pier foundations, grounding systems, and all necessary hardware. Design, furnish, and install drilled pier foundations for CCTV metal poles with all necessary hardware. The work covered by this special provision includes requirements for the design, fabrication, and installation of custom designed CCTV metal poles.

31.2. MATERIALS

Comply with applicable sections of the *2018 Standard Specifications for Roads & Structures*, hereinafter referred to as the *Standard Specifications*. Provide designs of completed assemblies with hardware that equals or exceeds *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, 6th Edition (hereafter called AASHTO), including the latest interim specifications. Provide assemblies with a round or near-round (18 sides or more) cross-section, or a multi-sided cross section with no less than six sides. The sides may be straight, convex, or concave.

After fabrication, hot-dip galvanized steel poles, and all parts used in the assembly in accordance with section 1076 of the *Standard Specification*. Design structural assemblies with weep holes large enough and properly located to drain molten zinc during galvanization process. Galvanize structures to meet or exceed AASHTO M 111. Provide galvanizing on hardware that meets or exceeds ASTM Standard A-153. Ensure that threaded material is brushed and re-tapped as necessary after galvanizing. Perform repair of damaged galvanizing that complies with the following:

- Repair of Galvanizing Article 1076-6

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

<https://connect.ncdot.gov/resources/safety/Pages/ITS-Design-Resources.aspx>

Comply with article 1098-1B "General Requirements" of the *Standard Specifications* for submittal requirements. Furnish shop drawings for approval. Provide the copies of detailed shop drawings for each type of structure as summarized below. Ensure that shop drawings include material specifications for each component and identify welds by type and size on the drawing details, not in table format. Do not release structures for fabrication until shop drawings have been approved by NCDOT. Provide an itemized bill of materials for all structural components and associated connecting hardware on the drawings.

Comply with Subarticle 1098-1(A) "General Requirements" of the *Standard Specifications* for Qualified Products List (QPL) submittals. All shop drawings must include project location description, CCTV inventory number(s), and a project number or work order number on the drawings.

Summary of information required for metal pole review submittal:

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| Item | Hardcopy Submittal | Electronic Submittal | Comments / Special Instructions |
|---|---------------------------|-----------------------------|--|
| Sealed, Approved ITS Plan/Loading Diagram | 1 | 1 | All structure design information needs to reflect the latest approved ITS plans |
| Custom Pole Shop Drawings | 4 sets | 1 set | Submit drawings on 11" x 17" format media Show NCDOT inventory number(s), contractor's name and relevant revision number in the title block. in or above the title block. All drawings must have a <u>unique drawing</u> number for each project and identified for multiple pages. |
| Structure Calculations | 1 set | 1 set | Not required for Standard QPL Poles |
| Custom Foundation Drawings | 4 sets | 1 set | Submit drawings on 11" x 17" format media. All drawings must have a <u>unique drawing</u> number for each project and identified for multiple pages. |
| Foundation Calculations | 1 | 1 | Submit copies of LPILE input, output and pile tip deflection graph paper per the "Non-Standard Foundation Design" subarticle of this section of these Project Special Provisions for each foundation. |
| Soil Boring Logs and Report | 1 | 1 | Report should include a location plan and a soil classification report including soil capacity, water level, hammer efficiency, soil bearing pressure, soil density, etc. for each pole. |

NOTE – All shop drawings and custom foundation design drawings must be sealed by a professional Engineer licensed in the state of North Carolina. All geotechnical information must be sealed by either a Professional Engineer or geologist licensed in the state of North Carolina. Include a title block and revision block on the shop drawings and foundation designs showing the NCDOT inventory number.

Shop drawings and foundation drawings may be submitted together or separately for approval. However, shop drawings must be approved before foundations can be reviewed. Foundation designs will be returned without review if the associated shop drawing has not been approved. Incomplete submittals will be returned without review. The Reviewer has the right to request additional analysis and copies of the calculations to expedite the approval process.

Fabricate CCTV metal poles from coil or plate steel to meet the requirements of ASTM A595 Grade A tubes. For structural steel shapes, plates and bars use A572 Gr 50 minimum or ASTM A709 Gr 50 minimum. Provide poles that are round in cross section or multisided tubular shapes and have a uniform linear taper of 0.14 in/ft. Construct shafts from one piece of single ply plate or coil so there are no circumferential weld splices. Galvanize in accordance with AASHTO M111 and/or ASTM A123 or an approved equivalent.

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Ensure that allowable pole deflection does not exceed that allowed per AASHTO. Ensure that maximum deflection at the top of the pole does not exceed 2.0 percent of the pole height.

Use the submerged arc process or other NCDOT previously approved process suitable for poles to continuously weld pole shafts along their entire length. The longitudinal seam weld will be finished flush to the outside contour of the base metal. Ensure shafts have no circumferential welds except at the lower end joining the shaft to the pole base. Provide welding that conforms to Article 1072-20 of the *Standard Specifications*, except that no field welding on any part of the pole will be permitted unless approved by a qualified engineer.

Refer to Metal Pole Standard Drawing Sheets M2 through M5 for fabrication details. Fabricate anchor bases from plate steel meeting, as a minimum, the requirements of ASTM A 36M or cast steel meeting the requirements of ASTM A 27M Grade 485-250, AASHTO M270 Gr 36 or an approved equivalent. Conform to the applicable bolt pattern and orientation as shown on Metal Pole Standard Drawing Sheet M2.

Ensure all hardware is galvanized steel or stainless-steel. The Contractor is responsible for ensuring that the designer/fabricator specifies connecting hardware and/or materials that do not create a dissimilar metal corrosive reaction.

Unless otherwise required by the design, ensure each anchor rod is 2" diameter and 60" length. Provide 10" minimum thread projection at the top of the rod, and 8" minimum at the bottom of the rod. Use anchor rod assembly and drilled pier foundation materials that meet the *Foundations and Anchor Rod Assemblies for Metal Poles* provision.

For each structural bolt and other steel hardware, hot dip galvanizing shall conform to the requirements of AASHTO M 232 (ASTM A 153). Ensure end caps for poles are constructed of cast aluminum conforming to Aluminum Alloy 356.0F.

Provide a circular anchor bolt lock plate that will be secured to the anchor bolts at the embedded end with two washers and two nuts. Provide a base plate template that matches the bolt circle diameter of the anchor bolt lock plate. Construct plates and templates from 1/4" minimum thick steel with a minimum width of 4". Galvanizing is not required.

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

Provide a 2-inch hole equipped with an associated coupling and weatherhead approximately 5 feet below the top of the pole to accommodate passage of CCTV cables from inside the pole to the CCTV camera.

Provide a 2-hole equipped with an associated coupling and conduit fittings/bodies approximately 18" above the base of the pole accommodate passage of CCTV cables from the CCTV cabinet to the inside of the pole. Refer to Metal Pole Standard Drawing Sheet M3 for fabrication details.

Have poles permanently stamped above the base hand hole with the identification tag details as shown on Metal Pole Standard Drawing Sheet M2.

For each pole, provide a 1/2-inch minimum thread diameter, coarse thread stud and nut for grounding which will accommodate #4 AWG ground wire. Ensure that the lug is electrically bonded to the pole and is conveniently located inside the pole at the hand hole.

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Provide a removable pole cap with stainless-steel attachment screws for the top of each pole. Ensure that the cap is cast aluminum conforming to Aluminum Association Alloy 356.0F. Furnish cap attached to the pole with a sturdy chain or cable approved by the Engineer. Ensure that the chain or cable is long enough to permit the cap to hang clear of the pole-top opening when the cap is removed.

31.3. Design of Drilled Pier Foundations for Metal Poles

A. General Requirements

Design all CCTV pole foundations using actual soil conditions at each pole location. Perform soil test in accordance with the subarticle entitled "Soil Test and Foundation Determination" below.

The Contractor is responsible for providing the shop drawing and soil test information for each CCTV metal pole to the Contractor's selected pole fabricator for a foundation design.

Analysis procedures and formulas shall be based on AASHTO 6th Edition, ACI code and the *Drilled Shafts: Construction Procedures and Design Methods* FHWA-IF99-025 manual. Design methods based on engineering publications or research papers needs to have prior approval from NCDOT. The Department reserves the right to accept or disapprove any method used for the analysis.

Use a Factor of Safety of 1.33 for torsion and 2.0 for bending for the foundation design.

Foundation design for lateral load shall not exceed 1" lateral deflection at top of foundation.

For lateral analysis, use LPILE Plus V6.0 or later. Inputs, results and corresponding graphs are to be submitted with the design calculations.

Skin Friction is to be calculated using the α -method for cohesive soils and the β -method for cohesion-less soils (**Bröms method will not be accepted**). Detailed descriptions of the " α " and " β " methods can be found in *FHWA-IF-99-025*.

Omit first 2.5ft for cohesive soils when calculating skin friction.

When extreme loading and poor soil conditions are encountered, the one diameter length omitted from the shaft depth calculations (per FHWA-IF-99-025) may be added back in for Torsion calculations (with prior NCDOT approval).

When hammer efficiency is not provided, assume a value of 0.70.

Design all custom foundations to carry the maximum capacity of each metal pole.

When poor soil conditions are encountered which could create an excessively large foundation design, consideration may be given to allowing an exemption to the maximum capacity design. The Contractor must gain approval from the Engineer before reducing a foundation's capacity. On projects where poor soil is known to be present, it is advisable that the Contractor gain foundation approval before releasing poles for fabrication.

B. Soil Test and Foundation Determination

(1) General:

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

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Some drilled piers for supporting metal poles may require wing walls to resist torsional rotation. Based upon this provision and the results of the required soil test, a drilled pier length requirement may be determined and constructed in accordance with the plans.

(2) Soil Test:

Perform a soil test at each proposed metal pole location. Complete all required fill placement and excavation at each pole location to finished grade before drilling each boring. Soil tests performed that are not in compliance with this requirement may be rejected and will not be paid. Drill one boring to a depth of 26 feet within a 25-foot radius of each proposed foundation.

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

A total of 100 blows have been applied in any two consecutive 6-in. intervals.

A total of 50 blows have been applied with < 3-in. penetration.

Describe each CCTV pole location along the project corridor in a manner that is easily discernible to both the contractor's designer and NCDOT reviewers. If a CCTV pole is at an intersection, label the boring the "Intersection of (Route or SR #), (Street Name) and (Route or SR #), (Street Name), _____ County, Signal Inventory No. _____". Label borings with "B- N, S, E, W, NE, NW, SE or SW" corresponding to the quadrant location within the intersection.

If the CCTV pole location is located between intersections, provide a coordinate location and offset, or milepost number and offset. Pole numbers should be made available to the geotechnical drilling Contractor. Include pole numbers in the boring label if they are available. If they are not available, ensure the boring labels can be cross-referenced to corresponding pole numbers or pole locations. For each boring, submit a legible (handwritten or typed) boring log signed and sealed by a licensed Geologist or Professional Engineer licensed in North Carolina. Include on each boring the SPT blow counts and N-values at each depth, depth of the boring, and a general description of the soil types encountered.

Borings that cannot be easily related to their specific pole location will be returned to the contractor for clarification, or if approved by the engineer, the foundation may be designed using the worst case soil condition obtained as part of r this project.

(3) Standard Foundation Determination:

Use the following method for determining the Design N-value:

$$N_{AVG} = \frac{(N@1' + N@2.5' + \dots + N@Deepest \text{ Boring Depth})}{\text{Total Number of N-values}}$$

$$Y = (N@1')^2 + (N@2.5')^2 + \dots + (N@Deepest \text{ Boring Depth})^2$$

$$Z = (N@1' + N@2.5' + \dots + N@Deepest \text{ Boring Depth})$$

$$N_{STD \text{ DEV}} = \left[\frac{(\text{Total Number of N-values} \times Y) - Z^2}{\text{Total Number of N-values}} \right]^{0.5}$$

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(Total Number of N-values) x (Total Number of N-values – 1)

Design N-value equals lesser of the following two conditions:

$$N_{AVG} - (N_{STD DEV} \times 0.45)$$

Or

$$\text{Average of First Four N-Values} = \frac{(N@1' + N@2.5' + N@5' + N@7.5')}{4}$$

Note: If less than four N-values are obtained because of criteria listed in Section 2 above, use average of N-values collected for second condition. Do not include the N-value at the deepest boring depth for above calculations if the boring is discontinued at or before the required boring depth because of criteria listed in Section 2 above. Use N-value of zero for weight of hammer or weight of rod. If N-value is greater than 50, reduce N-value to 50 for calculations.

Submit completed boring logs collected in accordance with Section 2 (Soil Test) above along with pole loading diagrams from the plans to the contractor-selected pole fabricator to assist in the pole and foundation design.

If one of the following occurs, contact the Engineer.

- The Design N-value is less than four.
- The drilled pier length, “L”, is greater than the depth of the corresponding boring.

Foundation designs are based on level ground around the pole. If the slope around the edge of the drilled pier is steeper than 8:1 (H:V) or the proposed foundation will be less than 10 feet from the top of an embankment slope, the Contractor is responsible for providing slope information to the foundation designer and to the Engineer so it can be considered in the design.

If assistance is needed, contact the Engineer.

(4) Non-Standard Foundation Design:

Design non-standard foundations based upon site-specific soil test information collected in accordance with Section 2 (Soil Test) above. Design drilled piers for side resistance only in accordance with Section 4.6 of the *AASHTO Standard Specifications for Highway Bridges*. Use the computer software LPILE version 5.0 or later manufactured by Ensoft, Inc. to analyze drilled piers. Use the computer software gINT version 8.0 or later manufactured by Bentley Systems, Inc. with the current NCDOT gINT library and data template to produce SPT boring logs. Provide a drilled pier foundation for each pole with a length and diameter that result in a horizontal lateral movement of less than 1 inch at the top of the pier and a horizontal rotational movement of less than 1 inch at the edge of the pier. Submit and gain approval of foundation designs including drawings, calculations, and soil boring before construction. Foundations installed without prior approval may be rejected.

31.4. CONSTRUCTION METHODS

A. General

Locate and mark proposed CCTV pole locations in the field and receive approval from the Regional ITS Engineer before performing any soil borings, foundation design and construction. Do not construct any conduits or junction boxes to proposed devices until the device locations

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are approved by the Regional ITS Engineer. The Regional ITS Engineer can be contacted at (336) 315-7080.

B. CCTV Metal Pole Foundations

Construct drilled pier foundations and install anchor rod assemblies in accordance with the "Foundations and Anchor Rod Assemblies for Metal Poles" section of these Project Special Provisions."

C. CCTV Metal Poles

Erect CCTV metal poles only after concrete has attained a minimum allowable compressive strength of 3000 psi. Final approval of foundation is contingent upon concrete achieving a compressive strength of 4,500 psi strength as required by *Foundations and Anchor Rod Assemblies for Metal Poles* provision. Connect poles to grounding electrodes and bond them to the electrical service grounding electrodes.

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

Attach the hand hole covers to the pole by a sturdy chain or cable. Ensure the chain or cable is long enough to permit the cover to hang clear of the opening when the cover is removed, and is strong enough to prevent vandalism. Ensure the chain or cable will not interfere with service to the cables in the pole.

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

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

Install galvanized wire mesh around the perimeter of the base plate to cover the gap between the base plate and top of foundation for debris and pest control.

Install a ¼" thick plate for concrete foundation tag to include: concrete grade, depth, diameter, and reinforcement sizes of the installed foundation.

Install CCTV metal poles, hardware, and fittings as shown on the manufacturer's installation drawings. Install poles so that when the pole is fully loaded it is within .5 degrees of vertical.

D. Metal Pole Removals**1. Description:**

Remove and dispose of existing metal poles, and remove and dispose of existing foundations, associated anchor bolts, electrical wires and connections.

2. Construction Methods:

Remove and promptly dispose of the metal pole foundations including reinforcing steel, electrical wires, and anchor bolts to a minimum depth of two feet below the finished ground elevation. At the Contractor's option, remove the complete foundation.

Assume ownership of the metal poles, remove the metal poles, and promptly transport the metal poles from the project. Use methods to remove the metal poles and attached equipment that will not result in damage to other portions of the project or facility. Repair damages that are a result of the Contractor's actions at no additional cost to the Department.

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Transport and properly dispose of the materials.

Backfill and compact disturbed areas to match the finished ground elevation. Seed unpaved areas.

Use methods to remove the foundations that will not result in damage to other portions of the project or facility. Repair damages that are a result of the Contractor's actions at no cost to the Department.

31.5. Measurement and Payment

CCTV metal pole will be measured and paid as the actual number of CCTV metal poles furnished, installed and accepted.

Soil test will be measured and paid as the actual number of soil tests with SPT borings performed, furnished and accepted.

Drilled pier foundation will be measured and paid as the actual volume of concrete poured in cubic yards that is furnished, installed and accepted. The cost of the foundation anchor rods will be incidental to the cost of the drilled pier foundations

Metal pole removal will be measured and paid as the actual number of metal poles removed.

Metal pole foundation removal will be measured and paid as the actual number of metal pole foundations removed and disposed.

No measurement will be made for CCTV metal pole designs and drilled pier foundation designs, as these will be incidental to furnishing and installing CCTV Metal Poles and Drilled Pier Foundations.

Payment will be made under:

| Pay Item | Pay Unit |
|-------------------------------|-----------------|
| CCTV Metal Pole | Each |
| Soil Test | Each |
| Drilled Pier Foundation | Cubic Yard |
| Metal Pole Removal | Each |
| Metal Pole Foundation Removal | Each |

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32. FOUNDATIONS AND ANCHOR ROD ASSEMBLIES FOR METAL POLES

32.1. DESCRIPTION

Foundations for metal poles include foundations for signals, cameras, overhead and dynamic message signs (DMS) and high mount and low-level light standards supported by metal poles or upright trusses. Foundations consist of footings with pedestals and drilled piers with or without grade beams or wings. Anchor rod assemblies consist of anchor rods (also called anchor bolts) with nuts and washers on the exposed ends of rods and nuts and a plate or washers on the other ends of rods embedded in the foundation.

Construct concrete foundations with the required resistances and dimensions and install anchor rod assemblies in accordance with the contract and accepted submittals. Construct drilled piers consisting of cast-in-place reinforced concrete cylindrical sections in excavated holes. Provide temporary casings or polymer slurry as needed to stabilize drilled pier excavations. Use a prequalified Drilled Pier Contractor to construct drilled piers for metal poles. Define "excavation" and "hole" as a drilled pier excavation and "pier" as a drilled pier.

This provision does not apply to materials and anchor rod assemblies for standard foundations for low level light standards. See Section 1405 of the *2018 Standard Specifications* and Standard Drawing No. 1405.01 of the *2018 Roadway Standard Drawings* for materials and anchor rod assemblies for standard foundations. For construction of standard foundations for low level light standards, standard foundations are considered footings in this provision.

This provision does not apply to foundations for signal pedestals; see Section 1743 of the *2018 Standard Specifications* and Standard Drawing No. 1743.01 of the *2018 Roadway Standard Drawings*.

32.2. MATERIALS

Refer to the 2018 Standard Specifications.

| Item | Section |
|--------------------------|----------|
| Conduit | 1091-3 |
| Grout, Nonshrink | 1003 |
| Polymer Slurry | 411-2(B) |
| Portland Cement Concrete | 1000 |
| Reinforcing Steel | 1070 |
| Rollers and Chairs | 411-2(C) |
| Temporary Casings | 411-2(A) |

Provide Type 3 material certifications in accordance with Article 106-3 of the *2018 Standard Specifications* for conduit, rollers, chairs and anchor rod assemblies. Store steel materials on blocking at least 12" above the ground and protect it at all times from damage; and when placing in the work make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials. Load, transport, unload and store foundation and anchor rod assembly materials so materials are kept clean and free of damage. Bent, damaged or deformed materials will be rejected.

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Use conduit type in accordance with the contract. Use Class A concrete for footings and pedestals, Class Drilled Pier concrete for drilled piers and Class AA concrete for grade beams and wings including portions of drilled piers above bottom of wings elevations. Corrugated temporary casings may be accepted at the discretion of the Engineer. A list of approved polymer slurry products is available from: connect.ncdot.gov/resources/Geological/Pages/Products.aspx

Provide anchor rod assemblies in accordance with the contract consisting of the following:

- Straight anchor rods,
- Heavy hex top and leveling nuts and flat washers on exposed ends of rods, and
- Nuts and either flat plates or washers on the other ends of anchor rods embedded in foundations.

Do not use lock washers. Use steel anchor rods, nuts and washers that meet ASTM F1554 for Grade 55 rods and Grade A nuts. Use steel plates and washers embedded in concrete with a nominal thickness of at least 1/4". Galvanize anchor rods and exposed nuts and washers in accordance with Article 1076-4 of the *2018 Standard Specifications*. It is not necessary to galvanize nuts, plates and washers embedded in concrete.

32.3. CONSTRUCTION METHODS

Install the required size and number of conduits in foundations in accordance with the plans and accepted submittals. Construct top of piers, footings, pedestals, grade beams and wings flat, level and within 1" of elevations shown in the plans or approved by the Engineer. Provide an Ordinary Surface finish in accordance with Subarticle 825-6(B) of the *2018 Standard Specifications* for portions of foundations exposed above finished grade. Do not remove anchor bolt templates or pedestal or grade beam forms or erect metal poles or upright trusses onto foundations until concrete attains a compressive strength of at least 3,000 psi.

A. Drilled Piers

Before starting drilled pier construction, hold a predrill meeting to discuss the installation, monitoring and inspection of the drilled piers. Schedule this meeting after the Drilled Pier Contractor has mobilized to the site. The Resident or Division Traffic Engineer, Contractor and Drilled Pier Contractor Superintendent will attend this predrill meeting.

Do not excavate holes, install piles or allow equipment wheel loads or vibrations within 20 feet of completed piers until 16 hours after Drilled Pier concrete reaches initial set.

Check for correct drilled pier alignment and location before beginning drilling. Check to see the holes are plumb frequently during drilling.

Construct drilled piers with the minimum required diameters shown in the plans. Install piers with tip elevations no higher than shown in the plans or approved by the Engineer.

Excavate holes with equipment of the sizes required to construct drilled piers. Depending on the subsurface conditions encountered, drilling through rock and boulders may be required. Do not use blasting for drilled pier excavations.

Contain and dispose of drilling spoils and waste concrete as directed and in accordance with Section 802 of the *2018 Standard Specifications*. Drilling spoils consist of all materials and fluids removed from excavations.

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If unstable, caving or sloughing materials are anticipated or encountered, stabilize holes with temporary casings and/or polymer slurry. Do not use telescoping temporary casings. If it becomes necessary to replace a temporary casing during drilling, backfill the excavation, insert a larger casing around the casing to be replaced or stabilize the excavation with polymer slurry before removing the temporary casing.

If temporary casings become stuck or the Contractor proposes leaving casings in place, temporary casings should be installed against undisturbed material. Unless otherwise approved, do not leave temporary casings in place for mast arm poles and cantilever signs. The Engineer will determine if casings may remain in place. If the Contractor proposes leaving temporary casings in place, do not begin drilling until a casing installation method is approved.

Use polymer slurry and additives to stabilize holes in accordance with the slurry manufacturer's recommendations. Provide mixing water and equipment suitable for polymer slurry. Maintain polymer slurry at all times so slurry meets Table 411-3 of the *2018 Standard Specifications* except for sand content.

Define a "sample set" as slurry samples collected from mid-height and within two feet of the bottom of holes. Take sample sets from excavations to test polymer slurry immediately after filling holes with slurry, at least every 4 hours thereafter and immediately before placing concrete. Do not place Drilled Pier concrete until both slurry samples from an excavation meet the required polymer slurry properties. If any slurry test results do not meet the requirements, the Engineer may suspend drilling until both samples from a sample set meet the required slurry properties.

Remove soft and loose material from bottom of holes using augers to the satisfaction of the Engineer. Assemble rebar cages and place cages and Drilled Pier concrete in accordance with Subarticle 411-4(E) of the *2018 Standard Specifications* except for the following:

- Inspections for tip resistance and bottom cleanliness are not required,
- Temporary casings may remain in place if approved, and
- Concrete placement may be paused near the top of pier elevations for anchor rod assembly installation and conduit placement or
- If applicable, concrete placement may be stopped at bottom of grade beam or wings elevations for grade beam or wing construction.

If wet placement of concrete is anticipated or encountered, do not place Drilled Pier concrete until a concrete placement procedure is approved. If applicable, temporary casings and fluids may be removed when concrete placement is paused or stopped in accordance with the exceptions above provided holes are stable. Remove contaminated concrete from exposed Drilled Pier concrete after removing casings and fluids. If holes are unstable, do not remove temporary casings until a procedure for placing anchor rod assemblies and conduit or constructing grade beams or wings is approved.

Use collars to extend drilled piers above finished grade. Remove collars after Drilled Pier concrete sets and round top edges of piers.

If drilled piers are questionable, pile integrity testing (PIT) and further investigation may be required in accordance with Article 411-5 of the *2018 Standard Specifications*. A drilled pier

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will be considered defective in accordance with Subarticle 411-5(D) of the *2018 Standard Specifications* and drilled pier acceptance is based in part on the criteria in Article 411-6 of the *2018 Standard Specifications* except for the top of pier tolerances in Subarticle 411-6(C) of the *2018 Standard Specifications*.

If a drilled pier is under further investigation, do not grout core holes, backfill around the pier or perform any work on the drilled pier until the Engineer accepts the pier. If the drilled pier is accepted, dewater and grout core holes and backfill around the pier with approved material to finished grade. If the Engineer determines a pier is unacceptable, remediation is required in accordance with Article 411-6 of the *2018 Standard Specifications*. No extension of completion date or time will be allowed for remediation of unacceptable drilled piers or post repair testing.

Permanently embed a plate in or mark top of piers with the pier diameter and depth, size and number of vertical reinforcing bars and the minimum compressive strength of the concrete mix at 28 days.

B. Footings, Pedestals, Grade Beams and Wings

Excavate as necessary for footings, grade beams and wings in accordance with the plans, accepted submittals and Section 410 of the *2018 Standard Specifications*. If unstable, caving or sloughing materials are anticipated or encountered, shore foundation excavations as needed with an approved method. Notify the Engineer when foundation excavation is complete. Do not place concrete or reinforcing steel until excavation dimensions and foundation material are approved.

Construct cast-in-place reinforced concrete footings, pedestals, grade beams and wings with the dimensions shown in the plans and in accordance with Section 825 of the *2018 Standard Specifications*. Use forms to construct portions of pedestals and grade beams protruding above finished grade. Provide a chamfer with a 3/4" horizontal width for pedestal and grade beam edges exposed above finished grade. Backfill and fill in accordance with Article 410-8 of the *2018 Standard Specifications*. Proper compaction around footings and wings is critical for foundations to resist uplift and torsion forces. Place concrete against undisturbed soil and do not use forms for standard foundations for low level light standards.

C. Anchor Rod Assemblies

Size anchor rods for design and the required projection above top of foundations. Determine required anchor rod projections from nut, washer and base plate thicknesses, the protrusion of 3 to 5 anchor rod threads above top nuts after tightening and the distance of one nut thickness between top of foundations and bottom of leveling nuts.

Protect anchor rod threads from damage during storage and installation of anchor rod assemblies. Before placing anchor rods in foundations, turn nuts onto and off rods past leveling nut locations. Turn nuts with the effort of one workman using an ordinary wrench without a cheater bar. Report any thread damage to the Engineer that requires extra effort to turn nuts.

Arrange anchor rods symmetrically about center of base plate locations as shown in the plans. Set anchor rod elevations based on required projections above top of foundations. Securely brace and hold rods in the correct position, orientation and alignment with a steel template. Do not weld to reinforcing steel, temporary casings or anchor rods.

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Install top and leveling (bottom) nuts, washers and the base plate for each anchor rod assembly in accordance with the following procedure:

1. Turn leveling nuts onto anchor rods to a distance of one nut thickness between the top of foundation and bottom of leveling nuts. Place washers over anchor rods on top of leveling nuts.
2. Determine if nuts are level using a flat rigid template on top of washers. If necessary, lower leveling nuts to level the template in all directions or if applicable, lower nuts to tilt the template so the metal pole or upright truss will lean as shown in the plans. If leveling nuts and washers are not in full contact with the template, replace washers with galvanized beveled washers.
3. Verify the distance between the foundation and leveling nuts is no more than one nut thickness.
4. Place base plate with metal pole or upright truss over anchor rods on top of washers. High mount luminaires may be attached before erecting metal poles but do not attach cables, mast arms or trusses to metal poles or upright trusses at this time.
5. Place washers over anchor rods on top of base plate. Lubricate top nut bearing surfaces and exposed anchor rod threads above washers with beeswax, paraffin or other approved lubricant.
6. Turn top nuts onto anchor rods. If nuts are not in full contact with washers or washers are not in full contact with the base plate, replace washers with galvanized beveled washers.
7. Tighten top nuts to snug-tight with the full effort of one workman using a 12" wrench. Do not tighten any nut all at once. Turn top nuts in increments. Follow a star pattern cycling through each nut at least twice.
8. Repeat (7) for leveling nuts.
9. Replace washers above and below the base plate with galvanized beveled washers if the slope of any base plate face exceeds 1:20 (5%), any washer is not in firm contact with the base plate or any nut is not in firm contact with a washer. If any washers are replaced, repeat (7) and (8).
10. With top and leveling nuts snug-tight, mark each top nut on a corner at the intersection of 2 flats and a corresponding reference mark on the base plate. Mark top nuts and base plate with ink or paint that is not water-soluble. Use the turn-of-nut method for pretensioning. Do not pretension any nut all at once. Turn top nuts in increments for a total turn that meets the following nut rotation requirements:

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| NUT ROTATION REQUIREMENTS (Turn-of-Nut Pretensioning Method) | |
|---|--------------------|
| Anchor Rod Diameter, inch | Requirement |
| $\leq 1 \frac{1}{2}$ | 1/3 turn (2 flats) |
| $> 1 \frac{1}{2}$ | 1/6 turn (1 flat) |

Follow a star pattern cycling through each top nut at least twice.

1. Ensure nuts, washers and base plate are in firm contact with each other for each anchor rod. Cables, mast arms and trusses may now be attached to metal poles and upright trusses.
2. Between 4 and 14 days after pretensioning top nuts, use a torque wrench calibrated within the last 12 months to check nuts in the presence of the Engineer. Completely erect mast arm poles and cantilever signs and attach any hardware before checking top nuts for these structures. Check that top nuts meet the following torque requirements:

| TORQUE REQUIREMENTS | |
|--------------------------------------|-------------------------------|
| Anchor Rod Diameter, inch | Requirement, ft-lb |
| 7/8 | 180 |
| 1 | 270 |
| 1 1/8 | 380 |
| 1 1/4 | 420 |
| $\geq 1 \frac{1}{2}$ | 600 |

If necessary, retighten top nuts in the presence of the Engineer with a calibrated torque wrench to within ± 10 ft-lb of the required torque. Do not over tighten top nuts.

- 13) Do not grout under base plate.

32.4. MEASUREMENT AND PAYMENT

Foundations and anchor rod assemblies for metal poles and upright trusses will be measured and paid for in accordance with the "CCTV Metal Poles" section of these Project Special Provisions.

No payment will be made for temporary casings that remain in drilled pier excavations. No payment will be made for PIT. No payment will be made for further investigation of defective piers. Further investigation of piers that are not defective will be paid as extra work in accordance with Article 104-7 of the *2018 Standard Specifications*. No payment will be made for remediation of unacceptable drilled piers or post repair testing.

U-6015**ITS-211****Alamance County****33. CCTV FIELD EQUIPMENT****33.1. 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[®] listed surge protection devices.

33.2. 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 integrated encoder, zoom lens, filter, control circuit, and accessories,
- Motorized pan, tilt, and zoom,
- CCTV power injector,
- Pole-mount camera attachment hardware,
- Built-in video encoder cable of H.264/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,
- Category 6 Ethernet cable for power supply and Ethernet communications, and
- Surge protection devices.

Provide Type 336A cabinets for CCTV cabinets as shown in the Plans.

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 and clamps. Submit catalog cuts/manufacturer's literature for banding hardware and clamps to the Engineer for approval.

B. Standards

- ANSI,
- ASTM,
- CE, Class B,
- EIA Standards 170, 232, 422, 250C and 485,

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- 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 TS 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. Camera

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:

- Image sensor size: 2 megapixels
- Video signal format: NTSC compatible resolution, user selectable up to a maximum of 1920 x 1080 (1080p)
- Maximum frames per second: 50
- 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,
- Minimum illumination: Color 0.2 lux, black/white 0.02 lux
- Input/output Connection: Single 10BASE-T/100BASE-T compatible outdoor-rated Category 6 cable for video and control, and IP66-rated RJ45 connector
- Security: Min. 20 users in unicast mode, unlimited in multicast

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- Open Application Programming Interface (API): ONVIF Profile S
- Primary supply voltage: 120 VAC, 74 watts maximum, and
- Camera power: Power Over Ethernet, 60 watts with heater and blower at 24 VAC, typical 16 watts without heater/blower.

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: 63.4 degrees at 4.3 mm wide zoom and 2.3 degrees at 129 mm telephoto zoom,
- Focal length: 4.4 mm to 132 mm, 30x optical zoom and 12x digital zoom,
- Zoom Speed: 2.9, 4.2 and 5.8 seconds,
- Lens aperture: Minimum of f/1.4 to f/4.6,
- Minimum illumination: Color 0.2 lux, black/white 0.02 lux
- 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.

3. Camera Housing

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. Equip each camera housing with a mounting assembly for attachment to the CCTV camera pole. 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

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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. Power Injector

Furnish a 60-watt POE power injector recommended by the manufacturer for use with the camera. Furnish a power sup injector ply that is rated for outdoor use, is compatible with the AC electric service source (e.g., traffic signal cabinet), and provides power within the input range of the camera.

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.

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 can withstand wind loading at the maximum wind speed and gust factor called for in the interim revision of the 6th 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

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- Compression: H.264 (MPEG-4 Part 10/AVC) baseline, main and high profiles and motion jpeg
- Resolution: Scalable; NTSC-compatible 320x180, 1280x720 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

Furnish cameras with a built-in digital video Ethernet encoder to allow video-over-IP transmission. The encoder units 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 Category 6 Ethernet cable to the camera,
- 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 (± 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

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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 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 pole-mounted version of the 336A CCTV cabinet.

2. Camera 12 NEMA 4 Cabinet (S. Main Street at E. Davis Street)

Provide a NEMA 4 stainless steel cabinet to replace the existing fiberglass cabinet to house the following equipment:

- Ethernet edge switch (paid for separately),
- Termination of the Category 6 Ethernet cable to the camera,
- Grounding bus bar,
- 120 VAC power supply,
- 120 VAC surge protected duplex outlets for equipment,
- Surge protection on incoming and outgoing electrical lines (power and data), and
- Power injector and power supplies (paid separately with their devices).

Provide a vented cabinet with a Corbin No. 2 lock.

Size the cabinet to fit the required equipment.

3. Ventilation

Provide a cooling fan in all cabinets with a minimum capacity of 100 CFM. Provide a thermostat to control the ventilation system.

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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.

4. 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 M Ω 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 M Ω when measured at the AC neutral.

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 using 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.

5. 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. 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:

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- UL 1449 version 3 for electrical power,
- UL 497B for paired data communications, and

Provide surge protection devices meeting UL 1449A. Provide an Ethernet surge protection device either inside the CCTV metal pole or strapped to the outside of the pole near the camera. Provide a camera manufacturer recommended unit suitable for exterior use. Provide an Ethernet surge protection device for the Category 6 cable entering the cabinet.

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 μ 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.

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 $\frac{1}{2}$ 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 stage 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.

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- 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 28 volts single phase and a maximum continuous operating voltage of 34 volts single phase.

The device's surge protection shall be rated at a minimum of 10,000 amps and have maximum clamping voltage ratings of 34 VAC. The surge protection shall also be UL listed for a minimum suppressed voltage of 330 volts per line to the neutral/ground. The maximum leakage current is 5 microhenries at 28 volts. The maximum load current is 10 amps. 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. 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 28 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.

H. 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 irreversible compression 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.

33.3. 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. CCTV Cabinet

Mount the CCTV cabinet on the pole supporting the CCTV camera it controls using approved hardware and attachment brackets. Mount the cabinet 4 feet from the ground to the

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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.

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.

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.

Stencil the CCTV camera number on both the front and rear doors of the Type 336A CCTV cabinet or the adjacent traffic signal controller cabinet where there is no separate CCTV cabinet. Place the CCTV camera number below the signal inventory number on traffic signal controller cabinets. Use 3-inch black characters.

Install new Type 336A CCTV camera cabinets as shown in the Plans. 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.

Ensure each camera is configured to operate its heater and blower.

C. Shared CCTV/Traffic Signal Cabinet

At locations shown in the Plans, mount the CCTV Ethernet surge protection, CCTV power injector and CCTV cabling in a traffic signal cabinet. Using a Category 6 Ethernet patch cord connect the Ethernet edge switch to the Power Over Ethernet injector. Using a Category 6 Ethernet patch cord connect the Power Over Ethernet injector to the Ethernet surge protection device. Connect the Ethernet surge protection device to the Category 6 Ethernet cable to the camera.

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At locations shown in the Plans, replace existing base mounted NEMA CCTV cabinets as follows:

- Remove cabinet and install new base extender
- Install new Type 336A base mounted CCTV cabinet on base extender
- Extend the electrical service conductors from the meter service
- Install new surge protection, CCTV power injector, interconnect center, Ethernet edge switch and CCTV cabling

1. Camera 12 (S. Main Street at E. Davis Street)

Camera 12 is mounted on the parapet wall of the LabCorp Building at the corner of S. Main Street at E. Davis Street. Replace the existing fiberglass NEMA cabinet with a NEMA 4 metal cabinet. Mount the cabinet as close as possible to existing location without protruding above wall or touching the roof membrane. Do not modify any or the decorative brick work.

Replace the electrical outlet and power wiring in the existing cabinet. Ground the cabinet to the 120-volt ground.

Install surge protection devices compatible with Ethernet communications. Replace the video and radio cabling. Install the camera and radio power injectors in the proposed cabinet. Install Category 6 Ethernet cabling between each device and its power injector and to the Ethernet edge switch.

E. Power Service

For Type 336A CCTV cabinets, provide 120 VAC power from an existing, modified or proposed electrical service as shown on the Plans. For locations where a power service is shared with by adjacent CCTV and signal cabinets, modify the existing electrical service or provide a new electrical service to provide separate breakers for the respective cabinets 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 locations identified in the Plans where there no separate CCTV cabinet is being installed, obtain 28VAC power from the adjacent traffic signal controller cabinet.

F. Grounding

Ground the CCTV pole and subsystems in accordance with the special details in the Plans.

G. Category 6 Cable

Using a Category 6 Ethernet patch cord connect the Ethernet edge switch to the Power Over Ethernet injector. Using a Category 6 Ethernet patch cord connect the Power Over Ethernet injector to the Ethernet surge protection device. Connect the Ethernet surge protection device to the Category 6 Ethernet cable to the camera.

H. 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. Install surge protection devices in the CCTV 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. Install surge protection devices in the CCTV in accordance with the special details in the Plans.

I. 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 can 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*, 6th Edition, and can support a minimum camera unit dead load of 45 pounds.

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.

1. Camera 12 (S. Main Street at E. Davis Street)

Replace the existing camera mounting arm. Mount the new arm as close as possible to the existing location with the camera arm extending out at diagonally from the corner of the building towards the center of the intersection. Ensure the camera arm extends beyond the edge of the building. Mount the radio on the camera arm and aim the radio to the corresponding radio at S. Main Street and Maple Avenue.

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Coordinate the naming of CCTV devices in the database and for the onscreen labeling of cameras on video monitors with the City of Burlington.

K. GPS Coordinates

Provide real world coordinates for all junction boxes and equipment cabinets installed or utilized under this project.

Comply with all requirements of the “Junction Boxes” section of these Project Special Provisions.

33.4. 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 power/Ethernet 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 it with the fiber-optic communications equipment as they are incidental to furnishing and installing the CCTV camera assembly and the CCTV cabinet.

CCTV cabinet (type) will be measured and paid as the actual number of each type CCTV cabinets 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 as shown in the Plans as such work will be incidental to furnishing and installing the CCTV cabinets.

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 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 and cabinets 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 incidental to furnishing and installing CCTV camera assemblies and CCTV cabinets.

Installation of Ethernet edge switches will be measured and paid for in accordance with the “Communications Hardware” section of these Project Special Provisions.

Installation of cabinet base extenders will be measured and paid for in accordance with the “Cabinet Base Adapters and Base Extenders” section of these Project Special Provisions.

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Payment will be made under:

Pay Item

CCTV Camera Assembly

CCTV Cabinet (336A)

CCTV Cabinet (NEMA)

Pay Unit

Each

Each

Each

34. CCTV SOFTWARE AND INTEGRATION

34.1. DESCRIPTION

Update the Department's existing VideoPro CCTV system software package on the existing video server and update the configuration to add the additional cameras, network video recorders, and video devices provided in this Project. Furnish and install VideoPro on the City Transportation Department server.

Furnish and install video wall management software to operate the new video wall in the TCC.

34.2. MATERIALS

A. VideoPro

Provide the latest version of Protronix VideoPro software that is necessary to maintain the video sharing requirement with the TRTMC.

B. Video Management Software

Provide Vendor-supplied configuration software to setup, configure and operate the cameras in the field. This software shall include features to set communications IP addresses and protocols, define camera ID lens control, digital signal processing (DSP) settings, azimuth configuration, presets, streaming profiles, and privacy zones. The software shall manage firmware upgrades to all cameras. The software shall permit the user to copy configuration settings to multiple cameras. The software shall include the ability to backup and restore camera settings. The software shall manage user accounts and passwords for the cameras. 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.

Provide software to operate, view and provide pan-tilt-zoom control of any camera from a workstation using keyboard, mouse, and joystick control. Provide software that program tours of one or more cameras. Provide software that generates alarms when errors or tampering occurs. The software shall permit the control of a network video recorder to selectively record cameras.

Provide the software with a mobile application for smartphones that allows authorized users to select, view and control any camera in the system.

C. Video Wall Software

1. General

Provide a Commercial Off the Shelf (COTS) video wall software that provides the following features:

- Windows-based,
- Wall configuration,
- Manage and select display sources (CCTV, workstations, TV tuner, and applications),
- Share content to remote display outside the TCC,
- System management (user rights, database configuration, devices, user authentication), and
- Wall control.

U-6015**ITS-226****Alamance County****2. System Management**

The system administrator shall be able to:

- Establish user account,
- Manage user privileges and access rights to devices and content,

3. Operating System And Application Compatibility

The video wall management software shall be compatible with Windows 10 Professional, Windows Server 2016 standard edition, Windows SQL Server 2016 standard edition, Microsoft Office 2016.

Provide integration with Active SDK, IP Socket, Serial Communication, Microsoft Access, and Microsoft.Net. Provide integration with the following browsers: Explorer, Chrome, Safari, Firefox, and Mozilla.

4. Security

Comply with Federal Information Processing Standards (FIPS) encryption as follows:

- 256-bit SHA1 has encryption for passwords
- 192-bit TripleDES encryption for communications with devices
- 256-bit encryption with client agent applications
- Strong password protection for database files
- Strong user password enforcement
- Role based security policies
- Real-time logging of user activities

5. System Configuration

The system software shall be configured with the following major components (paid separately):

- Video display software server (1),
- Display servers (2),
- Video wall monitors (10),
- Small form factor computers (3) that will decode display content for use on monitors (5) in the Public Works Building that are not in the Traffic Control Center,
- Ethernet communications network in the building, and
- Ethernet communications over fiber-optic cable to field devices.

The video management software shall communicate over Ethernet communications to remote small form factor computers to provide content to the remote monitors in the Public Works Building.

The software shall allow users to create windows and layouts of video wall content. The software shall permit the user to add, resize, move or delete windows. The software shall permit to share content to more than one display.

The software shall allow users with appropriate access rights, to manage content to remote devices.

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The software shall accept and integrate alarms and events from the signal system software and allow the user to configure how and where they are displayed. Alarms can be displayed on any combination of displays, desktops, and specific users.

Provide full KVM control of video wall servers.

The software shall permit a user to record and playback display content.

The software shall obtain content from:

- IP based HD CCTV cameras (H.264 encoding at 30 frames per second, MPEG-2, MPEG-4, H.265 and MJPEG)
- OPF Cable TV tuner
- Workstation screen content
- ITS applications on the network
- Internet based content

The software shall consist of the following components:

- Control Software: Client-based software based by the user to control/manage/ configure the video wall management system
- Client Capture Software: Client workstation, captures content from client workstations, display screens, and application windows for sharing anywhere on the network,
- Display Services: Server software to drive any shared display
- Monitoring Services: Administrative server-based software to manage devices, processes, send email, SMS, and SNMP alerts, remote monitoring of system.

34.3. CONSTRUCTION METHODS

A. VideoPro

Protronix's VideoPro is the existing regional video sharing and distribution system that controls the existing CCTV cameras and video monitors at the TCC. The software utilizes a client-server architecture. Modify the Protronix CCTV central software configuration at the TCC to display and map the CCTV devices from the network so that the CCTV video can be displayed on the new monitors and display devices in the TCC and at the City Transportation Department.

Install VideoPro on the City's workstations and laptops. Update the existing VideoPro server in the TCC and TRTMC and edit the existing device databases for the new cameras. All additions and edits to the databases must be viewable by all current users of the system.

Update the existing VideoPro server in the TCC for the new video wall monitors, IP cameras, network video recorder, and PTZ joysticks.

Configure administrative and user VLANs for the VideoPro servers in the TCC Ethernet core switch to enable video sharing.

Integrate the VideoPro software to allow for:

- Remote users (NCDOT TRTMC) to view and control all CCTV devices monitors connected to the TCC through the Ethernet network and the CCTV Control GUI

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furnished as part of this software such that a user in a the TCC or TRTMC can switch, view, and control cameras.

- City staff to control the network video recorder to record, playback and write to DVD video streams. Playback could be on a workstation monitor or wall monitor.

B. Video Management Software

Install the Vendor-supplied configuration software to setup, configure and operate the cameras on each laptop supplied with the project. Install the video management software on each client workstation and the video management server in the Project. Configure user rights and permissions upon coordination and approval by the City Traffic Engineer.

Configure all the cameras in the project in a tour for display at the Burlington Police Department Dispatch Center and the Alamance County 911 Center on their respective existing monitors and H.264 decoders. Do not provide control (PTZ) rights for Burlington Police Department Dispatch Center and the Alamance County 911 Center.

C. Video Wall Software

Install the software and servers in a clustered configuration bound to the City of Burlington's Active Directory. Utilize network single sign-on feature. The single sign-on shall provide access to network resources, security features, validate domain account privileges.

Work with the City staff to configure the user rights for each employee authorized to access the video wall system. The user rights will address access to specific source and destination devices, and content.

Configure the client control software on each workstation for the user interfaces. Configure user interface for each user.

Configure system to automatically backup configuration and database files

Configure the monitoring services software to identify errors and send alert messages. Errors will include, but not limited to, device failures, devices offline, stopped services and processes, video system communication failures, etc. Configure the monitoring services software to allow remote start, stop and restart.

34.4. MEASUREMENT AND PAYMENT

CCTV software (Modify) 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, install the VideoPro software on City Transportation Department server, complete system integration, and provide a complete operating system.

Video management 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 install video management software, install the appropriate software on City Transportation Department workstations and servers, complete system integration, and provide a complete operating system.

Video wall 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

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to install video wall software, install the appropriate software on City Transportation Department workstations and servers, complete system integration, and provide a complete operating system.

No separate measurement and payment will be made the Vendor supplied configuration software and video management software as such work will be incidental to furnishing and installing the CCTV cameras.

Payment will be made under:

Pay Item

Pay Unit

CCTV Software (Modify)

Lump Sum

Video Management Software

Lump Sum

Video Wall Software

Lump Sum

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35. SIGNAL SYSTEM SOFTWARE

35.1. DESCRIPTION

Furnish and install traffic control system software for the following applications:

- Distributed processing system software
- System support software
- Signal system timing plan database conversion software
- Maintenance management system software
- Install the following software as furnished by the Engineer:
- Local controller firmware (latest IP version of NCDOT's ASC/3[®] 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.

35.2. GENERAL REQUIREMENTS

A. Signal System Software

1. 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 ASC/3[®] 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[®] 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.

a) 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.

b) Software License

Provide a perpetual, irrevocable software license to the Department and the City of Burlington 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 by the City of Burlington Transportation Department, 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 Burlington-Graham 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 three 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 Burlington for software that may be used. Example: report-configuring, diagnostic, or monitoring software.

c) Operating System

The operating system for all server software provided under this project shall be Microsoft Windows Server® 2016, Microsoft SQL Server 2014 or newer. The operating system software for all workstations and laptops shall be Microsoft Windows® 10 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® 2016 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.).

The software shall support the use of Microsoft Active Directory.

d) NTCIP Standards

The software shall use NTCIP Standards 1201 and 1202. The central to field device communications shall utilize NTCIP 1202.

e) Software Updates

Furnish the latest version of software described in this section of the Project Special Provisions at the time of installation. Provide a means to automatically update the system software to all workstations and laptops in the network after new versions are installed on the server. Each time a user logs into the software shall check for newer client updates. The user shall have the option to automatically install or defer to later with no further user action.

B. Functional Requirements

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 2070LX controllers utilizing the local controller software to be deployed under this project.

The system software shall communicate directly with the local intersection 2070LX 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 ASC/3® 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 2070LX 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 350 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.

3. Power Failure

Interface system software with the uninterruptible power supply. Upon detection of a loss of power, the system software shall notify the operator.

The traffic control program may suddenly stop execution for various hardware or software reasons. In such event, alarms shall alert the operator as to the problem and circuitry shall ensure against the transmission of erroneous data by the field communications subsystem.

In the event that the operator determines that the operation of the system is improper, he/she shall be able to immediately force all system intersections to an off-line, or a time-base 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 backup application server, ITS communications server or the communication system. This backup shall be accomplished by means of time-base 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.

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The system shall be capable of automatically sending alphanumeric messages (SMS – text messaging) to cellular telephones, smart phones and email addresses upon detecting problems with the system or from any device. Malfunctions notifications shall also appear as a pop-up alarm, or similar notification approved by the department, on each workstation logged into the system. An audible alert shall be associated with a pop-up alarm, and configurable by the user.

The visual pop-ups and audible alerts shall be configurable to stay up for a specified time period or to stay up indefinitely until closed by the user. Malfunction notifications shall consist of at least three (3), user configurable, priority levels, to include low priority, medium priority and high priority alerts. Acknowledgements of incoming malfunction alarms shall be required for all medium and high priority on-screen notifications. Low priority alarm notifications shall not require acknowledgements.

Malfunction alerts shall be sent via text (SMS) or email notifications and shall be configurable by TOD/DOW, allowing recipients to be selected based upon severity or priority of event and to issue text/email messages sent to multiple devices or addresses.

Notifications shall allow a confirmation to assure that the malfunction has been acknowledged. If no acknowledgement is received upon expiration of a user programmable time-out period, subsequent notifications shall be configurable to be sent to alternate devices.

The system shall log all malfunction notifications, retries, and acknowledgements with time and date stamps. The first acknowledgement shall be recorded; all others shall be ignored.

8. Field Communications

Within the Burlington-Graham 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. The field communications will also include two Ethernet radios operating at 2.4 Ghz.

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 Department 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.

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 (ASC/3[®]).

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.

13. System Graphics

These dynamic condition maps shall provide a simple mechanism for system navigation, presentation of status, and selections within the user interface.

Backgrounds for the system-wide graphic shall be capable of containing commercial vector images of geographically accurate maps or scanned images. These images shall be compatible with common GIS packages such as ARC GIS. 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.

a) 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,

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intersection phase status). Intersection status and roadway links shall change color dynamically based on user definable color selection.

Intersection phase status (green, yellow and red) shall be displayed in real-time on the intersection phasing icon. The intersection control status shall be displayed as the background color on the intersection plan icon. Intersection plan information shall be displayed as a number on the intersection plan icon.

Link status shall be shown as different (user defined) colors for differing traffic flow conditions.

The system display shall be capable of being dynamically sized by a workstation user. Resizing the window shall not reduce the amount of data displayed on a workstation monitor and the same aspect ratio shall be monitored as before the resizing.

b) Control Section Map

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

The control section map shall provide a dynamic display of the signal system, including landmarks, streets, signalized intersections, interstate highways (if applicable), railroads (if applicable), system detectors, system detector actuation. Labels for these items shall also be displayed. All labeling shall be approved by the Engineer. The graphic shall also dynamically display the status of the controllers in the sub-area (e.g., coordination, emergency vehicle preemption, railroad preemption transition, free operation, flashing, failed, intersection phase status). Volume and occupancy levels shall be displayed as color bars on the map. Intersection phase status (green, yellow, and red) shall be displayed in real-time using arrow icons. Link status shall be shown as green for free flow or near free flow conditions. Yellow shall be shown for moderate congestion or transition conditions. Red shall be shown for congested conditions, and flashing red shall be used to indicate severe congestion or major delays. The control section display shall be capable of being dynamically sized by a workstation user. Resizing the window shall not reduce the amount of data displayed on a workstation monitor, and the same aspect ratio shall be monitored as before the resizing. The control section map graphic shall include a user-definable control section map title. North shall either be at the top or right side of the monitor when displaying a control sub-area. Vertical and horizontal scroll bars may be provided if the size of the sub-area is such that it cannot be displayed on a monitor at a scale (as determined by the Engineer) that is adequate for viewing by the operator. 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.

c) 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.)
 - 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 ASC/3[®] 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.

14. 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:

15. 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.

16. 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.

17. 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.

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- **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.

18. 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.).

19. 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.

20. 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.

21. 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

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plans for ASC/3[®] 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.

22. Phase Movements

The system shall monitor each independent movement of up to sixteen (16) phases, for the quad-ring ASC/3[®] controller. This monitoring shall include force off points, and permissive periods for each phase.

23. Clock Updates

Following each update of the clock on the communications server, the system shall update the clocks in each local controller and the distributed system server.

The system shall be able to receive clock updates from an external time synchronization source. Clock updates shall be demonstrated and approved by the Engineer. The system shall broadcast, unicast, or use a combination of both to send time updates to controllers on a user-configurable schedule. The user shall be able to configure how often the broadcast is performed, the hour at which the broadcast begins, the number of times the broadcast is repeated, and the time period between repeated broadcasts.

The system shall provide a means of monitoring the time drift of clocks on controllers, provided the controller supports this functionality.

For each controller that supports this functionality, the system shall allow checking controller clock times on a user-specified interval.

The system shall display the time the controller's clock was last checked and the difference between that controller clock and the system time reference.

The system shall also provide the ability to automatically synchronize a controller's clock if the time drift exceeds a user-specified threshold.

The system shall provide a means to synchronize controller clocks with the system time reference upon user command.

This functionality shall be provided in addition to the scheduled time broadcasts previously specified.

24. 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.

25. 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
- Traffic responsive operation
- Holidays
- Special Functions (supported by local controller type, including one-time events)

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.

a) Time-of-Day Operating Mode

The Time-of-Day/Day-of-Week/Day-of-Year (TOD/DOW/DOY) mode of operation shall allow the advance scheduling of the signal plan and timing plan to be implemented in each section. TOD/DOW/DOY scheduling shall be performed based on the schedule data stored locally at the controller and updated by upload/download operations.

b) Coordination Plan and Scheduler Resolution

Events in the scheduler (both turn-on and turn-off) shall be adjustable in minimum increments of one minute.

c) 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.

d) 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.

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.

26. 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.

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All data items entered from any workstation shall be tested for data type (numeric or text) and allowed range. All string data items shall be tested to ensure that they do not exceed the allowed length. The program shall not terminate because any data item is incorrectly entered. When errors or potential errors are detected, the program shall either display a specific diagnostic message on the screen or shall give an audible alarm and shall place the cursor in the proper field. In any case, the system shall allow the operator to re-enter the item. Prior to or simultaneously with reentry, the diagnostic message, if any, shall be erased.

Whenever a logical grouping of data (such as a full screen or the complete database file) has been entered or edited satisfactorily, that data shall be written to the proper record. This may take place upon return to the main menu or, alternatively, it may take place as the entry or editing of each distinct file is ended.

The screen organization and data entry/edit method shall enable the operator to use all functions without the need to use reference manuals or cards. The software shall minimize the use of mnemonics to interface with the user on the screen, in printed reports, and in the system's documentation or worksheets. Only mnemonics consisting of Engineer approved traffic engineering abbreviations and other straightforward abbreviations shall be acceptable.

All field descriptions and inputs shall be simple and all text shall be in simple English and common traffic engineering terminology. It shall not be necessary to perform any decoding to read the information. All necessary field descriptions shall be specifically and discretely provided on the same display screen as they are needed.

a) Copy Facility

It shall be possible to copy an entire controller database (except for intersection name and identification number) from one controller database to another controller database.

It shall be possible to copy from within the database software all logical segments of the controller database to other like segments of the same controller database using menu commands (IE Timing Table page 1 → Timing Table page 2).

It shall be possible to copy from within the database software all logical segments of the controller database to other like segments of another controller database using menu commands (IE Timing Table page 1 [intersection 100] → Timing Table page 2 [intersection 101]).

It shall be possible to copy from one cell within a database table to another like cell in the same table (IE min green phase 1 to min green phase 2).

b) Upload/Download of Database

Any workstation shall provide for uploading (copying) the database, and logical segments thereof, from any 2070LX controller. The software shall similarly provide for downloading (copying) the database, and logical segments thereof, to a 2070 controller using ASC/3[®] 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.

c) 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.

27. Reports

The system shall generate a number of pre-configured reports. The database software shall permit the operator to use structured query language (SQL) to retrieve data and 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

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.

28. 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 three 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. Privileges can also be defined with interjurisdictional rights. 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
- Traffic responsive
- Time Space Diagram
- AEM

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- 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

29. Help

The signal system software shall have comprehensive, online help screens. The help screens shall be context sensitive, providing information specific to the highlighted fields or windows displayed.

C. Local Controller Firmware

The Engineer will provide local controller firmware that is the latest version of the NCDOT-approved controller software ASC/3 at the time of burn-in. Request the software from the Engineer a minimum of five business days prior to burn-in. The controller firmware Econolite ASC/3 controller shall be compatible on all variants of Safetran 2070-LX configurations as well as the following other controller manufacturers' configurations:

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| Component | Manufacturer | |
|----------------------|-------------------------------------|--|
| | McCain | Intellight |
| Field I/O | M44021 Rev. B | 2070-2A Rev. H1 |
| Front Panel | M44017 Rev. A | 2070-3B Rev. E1 |
| Power Supply | M34020 Rev. A5 | 2070-4A 300101-0001 |
| 2070-1C Host Card | M52803 Rev B | 2070-1C Rev. D2/D4* |
| 2070-1C Engine Board | M52284 Rev A | 2070-1C Rev. G1 |
| 2070-1C Linux Kernal | 2.6.22 | 3.14 |
| Installed Software | ATC Menu and No Traffic Application | App Manager and No Traffic Application |

D. System Support Software and Devices**1. Devices**

Furnish one (1) Garmin eTrex Legend GPS Receiver, or approved equivalent, with Cigarette Lighter Adapter (#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.

E. Signal System Timing Software

Provide software to convert timing plan data produced with Synchro 10 to import into the signal system software database for implementation in the field.

F. Maintenance Management System Software

Provide maintenance management system software to manage signal system assets, track maintenance history, create and schedule work orders. Provide a commercial-off-the-shelf software that is fully integrated with the signal system software

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Provide a client/server architecture. Provide a maintenance management system software compatible with the following software and operating system:

- Server Operating System: Microsoft Server 2016, Standard Edition,
- Database Software: Microsoft SQL Server 2016, Standard Edition,
- Workstation/Laptop Operating System: Windows® 10 Professional, 64-bit, latest version

Provide a database editor to enter and edit asset data and asset attributes.

Provide a web server to support mobile applications.

The software shall support, at a minimum, the following types of locations: signalized and unsignalized intersections, CCTV, DMS, count station, shop inventory, and vehicles.

Provide predefined asset attribute types, including name, service date, manufacturer, model, description, owner/maintaining agency, serial number, and warranty date. Provide a means, for users with permissions, to create attribute types. The user created asset types can be drop down lists, checkboxes, user definable, date/time, currency, decimal and integer fields. A user definable asset can be a downloadable file.

The software shall include an inventory tracking feature to track active and spare equipment and parts. Provide a means to allow users to move asset's inventory locations, such as from the signal shop to a particular intersection.

The system shall track in-service times, failure histories, repair histories, changes to locations, preventative maintenance activities as well as depreciation and replacement values of individual assets.

2. Preventative Maintenance

Provide a means for a user to define activities as preventative maintenance (PM) tasks. Provide a means for a user to plan preventative maintenance activities by location, type, asset type, schedule frequency, and assigned technician. The system shall permit users to manage preventative maintenance activities by defining, scheduling and track those activities. The system shall provide a means to group PM activities and schedule together. For grouped activities, a user shall be able to check off specific activities completed

Provide a variety of input means appropriate to the work type to record completed work. These methods shall include user defined check-boxes, pull-down lists, single and multiline comment fields.

Provide the ability to see what activities at a specific location that have been complete.

3. Work Orders

Work orders are defined as citizen or staff generated requests to either diagnose and repair a problem from a staff or citizen request. The system shall provide a work order status window, displaying work orders with information describing the problem, the contact information, and the status of the work order.

A graphical map shall display the color-coded status of work orders currently open. The color status shall denote new work order that has been created and assigned to a technician or

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group but has not been acknowledged or accepted, work order assignment has been accepted by a user, work order has been started but the technician is not yet on site, technician is on site and work is underway on the work order is completed, but follow-up work is needed.

Provide a real-time display with the event details, along with a time and date stamp and any status information.

Provide an alert window shall provide a means by which users can acknowledge, un-acknowledge, and close individual critical and warning alerts. All acknowledgements, un-acknowledgements, and closures shall be time and date stamped with the user's credentials upon change of status.

Provide a means for a supervisory to reassign a work order to a different. The system shall allow work orders to be prioritized as "High", "Normal" or "Low". The system shall provide automated work order notifications.

Provide the ability to send an SMS text message and/or emails to individuals or groups of individuals, informing them that a work-order has been created and assigned to them.

Users shall be able to acknowledge a work order that has been assigned to them.

The system shall provide an escalation mechanism whereby work orders that are not acknowledged within a user specified timeframe will be pushed to additional users to make sure problems receive the desired attention.

The maintenance management system shall generate work orders using alarm notifications originating from the signal system software. These alarm conditions may include: Flash, communications failures, detector failures and other notifications as provided through the ATMS.

4. Mobile Device

The software shall provide access by mobile devices. The software shall support the users of Google Chrome, Firefox, Safari, and Internet Explorer browser applications.

The software shall require a user login and password. All data entries shall be automatically updated in the central database. Updates to the server shall include date, time, user and location.

The mobile application shall have ability to log activities and automatically update the server when users perform the following activities:

- Reassignment of assets and/or inventory from locations such as signal shop, vehicles and specific locations,
- Acknowledgement of assigned work orders,
- Arrival at a location of a PM task or work order
- Work orders and tasks/activities completed
- Preventative maintenance activities/tasks at a location
- Reassignment of a work order to another technician

Through the mobile application the user shall be able to download electronic documents such as plans images, etc.

The software shall provide a means to view open work orders and scheduled PM activities. Provide the software with the ability for users to select and assign open work orders and PM activities. The software shall permit the creation of new work orders.

Provide the ability to update the inventory tracking through mobile devices. Provide a means for user through a mobile device also to provide text comments on preventative maintenance activities. The mobile application shall permit a user to record all PM activities performed.

5. User Interface

a. General

The main application window shall be divided into multiple user-relocatable rectangular areas. Provide drag and drop status windows into one of these areas. Upon being dropped, or docked, the window shall automatically resize to fill the area. It shall be possible to click on the title bar of a docked window and drag it out of the container at which point it will become a free-floating window. It shall also be possible to float or to un-dock windows by clicking a button in the window's title bar.

It shall be possible to drop multiple windows into any area. When this occurs, the area shall provide a tabbed layout for the area with a tab for each contained window such that clicking on a tab will bring the associated window into view in the container. It shall be possible to open multiple application windows. It shall be possible for the user to select different arrangements or numbers of areas in the main application windows. It shall be possible to change the size of areas by clicking and dragging the border between container areas.

A user's main window configuration shall be restored to its last known state when the user logs into the system. A user may also opt to have the system restore to a default setting instead of the last known display configuration.

It shall be possible for a user to save and name the preferences allowing other users to open and view the same display content from another workstation.

b. Main Map Display

The system shall incorporate an area-wide map as a component of the main graphics display. Maps may be docked in any or all available areas. Any maps docked into multiple containers shall be refreshed simultaneously. The map displays shall have pan and zoom capabilities. Zoom level ranges shall be configurable.

Users shall be able to save a map's pan and zoom levels to a named map that may be loaded again later. Users shall be able to specify a current map, with its pan and zoom levels as a default map that will be loaded any time a new map is opened for viewing.

At each zoom level range, the display of different dynamic status and real-time status data shall be configured.

It shall be possible for a user to interactively enable or disable the display of defined map layers.

Provide a system that can utilize multiple map sources for the base map. These sources shall include, but not limited to:

- Navtec,

- ESRI shape files,
- Bing Maps,
- WMS Maps (NC OneMap aerial photography)

An integrated map editing tool shall be provided to allow users to place icons and symbols on the map to represent various types of ITS and other assets and locations on the map for the purposes of monitoring and accessing information about the locations and any assets and work order status information related to the location.

The system editor tool shall allow a user to place a special icon on the map that will be used by the system to indicate that a work order is currently active at a specific location

The system shall support a variety of locations and provide icons related to the different types of locations. At a minimum, location types shall include:

- Signalized intersections
- Non-signalized intersections
- CCTV locations
- DMS locations
- Count station locations
- Equipment storage facilities
- Vehicles
- Manufacturers
- Maintenance shops

The system shall periodically update the status of work orders and supported ITS equipment on all map display. Work order status shall be indicated by a color-coded flags denoting: new work order that has not been acknowledged or accepted, work order assignment has been accepted by a user or work is underway on the work order.

6. Scheduling

Provide a graphical calendar to manage preventative maintenance activities. Provide user-selectable views (day, week, month, etc.). Permit a user to select and edit activities through the calendar tool. A supervisory user shall have the ability to establish the on-call technician schedule for assigning work. The on-call scheduler shall provide different views based on individual days, weeks or months. Users shall be able to add on-call schedules from the calendar tool, selecting either an individual user or a user group for the schedule. The scheduler shall provide a mechanism allowing the user to select both start and end dates and times as well as a recurrence for a new schedule.

Provide the ability to schedule activities by time-of-day and day-of-week, and shall include means by which the activities can be called with the following frequencies: daily, weekly, annually, seasonally. and holidays.

When creating or modifying a schedule, users shall be able to designate an on-call plan as either a regular schedule or as an exception.

7. Reports

The system shall include user standard or user-define reports and administrative reports restricted to specific users.

a. User Reports

Provide the following user standard reports in the maintenance management system:

- Asset Summary: Total number of assets and inventory types.
- Pending PM Status: PM tasks that are coming due or that are past due.
- PM Completion: PM tasks have been performed, tasks started and completed dates by staff
- Asset Aging and Status: Summary report listing age and current status of all assets
- Asset and Inventory Counts: Summary report listing inventory of assets both in stock and deployed to locations or on vehicles.
- Asset History: Lists the history of installation and repair of as specific asset
- Inventory Stock Levels: Summarizes the current level of inventory not deployed for use in ordering spare materials
- Work Order Status History: Work orders have been performed, tasks started and completed dates by staff
- On Call Schedule: Defines the technician(s) assigned to on-call or standby duty.

Design the system to allow users to select report parameters and to customize report filtering and data selection. Provide a means to save specific report parameters to a named report that the user can run again later without re-selecting the parameters. Permit user reports to be tagged as “private” or “public” which determines whether other users can access the report. Provide a method to run standard or user-defined reports automatically or manually.

Report output formats shall include, at a minimum, PDF, Microsoft Word and Microsoft Excel formats.

b. Administrative Reports

Provide the ability to manage all work orders, preventive maintenance and on-call schedules, assets, user login credentials, system maps and configuration parameters from one central location.

Each user shall have a unique user name and password. assigned by the system administrator. The username and password may be the same as that used by the operating system of the laptop workstation or mobile device, but shall be required to be entered for each new system session.

The system shall allow the system administrator to define and assign for user and group privileges. Operating privileges include the following:

- System Administrator Configuration: Full access to all system functions,

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- User Profile Configuration: Full access or read-only access to functions below (at a minimum), regardless of device type,
- Database Configuration: Access to modifying or editing segments (all or portions) of existing device databases,
- Database Maintenance: Backup, restore, archiving, etc.,
- Database Report Creation and Generation: Includes standard and custom reports,
- Map Display Characteristics: Base map controls and intersection display editing,
- GUI Settings and Editing: Modifying desktop settings, and
- Communications Configurations: Modifying communications to the field.

35.3. 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 Burlington-Graham 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 Burlington and NCDOT shall be identified as the registered owner of all software.

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

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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 Firmware

Install NCDOT-furnished local controller firmware on all new controllers. Use the latest version available at the time of installation as directed by the Engineer. Request local controller firmware from Engineer a minimum of one (1) week prior to use of software during burn-in period.

The Contractor shall demonstrate porting and functionality of Econolite ASC/3 controller software on the controller vendors listed in Subsection 35.2.C of these Project Special Provisions. This demonstration will be required on all three configurations of controllers regardless of the manufacturer that is selected for the Project.

All controllers in the final signal system shall have identical local firmware.

D. System Support Software and Devices

Install software, devices, productivity software, and utility software on all workstations and laptop computers provided with the project.

E. Signal System Timing Database Conversion Software

Install software on the workstation and laptop in the TCC to convert the Synchro timing database conversion software.

F. Maintenance Management System Software

Install maintenance management system software server application on the signal system software primary and backup applications servers. Install the client application on all workstations and laptops included the Project. Setup the asset management database with all of the NCDOT and Cities of Burlington and Graham traffic signal assets.

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35.4. TESTING

A. General

Provide the following tests and demonstration of the system software:

- System Demonstration Test, if required (see below)
- System Operational Test (as called for in “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 Burlington-Graham 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.

35.5. MEASUREMENT AND PAYMENT

Signal system software shall be measured and paid as a lump sum, including furnishing, installation and testing, and all materials, 3rd party software for reporting, equipment, labor, tools, storage, shipping and incidentals necessary to install the software, complete system integration and provide a complete 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, including furnishing and installation, and all materials, equipment, labor, tools, storage, shipping and incidentals necessary to install and configure the software and provide a complete operating system. Payment for this item will be made as follows: 100% of the lump sum price upon delivery, installation and testing of the software into the appropriate hardware. GPS receivers will not be paid for separately but will be incidental. No payment will be made for providing software license and source code as required in these Project Special Provisions.

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Signal timing database conversion software shall be measured and paid as a lump sum, including furnishing and installation, and all materials, equipment, labor, tools, storage, shipping and incidentals necessary to install and configure signal timing database conversion software. No payment will be made for providing software license and source code as required in these Project Special Provisions.

Maintenance management system software shall be measured and paid as a lump sum, including furnishing and installation, and all materials, equipment, labor, tools, storage, shipping and incidentals necessary to install and configure maintenance management system software. 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.

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 incidental. No payment will be made for providing software license and source code as required in these Project Special Provisions.

The City of Burlington will purchase the licenses for the distributed processing system software.

The controller firmware will be furnished by the Department, the Contractor will conduct demonstration test described in these Project Special Provisions and install the firmware on each controller in the project. The cost of installation of the firmware will be included in the cost of the controller installation.

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

Payment will be made under:

| Pay Item | Pay Unit |
|--|-----------------|
| Signal System Software | Lump Sum |
| System Support Software and Devices | Lump Sum |
| Signal Timing Database Conversion Software | Lump Sum |
| Maintenance Management System Software | Lump Sum |

36. COMPUTER HARDWARE AND PERIPHERALS

36.1. 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 one computer workstation in the TCC. Install one computer workstation in the City Traffic Engineer's, Signal Shop, and Traffic Supervisor's offices. Install one laptop in the TCC and one laptop in the Traffic Supervisor's office. Install six laptops in the Signal Shop for diagnostic work on the traffic signal and CCTV 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 ITS servers to host the signal system software, communications applications, video decoding and video display.

1. Signal System Servers

Furnish and install signal system servers in the TCC as described in the Plans and these Project Special Provisions. Furnish and install application servers (one primary signal system application server and one redundant signal system application server) and one communications server in the TCC. Connect the servers in the TCC to the Ethernet core switch and to a UPS protected outlet.

2. Video Servers

Furnish and install video servers in the TCC as described in the Plans and these Project Special Provisions. Furnish and install video display servers and a control server to manage and operate the video wall in the TCC. Connect the servers in the TCC to the Ethernet core switch and to a UPS protected outlet.

B. Computer Workstations

Furnish and install computer workstations consisting of a CPU, two or three monitors as shown and listed in the Plans, keyboard, UPS and mouse in the TCC and at the City Traffic Engineer's, Signal Shop, and Traffic Supervisor's offices.

C. Small Form Factor Computer

Furnish and install small form factor workstations for mounting behind and controlling remote video monitors in the Public Works Building.

D. Workstation Monitors

Furnish and install monitors for the workstations and laptops in the Public Works Buildings as shown in the Plans.

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Furnish and install laptop computers consisting of the computer, power supply, carrying bag, and mouse for use by Department staff in the TCC and City Transportation Department staff.

F. 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.

G. UPS

Furnish and install uninterruptible power supply (UPS) units for the Ethernet core switch in the TCC. Each UPS shall also include any ancillary equipment or incidental items, such as required mounting hardware and cabling.

H. Existing Equipment

Remove existing computer equipment from the TCC noted to be removed in the Plans.

36.2. 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 one signal system application server and one backup application server meeting the following minimum requirements:

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- Chassis: Sized for up to eight (8) 3.5-inch hard drives,
- Processor: Dual quad core Intel Xeon E5-2640 v3 or better at 2.6 GHz or greater, QPI, HT, 8C/16T, 20 MB cache, max 1866 MHz, 8.00 GT/s,
- Memory: Minimum 32 GB (4x8 GB) RDIMMS, 2133 MT/s, dual rank, x8 data width,
- Backplane: 1x6 backplane for 3.5-inch drives, expandable to eight drives,
- Power Supply: Dual hot-plug and redundant, separate power cords, NEMA 5-15p to C13 wall plug, 15 amps,
- PCIe Riser: Riser with three x 8 PCIe and one PCIe x16 slots
- RAID Controller: PERC H730, 1 GB NV cache,
- Raid Configuration: RAID 5 for H330/H730/H730P (3-16 drives),
- Hard Drives: 4 x 300 GB, 10k RPM, SAS, 6 Gbps 2.5-inch hotplug, 3.5-in HYB CARR,
- CD/DVD 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,
- Mounting: Slide rails and cable management arm,
- Network: Broadcom 5720 QP 1 GB daughter card,
- Embedded Controller: Out of band management, iDRAC8 Express, integrated remote access controller,
- Operating System: Microsoft Server 2016, Standard Edition with 5 CALs, and
- Database Software: Microsoft SQL Server 2016, Standard Edition, with 10 CALs.

Provide one signal system communications server meeting the following minimum requirements:

- Chassis: Sized for up to eight (8) 3.5-inch hard drives,
- Processor: Dual quad core Intel Xeon E5-2640 v3 or better at 2.6 GHz or greater, QPI, HT, 8C/16T, 20 MB cache, max 1866 MHz, 8.00 GT/s,
- Memory: Minimum 16 GB (4x4GB) RDIMMS 2133 MT/s, single rank, x8 data width,
- Power Supply: Dual hot-plug and redundant, separate power cords, NEMA 5-15p to C13 wall plug, 15 amps,
- RAID Controller: PERC H330, 1 GB NV cache,
- Raid Configuration: RAID 1 for H330/H730/H730P (2 drives),
- Hard Drives: 500 GB (2 x 250 GB), 7.2k RPM SATA, 6 Gbps, 3.5-inch, Hotplug,
- CD/DVD 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: VGA,
- Mounting: Slide rails and cable management arm,

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- Network: Broadcom 5720 QP 1 GB daughter card,
- Embedded Controller: Out of band management, iDRAC8 Express, integrated remote access controller, and
- Operating System: Microsoft Server 2016, Standard Edition and 5 CALs.

Provide one video wall system control server meeting the following minimum requirements:

- Chassis: 2GB cache, DDR3-1, 866 MHz, 72-bit bus at 14.9 GB/s,
- Memory: Minimum 32 GB DDR4 2133 MT/s,
- Processor: Dual processor twelve core Intel E5-2650v4 or better at 2.53 GHz or greater, 2,133 MHz, 8.00 GT/s,
- Power Supply: Hot-plug and redundant, NEMA 5-5p to C13 wall plug, 15 amp,
- Hard Drive Controller: HP Dynamic Smart Array B140i,
- Hard Drives: Dual removable 120 GB, SSD HP 6G,
- Video Card: 512 MB GDDR5,
- Video Adaptor: VGA,
- Mounting: Slide rails and cable management arm,
- Network: 2 x 1 GB,
- Embedded Controller: HP iLO 4, HP Intelligent provisioning, HP SUM,
- Operating System: Microsoft Server 2016, Standard Edition and 5 CALs.

Provide two video wall display servers meeting the following minimum requirements:

- Chassis: 8GB L3 cache, 866 MHz,
- Expansion Chassis: 11-slot PCIe Gen 3 with PCIe x8 host connection
- Memory: Minimum 32 GB (4x8 GB) 2133 MT/s,
- Processor: Dual processor Intel i7 at 3.6 GHz or greater, 2,133 MHz,
- Power Supply: Hot-plug and redundant, NEMA 5-5p to C13 wall plug, 15 amp,
- RAID Controller: PERC H330, 1 GB NV cache,
- Raid Configuration: RAID 1 for H330/H730/H730P (2 drives),
- Hard Drives: Two 240 GB SSD,
- Video Output Card: DataPath DP4 graphics with four DisplayPort ver 1.1,
- Video Adaptor: VGA,
- Mounting: Slide rails and cable management arm,
- Network: 4 x 1 GB,
- Embedded Controller: Out of band management, iDRAC8 Express, integrated remote access controller, and
- Operating System: Microsoft Server 2016, Standard Edition and 5 CALs.

Provide two video management server meeting the following minimum requirements:

- Chassis: 8GB L3 cache, 866 MHz,
- Memory: Minimum 8 GB DDR3-1600,
- Processor: Dual processor Intel i7 at 3.6 GHz or greater, 2,133 MHz,
- Power Supply: Hot-plug and redundant, NEMA 5-5p to C13 wall plug, 15 amp,

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- RAID Controller: PERC H330, 1 GB NV cache,
- Hard Drive: SATA, 1 TB, 256 MB cache, 6 Gbits/s, 7200 RPM,
- Video Output 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: VGA,
- Mounting: Slide rails and cable management arm,
- Network: 2 x 1 GB,
- Embedded Controller: Out of band management, integrated remote access controller, and
- Operating System: Microsoft Server 2016, Standard Edition and 5 CALs.

3. Physical Features

Provide rack-mounted ITS servers for proposed enclosed 19-inch communications rack located in the TCC. 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.

Provide servers with at least one direct 10/100/1000 Base T Ethernet LAN interface. The network connector shall be RJ-45 for Category 6 STP 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 City's Public Works Building.

2. Performance

Provide computer workstations meeting the following requirements:

- Processor: Quad core Intel Xeon E5-1603 v23 processor at 2.8 GHz or greater, 10 MB cache, L2 cache at 1333 MHz,
- Memory: 8 GB DDR3 ECC at 1866 MHz ECC RIMM,
- Network: 10/100/1000 Base T Ethernet PCI Express with RJ-45 connector,
- Hard Drive Controller: Integrated AHCI chipset SATA, non-RAID, six ports (6x6 Gbps SW RAID), SW RAID 0/2/5/10,
- Hard Drive: SATA 500 GB SATA, operating at 7200 RPM,

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- CD/DVD ROM: 8X 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 Cards (2): 2 GB GDDR3 memory, 128-bit, up to 64 Gbps, PCIe 3.0 compliant with four DisplayPort video outputs, maximum digital resolution 4096x2160, with display port to HDMI breakout cables for triple displays,
- Video Output: RGB and DVI connector,
- Desktop Monitor Color: 16.7 million colors,
- Operating System: Windows® 10 Professional, 64-bit, latest version,
- Application software: Microsoft Office 2016 Professional Edition, Enterprise version of Sophos antivirus software, and DVD burning software.

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 four rear and two front USB 2.0 ports (min. six 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 6 STP or 6 UTP for interfacing with the Ethernet core switch.

C. Small Form Factor Computers

1. Functional

Provide small form factor computers that can operate video control software over an Ethernet network and drive remote video monitors in the City's Public Works Building.

2. Performance

Provide small form factor computers meeting the following requirements:

- Processor: Intel i7-7567 processor,
- Memory: 16 GB DDR4 2400 DIMM,
- Network: Integrated 10/100/1000 Base T Ethernet with RJ-45 connector,
- Hard Drive: M.2 SSD
- CD/DVD ROM: 8X DVD+/- RW,

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- Video Output: HDMI 2.0a, USB-c(DP1.2), and
- Operating System: Windows® 10 Professional, 64-bit, latest version.

3. Physical Features

Provide small form factor computers meeting the minimum power requirements:

- Input voltage: 90-135 V at 50/60 Hz, and

Provide small form factor computers meeting the minimum port requirements:

- Keyboard: One USB connection,
- Mouse: One USB connection,
- Audio: 7.1 digital (HDMI mDP), miniature phono jacks – line out, line in, and microphone,
- Ethernet: 10/100 Base T Ethernet with RJ-45 connector, and
- USB Port: At least two rear and two front USB 2.0 ports (min. four total)

Equip all small form factor computers with at least one direct 10/100 Base T Ethernet LAN interface. The network connector shall be RJ-45 for Category 6 STP or 6 UTP for interfacing with the Ethernet core switch.

D. Workstation Monitors

Provide computer and laptop monitors for the proposed computer workstations and laptops in the City's Public Works Building as shown in the Plans.

1. Performance

Provide computer and laptop monitors meeting the following requirements:

- Display: LED, 24-inch, digital flat panel display, DVI-D, HDCP DisplayPorts,
- USB Ports: USB 3.0, one upstream port and three downstream ports,
- Resolution: 1,920 x 1,080 dpi,
- Pixel Pitch: 0.275 mm
- Viewing Angle: 178 degrees vertically and horizontally
- Contrast Ratio: 1,000:1 (typical) and 10,000:1 (dynamic)
- Brightness: 250 cd/m²
- Colors: 16.7 million colors.

2. Physical Features

Provide computer and laptop monitors meeting the minimum power requirements:

- Input voltage: 90-135 V at 50/60 Hz, and
- Output wattage: 825 W.

E. 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 City's Public Works Building, in field cabinets, 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 TCC and over the Internet. Configure the laptop computers for connection anywhere in the network to facilitate maintenance and troubleshooting activities.

- Processor: Intel quad core i7-6820HQ at 2.7 GHz or greater, 3.60 GHz Turbo mode, 3M L2 cache at 1066 MHz,
- Memory: 8 GB (2x4GB) 2133MHz DDR4 SDRAM, Non-ECC,
- Network: Integrated 10/100/1000 Base T Ethernet with RJ-45 connector, 802.11g wireless LAN card,
- WiFi Adaptor: Dual-band, AC 8260, 802.11 A/G/N 2X2 mini card with Bluetooth 4.1,
- Hard Drive Controller: C1, All SATA drives, non-RAID,
- Hard Drive: 256 GB M.2 PCIe NVMe Class 50 Solid State Drive,
- 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: 2 GB GDDR5 memory, 128-bit bus width, 80 Gbps memory bandwidth, MXM 3.1 Type A device type, 3 monitor support, VGA, HDMI and display port support, 4096x2160 maximum external resolution, 128-bit, 993 MHz clock speed,
- Internal Monitor: 16.5-inch HD, LED backlit, 1920x1080,
- Operating System: Windows® 10 Professional, 64-bit, latest version,
- Application software: Microsoft Office 2016 Professional Edition, 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 6 STP to interface with the Ethernet core switch.

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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.

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.

G. UPS**1. Functional**

Provide UPS units that produce uninterruptible power and power conditioning for the computer workstations in the City Transportation Department as well as the computer workstations in the TCC.

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,

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- 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%.

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.

H. Ethernet Patch Panel

Furnish a rack-mountable 48-port Ethernet patch panel for installation in the enclosed 19-inch communications rack inside the TCC. Provide patch panels designed for Category 6 cable and that meets TIA/EIA-568-C.1 Category 6 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.

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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 network so all applications will be fully functional. Install the operating system, software and antivirus software to NCDOT 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 TCC server equipment as shown in the Plans in enclosed 19" communications racks.

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 servers described above in the proposed enclosed 19-inch communications racks located in the TCC as shown in the Plans. 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 TCC. 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 TCC. Perform the following operational tests for each computer component in accordance with the test plans. After the equipment has been installed, perform the following:

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- 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. Small Form Factor Computers

Install the small form factor computers in locations as shown in the Plans. Each small form factor computers shall be used to deliver video content from the video wall system and drive one or two video monitors each. Install the client software packages described in these Project Special Provisions.

Connect the small form factor computers in to the ITS LAN by installing Ethernet patch cords between the Ethernet patch panel and the Ethernet core switch in the TCC. Connect the small form factor computers to its respective monitors(s). Perform the following operational tests for each small form factor computers in accordance with the test plans. After the equipment has been installed, perform the following:

- Connect all components (network cables, video cables, and 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.

E. Workstation Monitors

Install the workstation and laptop monitors with supporting hardware in the Public Works Building. Connect the workstation and laptop monitors to through the respective Ethernet workstation and laptops as called for in the Plans.

F. Laptop Computers

Install the laptop computers with supporting hardware in the Public Works Building. Connect the laptops to the ITS LAN through the respective Ethernet switches.

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.

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Install the KVM assembly in the enclosed 19-inch communications rack with the ITS servers in the TCC. 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.

H. UPS

Install UPS units in the TCC and in the City Transportation Department 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 TCC and City Transportation Department for remote monitoring of the respective UPS units. Configure the remote monitoring to send email alerts. Run the UPS diagnostics.

I. Ethernet Patch Panel

Mount the 48-port Ethernet patch panel in the enclosed communications rack inside the TCC 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.

J. Existing Equipment

Reuse the existing printers in the TCC. 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 Department. Dispose of all other equipment.

36.4. 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 Burlington.

36.5. 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.

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36.6. MEASUREMENT AND PAYMENT

ITS server will be measured and paid as the actual number of ITS servers (signal system application, communications server, video display, video system control and VideoPro) furnished, installed and accepted.

Computer workstation will be measured and paid as the actual number of computer workstations with keyboard, UPS, mouse, operating system and software furnished, installed, and accepted.

Small form factor computer will be measured small form factor computers with 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.

Workstation monitor will be measured and paid as the actual number of workstation monitors, AC adaptors, stands and video cables 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 communication and video cables, electrical cables, mounting hardware, nuts, bolts, brackets, connectors, risers, grounding equipment or surge suppression, as these will be incidental to the pay items for installing ITS servers, small form factor, laptop, workstation computers and KVM switch.

No separate measurement will be made for the Ethernet patch panels as these will be incidental to the pay item for Ethernet cable. Ethernet cable will be measured and paid in accordance with the "Ethernet Cable" section of these Project Special Provisions.

No separate measurement will be made for UPS units supplied with each workstation. The UPS units for workstation computers will be 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 Public Works Building as such work will be incidental to furnishing and installing computer hardware and peripherals and communications hardware at those locations.

Payment will be made under:

| Pay Item | Pay Unit |
|----------------------------|-----------------|
| ITS Server | Each |
| Computer Workstation | Each |
| Small Form Factor Computer | Each |
| Laptop Computer | Each |
| Workstation Monitor | Each |

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KVM Switch

Each

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37. COMMUNICATIONS HARDWARE

37.1. 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 6 Ethernet cable patch panel for the TCC. 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 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.

C. Wireless Access Point

Furnish and install a wireless access point in the signal shop to provide wireless access for the technician laptops.

D. Firewall

Furnish and install a firewall appliance in the TCC 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 the City’s network management software (NMS) for configuration, troubleshooting, security, and system monitoring. The software shall be furnished and installed by the Contractor to manage and monitor the Ethernet core and Ethernet edge switches and the ITS devices. The Contractor shall perform the initial system integration of all core and edge switches installed on the project.

Install the City’s network management software on all relevant communications hardware, including workstations, laptops and servers, as recommended by the manufacturer’s instructions.

F. Uninterruptible Power Supply (UPS)

Furnish and install a new rack-mounted UPS in the TCC to serve the Ethernet core switch, ITS servers and other equipment mounted in the communications racks in the server room. 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.

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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 and Ethernet edge switches with the connector panels of fiber-optic splice centers. 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 and Ethernet edge switch.

Provide SMFO jumpers that are a minimum of three feet in length for Ethernet switches inside controller cabinets, CCTV cabinets, the TCC and the City Transportation Department. Furnish SMFO jumpers that are a minimum of 6 feet in length for the communications racks inside the TCC. Ensure SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

B. Ethernet Core Switch**1. Standards**

Provide an Ethernet core switch that complies with the following IEEE networking standards for Ethernet communications:

- IEEE 802.1AB Link Layer Discovery Protocol (LLDP)
- 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 802.3ad Ethernet Link Aggregation
- IEEE 802.3i for 10BASE-T (10 Mbit/s over Fiber-Optic)
- IEEE 802.3ab for 1000BASE-T (1Gbit/s over Ethernet)
- IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX,
- 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 four (4) 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 6 copper transmission media.

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 four (4) 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.

- One switch 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.

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 6 shielded 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 6 ports only), and power LEDs.

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,

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- 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 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 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 802.1AB standard for Link Layer Discovery Protocol (LLDP)
- 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 802.3ad standard for Ethernet Link Aggregation
- IEEE 802.3ab standard for 1000BASE-T (1Gbit/s over Ethernet)
- IEEE 802.3i standard for 10BASE-T (10 Mbit/s over Fiber-Optic)
- IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX,
- IEEE 802.3x standard regarding flow control with full duplex operation, and
- IEEE 802.3z standard for 1000BASE-X (1 Gbit/s Ethernet over Fiber-Optic)
- RFC 783 – TFTP
- RFC 854 – Telnet Protocol Specification,
- RFC 1112 – IGMP v1,
- 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 SNTP. 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.

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.

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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 6 shielded twisted pair network cables are compliant with the EIA/TIA-568-C.1 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,
- Provide support for the following RMON–I groups, at a minimum:
 - Part 1: Statistics
 - Part 2: History
 - Part 3: Alarm
 - Part 9: Event
- Provide support for the following RMON–2 groups, at a minimum:
 - Part 13: Address Map
 - Part 16: Layer Host
 - Part 17: Layer Matrix
 - Part 18: User History
- 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.

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),

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- 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 6 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).

D. Wireless Access Point

1. Standards

Ensure that the wireless access point complies with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

- IEEE 802.11a
- IEEE 802.11ac
- IEEE 802.11b
- IEEE 802.11g

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- IEEE 802.11n
- IEEE 802.af
- IEEE 802.3at

Ensure that the wireless access point 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.

2. Performance Requirements

Ensure that the Wireless Access Point meets the following minimum performance requirements:

- Dual Band: 2.4 GHz and 5 GHz,
- 2.412-2.462 GHz:
 - 11 channels for 801.11b/g, 802.11n (20 MHz),
 - 7 channels for 801.11b/g, 802.11n (40 MHz),
- 5.18 to 5.23 GHz:
 - 9 channels for 801.1a, 802.11n (20 MHz),
- Multiple input, multiple output dual band,
- Antenna: 2.4/5 GHz, 2.0 dBi, 360-degree horizontal beam width

3. Functional Requirements

Ensure that the Wireless Access Point supports the following features which shall include, but not be limited to:

- Power over Ethernet
- MIMO single radio module with three antenna ports,
- Autosensing uplink 802.3 10/100/1000BASE-T Ethernet

4. Physical Features

Copper Ports: Provide a Wireless Access Point that includes an Ethernet 10/100/1000 Base-T copper ports. Provide Type a RJ-45 copper port that auto-negotiate speed (i.e., 10/100/1000 Base) and duplex (i.e., full or half). Ensure that the port meet the specifications detailed in this section and are compliant with the IEEE 802.3 standard pinouts. Ensure that all Category 6 shielded twisted pair network cables are compliant with the EIA/TIA-568-C.1 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 Wireless Access Point meets the following electrical requirements:

- Input voltage range: 110 VAC to 130 VAC, auto ranging, and
- Input frequency: 60 Hz.

6. Management Capabilities

Ensure that the Wireless Access Point 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:

- Advance Clustering:

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- Wireless network identifier (SSID):
- Security features
- QoS
- Radio Settings
- Wireless Interface Settings
- Guest welcome screen
- Graphic user interface (GUI),

Network Security: Provide a Wireless Access Point that supports/complies with the following (remotely) minimum network security requirements:

- Hardware Assisted Encryption (AES) standard,
- WPA/WPA2 encryption,
- Access control lists,
- MAC Address filtering,
- Rogue access point detection
- Secure guest access,

7. Environmental Specifications

Provide a Wireless Access Point that adheres to the following environmental constraints if located within a climate-controlled environment:

- Operating temperature range: 32°F to 104°F,
- Operating relative humidity range: 10% to 95%, non-condensing.

E. Firewall

1. Standards

Ensure that the firewall appliance complies 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 appliance 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.

2. Performance Requirements

Ensure that the firewall appliance meets the following minimum performance requirements:

- Firewall Throughput: 350+ Mbps.
- Advanced Encryption Standard (AES) VPN Throughput: 100 Mbps.
- 3DES Encryption VPN Throughput: 100 Mbps.

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- 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 appliance supports 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-3 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.
- 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 6 shielded twisted pair network cables are compliant with the EIA/TIA-568-C.1 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.

Ensure that if the firewall appliance requires 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).
- Support SHA-3.
- 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),

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- 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

Modify the configuration of the City's network management software that provides configuration, troubleshooting, security and system monitoring for the ITS communications network.

G. Uninterruptible Power Supply (UPS)

Provide UPS units that produce uninterruptible power and power conditioning for the devices listed below.

Provide external battery units as necessary to achieve the minimum runtime.

1. Standards

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,

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- 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,
- 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.

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.

37.3. 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 6 four-pair shielded twisted pair cabling with solid copper 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 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 Engineer will designate who their network administrator is for the ITS LAN. Upon project completion ensure that the 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 Address, Default Gateway, Subnet Mask and VLAN ID information are assigned as defined in the System Design Report. Ensure they conform to the City's IP schema. Ensure that at a minimum, the switch configuration includes the following features: SNMP, STP, Port Security, all required VLANs, Unicast Routing protocol, and Multicast Routing protocol. Ensure unused switch ports are disabled.

Ensure that the network administrator will be able to manage each Ethernet 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 6 four-pair shielded twisted pair cabling with solid copper 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 TCC as shown in the Plans and provide full Layer 3 functionality. Ensure that the Ethernet core switch communicates with the Ethernet edge switch at the City Transportation Department, firewall, existing and proposed ITS servers, field device cabinets, traffic signal controller and 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 TCC with Ethernet patch cords.

Install and configure the Ethernet core switch to be fully compatible with 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, STP, 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 splice center for redundant communications.

3. 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 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 6 4-pair shielded twisted pair cabling with solid copper conductors and RJ45 connectors.

C. Wireless Access Point

Install the wireless access point in the signal shop on block wall in such a manner it will not be damaged by normal activity in the signal shop as shown in the Plans. Connect the Ethernet edge switch in the signal shop to the wireless access point with Ethernet patch cords.

Ensure that the wireless access point communicates with the Ethernet edge switch at Ethernet data transmission rates (100 Mbps).

Ensure that the network administrator will be able to remotely manage each wireless access point for configuration, performance monitoring, threat detection, and troubleshooting. Configure the wireless access point for internal use only, no guest access.

D. Firewall

Install the firewall appliance in a rack as shown in the Plans in the TCC. Connect the Ethernet core switch to the firewall in the TCC 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 internal ITS network from Internet-based attacks from the Internet. Configure an IPsec VPN on each firewall to connect to the City Transportation Department workstation via a secure link over the NCDOT dedicated fiber-optic communications network. Configure remote access VPN capability to allow NCDOT and City traffic services 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.

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E. Network Management Software

Modify the City of Burlington's existing Network Management Software (NMS) application to add the devices in this project. 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.

Update graphical network views. Use mapping images provided by manufacturers to geographically locate devices.

F. Uninterruptible Power Supply (UPS)

Install UPS unit in the communications rack in the TCC and the Ethernet core switch and ITS server to the UPS. Configure the UPS for remote monitoring.

37.4. 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 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.

Wireless access point will be measured and paid as the actual number of Wireless Access Points furnished, installed and accepted.

Network management software (modify) will be measured and paid as lump sum furnished, installed and accepted.

UPS (TCC) will be measured and paid as the actual number of rack-mounted 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.

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Payment will be made under:

Pay Item

Pay Unit

Ethernet Core Switch

Each

Ethernet Edge Switch

Each

Wireless Access Point

Each

Firewall

Each

Network Management Software (Modify)

Lump Sum

UPS (TCC)

Each

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38. DIGITAL VIDEO EQUIPMENT

38.1. DESCRIPTION

Furnish and install monitors to expand the existing monitor wall in the TCC and relocate existing monitors elsewhere in the Public Works Building.

Provide USB-based joysticks for CCTV selection and control.

Provide network video recorder to record streaming digital video streams.

38.2. MATERIALS

A. Digital Video Monitors

Provide ultra-thin bezel LED monitors, 55-inch minimum, to entirely fill the existing monitor wall width in the TCC leaving as little wall space as possible. Coordinate with the City to determine the height of the bottom monitor row and the lateral location, ensuring monitors are visible from the consoles. Provide only new video monitors; do not furnish used or refurbished monitors. Furnish monitors made by the same manufacturer. Provide power cords for all monitors of sufficient length to plug into duplex and quadplex wall receptacle adjacent to monitor mounting location. Monitors and layout must be approved by the Engineer.

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 adjustment to align the monitors. 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 monitors meeting the following requirements:

- Display Type: LED, widescreen flat panel, direct LED backlight,
- LED Lifespan: 50,000 hours, 24-hour operation,
- Mounting: Wall-mount,
- Bezel Size: Combined 0 to 1.7 mm.,
- Resolution: 1,920 x 1,080 dpi,
- Pixel Pitch: .63 mm.,
- Response Time: 8 ms.,
- Colors: Minimum 16.7 million colors,
- Horizontal Scanning Frequency: >85 kHz,
- Vertical Scanning Frequency: 50-86 Hz,
- Contrast Ratio: 4000:1,
- Aspect ratio: 16:9,
- Viewing Angle (Horizontal): 178 degrees,
- Viewing Angle (Vertical): 178 degrees,
- Brightness: 700 nits (cd/m²),
- HDTV Supported Formats: 720p and 1080p,
- Digital Inputs: DisplayPort, HDMI, and (2) DVI-D,
- Digital Outputs: DVI, VGA, composite,
- Analog Inputs: Component, VGA, S-video, composite,

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- Controls: RS-232, RS-485, 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 TCC to the wall monitors. 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.

B. TCC Video Wall Mounting System

Provide a video wall mounting system that allows very precise seamless vertical and horizontal adjustment of each video display for the monitors in the TCC without special tools. Use mounting brackets specifically designed for wall mounting 55" monitors. Provide a means to service, remove, and replace a monitor. Provide mounting hardware that can attach to wood or metal studs and concrete block.

C. Network Video Recorder

The network video recorder (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 one network-based NVRs in the TCC. Provide an NVR with the capability to record from IP streams 27 IP cameras each simultaneously. Record cameras at H.264 compression, 1080P resolution, camera resolution up to 5 Mbps, 30 frames per second with storage time for seven days. Provide an NVR 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 10 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,

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- Video: SVGA, and
- USB Port: Four USB 2.0 ports.

D. PTZ Joysticks

Provide new 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.

38.3. 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.

B. Video Server

Relocate the video server from the existing communications rack in the control room to the new communications racks in the server room as shown in the Plans. Install the video graphics card in the existing video server. Reconnect the power cords to adjacent receptacles in the communications rack. Connect the video server to the Ethernet core switch. Update the existing video management software on the video server.

C. Digital Video Monitors

Mount the TCC monitors on the wall as shown in the Plans and as approved by the Engineer. The monitors shall align exactly 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. 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 all power and video cables will be concealed behind the monitors.

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Provide a means to service, remove, and replace any monitor. Utilize a wall mounting system designed for the type monitors provided in this project that can attach to wood or metal studs and concrete block. Utilize a minimum of four bolts into in factory installed mounting threaded holes in each monitor and four bolts for each mounting bracket into the wall. Ensure the mounting brackets are secured to wall studs or plywood backboard according to the manufacturer's recommendations. Ensure the monitors are level and plumb on the wall. Conceal all video and power supply wiring behind the monitors. Route video wiring through wall up to ceiling over the suspended ceiling to the server room.

Align the monitors precisely horizontally and vertically so the bezels exactly align so images can be displayed across multiple monitors are seamless.

E. Reuse Digital Video Monitors

Reuse the existing mounting brackets from the existing monitors in the City Traffic Engineer office, Traffic Supervisor office and the signal shop. Ensure the mounting brackets are secured to wall studs or plywood backboard with at least four anchoring points according to the manufacturer's recommendations. When two monitors are mounted together align the monitors vertically and horizontally with each other as shown in the Plans. Ensure the monitors are level and plumb on the wall.

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.

F. 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 Category 6 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.

G. PTZ Joysticks

Install joystick controls for camera control in the TCC. Connect each joystick with its respective workstation.

38.4. 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, connectors, serial cables, HDMI 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.

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Digital display monitor will be measured and paid as the actual number of digital display monitors furnished, installed, and accepted.

No separate measurement will be made for the video wall mounting system as it will be incidental to the Digital Display Monitor listed above

Digital display monitor (relocate) will be measured and paid as the actual number of existing digital display monitors relocated, 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.

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 incidental to the pay items listed above.

Payment will be made under:

| Pay Item | Pay Unit |
|------------------------------------|-----------------|
| Digital Display Monitor | Each |
| Digital Display Monitor (Relocate) | Each |
| Network Video Recorder | Each |
| PTZ Joystick | Each |

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39. COMMUNICATIONS RACKS

39.1. DESCRIPTION

Furnish and install freestanding enclosed communications racks at the TCC.

39.2. MATERIALS

Provide freestanding enclosed communications racks for the TCC 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 TCC Server Room: 45 rack units high (approx. 84 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.

Provide a means for the entry of multiple cables (fiber-optic, video and Ethernet) into the racks from the cable tray above the communications racks or from the raised floor below.

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.

39.3. CONSTRUCTION METHODS

Ground the racks to a building ground.

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 TCC as shown in the Plans.

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.

39.4. MEASUREMENT AND PAYMENT

Communications rack will be measured and paid as the actual number of full-size, freestanding, enclosed communications racks furnished, installed and accepted.

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 incidental to furnishing and installing the communications racks.

Payment will be made under:

Pay Item

Communications Rack

Pay Unit

Each

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40. BUILDING MODIFICATIONS AND FIBER-OPTIC CABLE TERMINATION**40.1. DESCRIPTION**

At locations called for in the Plans, route fiber-optic cable in new and/or existing conduits and install conduits into the Public Works Building as shown. Terminate fiber-optic cable in fiber-optic splice centers in the Public Works Building as shown in the Plans. Furnish and install cable and cable routing facilities as shown in the Plans.

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 the building modification pay items. Electrical work inside the buildings and construction/relocation of walls/partitions will have been performed by the City.

40.2. 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.

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.

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. Public Works Building Modifications

1. Rack-Mounted Splice Centers

Furnish rack-mountable modular splice centers each comprising integrated connector panels and splice trays for splicing the fibers in the incoming signal system trunk cables to SMFO fiber-optic pigtailed and terminating on patch panels in the communications cabinet being installed in the TCC (i.e., one splice center for each incoming cable). Each connector housing shall have LC-compatible connector panels and shall have a capacity for terminating a minimum of 48 fibers on the connector panels as called for in the Plans. Each connector housing shall occupy no more than 3 rack units. Provide a matching splice housing for each connector housing and provide necessary splice trays for fusion splicing the incoming single-mode fibers in incoming 36- and 48-fiber trunk cables to the pigtailed. Each splice housing shall occupy no more than 3 rack units, shall be of the same manufacturer as the associated connector housing and designed to work with the connector housing. Each splice housing shall have the capacity to splice at least 96 fibers to pigtailed. Provide all hardware needed to install the splice centers units in the communications rack.

2. Cable Entry

Provide a 2-2" RGS conduits from a proposed oversized junction box outside the northwest corner of the Public Works Building through the exterior wall below grade of the building into the server room. Conduits should enter building between the concrete floor slab and the raised floor elevation. Core drill through block wall as shown in the plans and insert 2-2" RGS conduit. Install bushings and lock nuts to protect cables. Seal with waterproof caulk.

3. Cable Tray

Furnish a cable tray between the communications racks as show in the Plans. Provide a wire mesh cable tray 12" wide and 2" high. Provide a cable tray system using stainless steel hardware. Provide hardware to secure the cable tray to the racks. Provide a vertical cable tray transition with drop out kits from the cable tray to the top of each communications rack. Provide a manufactured tee section to join cable trays at 90-degree angles.

4. Cable and Conduit Hangers

Furnish conduit hangers to secure 1" EMT conduit to walls and ceiling joists. Secure the conduit with hangers at least every six feet to the wall or from roof joists. Use galvanized steel hardware.

Furnish cable hangers to secure Ethernet and video cable to walls and ceiling joists. Secure the cable with hangers at least every six feet to the wall or from roof joists. Use galvanized steel hardware.

5. Network Wiring

Furnish all conduit, conduit fittings, outlet bodies, cover plates, conduit straps, rod-to-beam fasteners, conduit fasteners, new conduit and network boxes (i.e., Ethernet outlets) in the TCC to convey Ethernet cabling within the TCC and to the Signal and Sign Shops as shown in the Plans.

40.3. CONSTRUCTION METHODS

A. General

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

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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.

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.

B. Public Works Building

1. General Requirements

Install equipment and route cable into the TCC through proposed EMT conduit as shown in the Plans. Contact Jason Geary, City Traffic Engineer, at (336) 570-6156 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 Public Works 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 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 City or the Department.

2. Cable Entry

Core drill new conduit entrance into building as shown in the Plans. Insert two 2-inch rigid galvanized conduits through the new hole. Seal the conduit drill hole with waterproof grout made for masonry applications. Secure the conduit inside the server room with washers and a lock nut.

3. Signal System FO and Other Cables and TCC Equipment

Install the required rack-mounted splice centers in the communications racks in the TCC as shown in the Plans. Pull the proposed signal system fiber-optic communications cables inside the building. Leave a pull tape for use by others for pulling additional fiber-optic communications cables into the TCC at a later date.

Fusion splice all fibers in the entering fiber-optic cables to SMFO pigtailed inside rack-mounted splice housing, then connect the pigtailed to the appropriate connectors in the connector housing. Terminate all pigtailed from the incoming cable. Clearly label the patch panels of the

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connector housing center using an approved labeling method. Install SMFO jumpers between the connector panels and the Ethernet core switch. Store a minimum of 20 LF of each fiber-optic cable inside the communications rack that contains the splice center.

Remove and replace the video cabling as the new video wall is constructed.

Install new Ethernet cable for the outlets as shown in the Plans. Terminate the cable in the control room in network jacks. Terminate the Ethernet cable in the server room in the Ethernet patch panel in the communications rack.

40.4. MEASUREMENT AND PAYMENT

TCC building 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 TCC as shown in the Plans, as well as any other work not called for under other items but required to accomplish the building modifications.

The Ethernet cables in the Public Works Building 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 and Ethernet outlet boxes with RJ-45 jacks as these will be incidental to the building modifications.

No separate measurement will be made for mounting hardware, nuts, bolts, concrete/masonry anchors, brackets, connectors, grounding equipment as these will be considered incidental to the pay items listed above. No separate payment will be made for wall-mount cabinets/junction boxes, splice housings, connector housings, interconnect centers, patch panels, splice trays, splicing, conduit, conduit fittings, conduit hangers, conduit surface mounting hardware and brackets, and fire-stop sealant as these will be incidental to the building modifications.

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

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:

Pay Item

TCC Building Modifications

Pay Unit

Lump Sum

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Furnish and install freestanding operator consoles in the TCC.

41.2. MATERIALS**A. General**

Provide modular steel consoles that include a user adjustable sit-stand center section to allow the user to work standing or seated. Provide consoles with a worksurface depth of 21" nominal. Provide a 24" x 78" nominal credenza for the left console against the wall as shown in the Plans. Provide the credenza with doors to enclose the storage below.

Provide a shared 30" x 42" nominal work surface between the two consoles. The shared workspace shall have two shelves and a two-door cabinet with shelves underneath.

Provide a freestanding credenza with work surface against the wall for the right console that is 30" x 48". The credenza against the wall shall have three drawers and a two-door cabinet underneath. A slat wall shall screen the work surfaces and support the addition of accessory items described below. Provide cable management in the slat walls.

Provide quick-release soft close European style hinges.

B. Finishes

Coordinate and obtain approval of the final selection of colors and finishes of the console furniture with the City Traffic Engineer prior to ordering. Provide metal components with matte black metal finish. Provide all work surfaces with Nickel EV laminate. Provide flannel fabric on wall panels. Provide urethane edge molding

C. Accessory Items

Provide for each console (3) 23" single stack monitor arms shelves and a two-door cabinet underneath. Provide an adjustable task light for each console mounted on the slat wall. Provide a phone shelf mounted on the slat wall. Provide electrical outlets in the workstation bay and in the countertop.

Provide adjustable and removable backstops for the shelves to support books and manuals.

41.3. CONSTRUCTION METHODS

Install two consoles in the TCC as shown in the Plans. The consoles shall face the video wall. Ensure ADA requirements are met for walking space around the consoles. Ensure the consoles Route all network and telephone cabling under the raised floor from the server room. Utilize existing electrical outlets under the raised floor for lighting and power needs.

Conceal all wiring (electrical, video and communications) in wiring chaises, in slat walls, or under floor.

41.4. MEASUREMENT AND PAYMENT

Consoles will be measured and paid as the actual number of consoles furnished, installed and accepted. No separate measurement and payment will be made for console set-up and assembly, shelves, keyboard drawers, drawers, shelves, power strips, mounting of all accessories and equipment specified for installation within the consoles, all brackets, fasteners, and hardware

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required for properly mounting equipment in the rack, as such materials and work will be incidental to furnishing and installing the consoles.

Payment will be made under:

Pay Item

Pay Unit

Consoles

Each

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42. SUBMITTAL DATA AND DOCUMENTATION**42.1. DESCRIPTION**

Provide project documentation for Department review and approval as described below.

42.2. 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 Contractor shall develop and submit for approval the system design report early in the project, within 45 days of notice-to-proceed, and shall proceed submittals of equipment and software.

The Contractor shall develop and submit for approval the migration plan, within 45 days of notice-to-proceed.

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,

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- Task Begin and End Dates,
- Milestones,
- Material Submittals,
- Submittal Review Periods,
- Equipment Deliveries,
- 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 and security protocols and settings to ensure the integrity of the City's wide area network. The network configuration shall comply with City's IP address schema.

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.

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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 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:

| Submittal Package | Description |
|------------------------------------|--|
| System Design Report | See "System Design Report" subsection above. |
| Controllers and Cabinets | 2070LX Controllers, 332A and 336S Cabinets, Conflict Monitors, Base Adapters, Base Extenders, Preformed Cabinet Foundations and Base Extenders/Adapters |
| Fiber-optic Cable | Fiber-optic Cable, Drop Cables, Splice Enclosures, Interconnect Centers, Splice Trays, Cable Addition Kits, Delineator Markers, Cable Markers, Communications Cable Identification Markers |
| CCTV Equipment | CCTV camera, Power over Ethernet Injectors, CCTV cabinet |
| Video Equipment* | Network Video Recorder, Video Monitors and Mounting Hardware, Video Joysticks |
| Wireless Communications Equipment* | 2.4 GHz Ethernet radio system, mounting hardware, RF disconnect switch, RF warning sign and decals, lightning arrestors |
| Computer Hardware | ITS Servers, Workstations, Laptops, Ethernet Cable |

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| Submittal Package | Description |
|---------------------------|---|
| Communications Equipment* | Ethernet Core Switch, Firewall, Ethernet Edge Switches, KVM Switch, Wireless Access Point, Network Management Software Modification (see “Communications Hardware” section of these Project Special Provisions for further requirements); Communications Racks |
| Field Infrastructure | Conduit, Junction Boxes, Terminal Splice Boxes/Cabinets, Electrical Service Equipment (Disconnects, Meter Bases, Combination Panels), Pole-Mount Radio Cabinet, Heat Shrink Tubing and Retrofit Kits, Signal Heads, Pushbutton Integrated Accessible Pedestrian Signals, 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.

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.

42.3. 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:

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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 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.

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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.
- 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.

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.

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.

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42.4. 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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43. SYSTEM SUPPORT AND TEST EQUIPMENT

43.1. 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.

43.2. 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. 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 Category 6 cable,
- 20 Category 6 patch cords, 5 feet long with molded strain relief cables, and
- 20 RJ-45 male connectors.

C. 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: ± 3 percent (± 0.1 dB) at -20 dBm at 70 degrees F at calibrated wavelengths,
- Readout resolution: 4 digits, 0.01 dBm,
- Display: Backlit LCD,
- Fiber-optic connector: 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

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D. Optical Light Generator

Furnish one optical light generator 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
- Display: Backlit LCD,
- Fiber-optic connector: LC, SC and ST
- Power/signal stability: ± 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.

E. 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, pigtailed and patch panels, such as 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)

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Furnish two standalone, portable conflict monitor test units with notebook computers 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.

G. 2070 Controller Tester

Furnish two portable 2070 controller testers designed to test all variations of the 2070 series controllers. Furnish testers mounted in a high impact ABS plastic case. The testers shall have an internal power supply such that no controller power is required.

Provide testers with C1 (M104 connector) and C11 (CPC 23-37 plug) connectors.

Provide testers that tests and displays all standard and extended controller functions colored LEDs and their respective C1 and C11 terminal numbers. The testers shall feature five-way test points (signal ground, power interrupt and neutral (3)). The power interrupt test shall be adjustable from .1 to 2.5 seconds. Provide 69 on/off/momentary on test switches. Provide testers that displays all C1 and C11 connector pinouts. Provide multi-purpose label overlays for a variety of controller and software applications.

H. Ethernet Radio Support Equipment

Furnish one 2.4 GHz Ethernet radio identical to the type installed for the CCTV cabinets to be used for emergency restoration of the system and the wireless communications system. In addition, furnish one Ethernet radio lightning arrestor identical to each type installed in the CCTV cabinets to be used for emergency restoration of the transient voltage suppression equipment.

I. Test Controllers with Cabinets

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 each test cabinet into an existing wall receptacle adjacent to the cabinet.

Furnish and install Model 2070LX controllers with Type 332A test cabinets at the TCC. The test cabinets shall include a full complement of detector cards, auxiliary file, 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 Type 332A test cabinet with an auxiliary output file to simulate flashing yellow arrow phasing.

Furnish and install Model 2070LX controllers with a Type 336 test cabinet at the TCC. The test cabinet shall include a full complement of detector card, switch packs, a conflict monitor, two (2) AC isolators, two (2) DC isolators and a railroad preemption test panel. Provide a

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railroad preemption panel that is identical to those installed at railroad preemption locations in the field under this contract.

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 purposed, 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.

J. CCTV Test Cabinet

Furnish and install a Type 336A CCTV test cabinet in the TCC. 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.

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 TCC.

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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 incidental to furnishing the conflict monitor tester.

Furnish 2070 controller tester will be measured and paid as the actual number of 2070 controller testers furnished and accepted.

Furnish detector card (Model 222) will be measured and paid as the actual number of Type 222 detector cards furnished and accepted.

Furnish 2070LX controller will be measured and paid as the actual number of 2070LX 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 2.4 GHz Ethernet radio will be measured and paid as the actual number of 2.4 GHz Ethernet radios furnished and accepted. This item includes one spare antenna of each type used on the project, lightning arrestor, coaxial cable shield grounding system with weatherproofing, power supply and power cord per radio.

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 CCTV cabinets furnished and accepted.

Type 332 test controller with cabinet will be measured and paid as the actual number of 2070LX controllers with a Type 332 test cabinet furnished, installed in the TCC and accepted.

Type 336 test controller with cabinet will be measured and paid as the actual number of 2070LX controllers with a Type 336 test cabinet furnished, installed in the TCC and accepted.

CCTV test cabinet with CCTV camera assembly will be measured and paid as the actual number of 336A CCTV test cabinets with CCTV camera assembly furnished, installed and

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accepted in the TCC. No measurement will be made of the camera assembly nor for the Ethernet cables required to connect the CCTV test cabinet to the Ethernet core switch and the power cord required to plug the test cabinet into the existing wall receptacle as they will be incidental to furnishing and installing the CCTV test cabinet.

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 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 incidental to furnishing and installing the test controllers with cabinets.

Payment will be made under:

| Pay Item | Pay Unit |
|--|-----------------|
| Furnish Fiber-Optic Power Meter | Each |
| Furnish Optical Light Generator | Each |
| Furnish Visual Fault Locator | Each |
| Furnish Video Monitor | Each |
| Furnish Conflict Monitor Tester | Each |
| Furnish 2070 Controller Tester | Each |
| Furnish Detector Card (Model 222) | Each |
| Furnish 2070LX Controller | Each |
| Furnish 336S Cabinet | Each |
| Furnish 332 Cabinet | Each |
| Furnish 2018 Enhanced Conflict Monitor | Each |
| Furnish Ethernet Edge Switch | Each |
| Furnish 2.4 GHz Ethernet Radio | Each |
| Furnish CCTV Camera Assembly | Each |
| Furnish CCTV Cabinet | Each |
| Type 332 Test Controller with Cabinet | Each |
| Type 336 Test Controller with Cabinet | Each |
| CCTV Test Cabinet | Each |

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44. TRAINING

44.1. DESCRIPTION

Provide training for the installation, operation and maintenance of:

- Ethernet core switch,
- Ethernet edge switches,
- ITS 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,
- Wireless communications equipment
- CCTV field equipment,
- Video wall,
- Signal system, CCTV and video wall software,
- Maintenance management software,
- Controller hardware and local controller software including:
 - 2070LX Controllers,
 - Cabinets,
 - Conflict monitors,
 - Detectors,
 - ASC/3[®] IP (Version) controller software,
- UPS,
- System support,
- Test software and test equipment.

44.2. 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.

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

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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 Department will 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 Division 7 staff and City staff 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 | 15 | 2 | 5 |
| Fiber-Optic Communications | Lecture and Hands-on Exercises | | | 3 |
| CCTV Field Equipment | Lecture and Hands-on Exercises | | | 1 |
| Wireless Communications Equipment | Lecture and Hands-on Exercises | | | 2 |
| Digital Video Equipment | Lecture and Hands-on Exercises | | | 0.5 |
| Signal System Software | Lecture and Hands-on Exercises | | | 4 |
| CCTV and Video Wall Management Software | Lecture and Hands-on Exercises | | | 2 |
| Maintenance Management System Software | Lecture and Hands-on Exercises | | | 2 |
| 2070LX Traffic Signal Controllers, Conflict Monitors, Cabinets, and ASC/3 Controller Firmware | Lecture and Hands-on Exercises | | | 5 |
| UPS | Lecture and Demonstration | | | 0.25 |

* Length per session

** 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:

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| Course | Type of Training | Total Students | No. of Sessions | Length (Days) | | | |
|---|-------------------------------------|----------------|-----------------|---------------|----|---|---|
| Ethernet Communications and Networks | | | | | | | |
| Terminology | Lecture | 15 | 2 | 2 | | | |
| 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 | | | | | | |
| Ethernet Switches (all types and configurations) | | | | | | | |
| Introduction | Lecture | 15 | 2 | 2 | | | |
| Configuration and programming | Lecture and Hands-on | | | | | | |
| 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 | | | | | | |
| Network Management Software | | | | | | | |
| Introduction | Lecture | | | | 15 | 2 | 1 |
| 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 | Total Students | No. of Sessions | Length (Days) |
|--|-------------------------------------|----------------|-----------------|---------------|
| Ethernet Switches – Optics | | | | |
| Safety | Lecture | | | |
| Introduction to Ethernet switch optics | Lecture | | | |
| Review of Maintenance Manual – optics | Lecture | 15 | 2 | 1 |
| Review of Operations Manual – optics | Lecture | | | |
| Question and answer session | Lecture | | | |
| Fiber-Optic Cable System | | | | |
| 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 | | 15 | 2 | 2 |
| 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 | | | | |

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| Course | Type of Training | Total Students | No. of Sessions | Length (Days) |
|--|-------------------------------------|----------------|-----------------|---------------|
| 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. | | | | |

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 | Total Students | No. of Sessions | Length (Days) |
|--------------------------|-------------------------------------|----------------|-----------------|---------------|
| Operations | Lecture | 15 | 2 | 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 | | | |

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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 | Total Students | No. of Sessions | Length (Days) |
|-------------------------------------|-------------------------------------|----------------|-----------------|---------------|
| Operations and theory of operations | Lecture | 6 | 1 | 0.25 |
| Programming | Lecture, Demonstration and Hands-on | | | 0.25 |
| Maintenance | | | | |
| Routine maintenance | | | | |
| Testing | | | | |
| Troubleshooting | | | | |

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 | Total Students | No. of Sessions | Length (Days) |
|---|-------------------------------------|----------------|-----------------|---------------|
| Part 1 | Lecture & Demonstration | 15 | 2 | 1 |
| Overview of Part 1 | | | | |
| Time-of-day operation and event scheduling | | | | |
| Traffic responsive pattern selection algorithms | | | | |
| Reporting Capabilities | Lecture, Demonstration and Hands-on | 15 | 2 | 1 |
| Interactive database manipulation | | | | |
| Theory and application of traffic responsive operations | | | | |
| Special functions | Lecture and Hands-on | 15 | 2 | 1 |
| Part 2 | | | | |
| Review of Part 1/Overview of Part 2 | | | | |
| System operations and recommended procedures | Lecture, Demonstration and Hands-on | 15 | 2 | 2 |
| Part 3 | | | | |
| Review of Parts 1 & 2/Overview of Part 3 | | | | |

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| Course | Type of Training | Total Students | No. of Sessions | Length (Days) |
|---|------------------|----------------|-----------------|---------------|
| Development and modification of system graphics | | | | |
| Preparation of dynamically functioning graphics | | | | |

G. CCTV and Video Wall Software

Provide training that includes operational theory and procedures of the camera and video wall management 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 | Total Students | No. of Sessions | Length (Days) |
|---|-------------------------------------|----------------|-----------------|---------------|
| CCTV Software | Lecture & Demonstration | | | |
| Part 1 | | | | |
| System Overview | Lecture, Demonstration and Hands-on | 6 | 1 | .5 |
| System Configuration | | | | |
| User Interface and User Rights | | | | |
| Applications | | | | |
| Part 2 | | | | |
| Development and modification of system graphics | Lecture, Demonstration and Hands-on | 6 | 1 | 1 |
| Part 3 | | | | |
| Development and modification of system graphics | Lecture, Demonstration and Hands-on | 15 | 2 | .5 |

H. Maintenance Management System Software

Provide training that includes procedures in the use of the maintenance management system software. This training shall be oriented towards supervisors, 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 | Total Students | No. of Sessions | Length (Days) |
|--------------------------------|-------------------------------------|----------------|-----------------|---------------|
| Part 1 | | | | |
| Overview of Part 1 | Lecture, Demonstration and Hands-on | 15 | 2 | 1 |
| Setup and User Interface | | | | |
| Preventative Maintenance Tools | | | | |
| Reporting Capabilities | | | | |

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| Course | Type of Training | Total Students | No. of Sessions | Length (Days) |
|-------------------------------------|---|----------------|-----------------|---------------|
| Part 2 | Lecture, Demonstration and Hands-on | | | 1 |
| Review of Part 1/Overview of Part 2 | | | | |
| Schedulers | | | | |
| Work Order Generation | | | | |
| Mobile Device Applications | | | | |

I. 2070LX 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.

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 2070LX 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 2070LX 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.

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- Formal classroom presentation and hands-on workshop on operation of controller tester.
- Hands-on workshop of proper installation, programming, and troubleshooting of conflict monitors.
- Hands-on workshop of proper installation, programming, and troubleshooting of detector cards and lead-in cable.
- Hands-on workshop wherein maintenance personnel will troubleshoot simulated controller and cabinet assembly faults to the component level.

The 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):

| Course | Type of Training | Total Students | No. of Sessions | Length (Days) |
|--------------------------------|-------------------------------------|----------------|-----------------|---------------|
| Programming | Lecture, Demonstration and Hands-on | 15 | 2 | 1.5 |
| Phasing, | | | | |
| Timing, | | | | |
| Preemption, | | | | |
| Coordination, Data transfer | | | | |
| Operations | Lecture | 15 | 2 | 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.

J. Wireless Communications System

Provide training for the 2.4 GHz Ethernet radio equipment as described below:

| Course | Type of Training | Total Students | No. of Sessions | Length (Days) |
|--|-------------------------------------|----------------|-----------------|---------------|
| Operations | Lecture, Demonstration | 15 | 2 | 1.0 |
| Theory of operation | Lecture | | | |
| Safety | Lecture | | | |
| Antenna alignment | Lecture | | | |
| Site Surveys | Lecture, Demonstration and Hands-on | | | |
| Procedures | | | | |
| Interpreting and understanding the results | | | | |

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| Course | Type of Training | Total Students | No. of Sessions | Length (Days) |
|--------------------------|-------------------------------------|-----------------------|------------------------|----------------------|
| Programming and software | Lecture, Demonstration and Hands-on | | | |
| Configuration | | | | |
| Repeater applications | | | | |
| Maintenance | Lecture | | | |
| Routine maintenance | Lecture, Demonstration and Hands-on | | | |
| Testing | Lecture, Demonstration and Hands-on | | | |
| Troubleshooting | Lecture, Demonstration and Hands-on | | | |

K. UPS

Provide training for the UPS units that is 2 hours in length, including both classroom and “hands-on” training.

44.3. 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

Training

Pay Unit

Lump Sum

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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.

45.2. 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. TCC 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.

U-6015**ITS-331****Alamance 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 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.

G. UPS

Perform the following operational tests for each UPS in accordance with the test plans. After the UPS has been installed:

- Connect all field devices to UPS,
- Connect UPS monitoring cable to managed Ethernet switch,
- Install and configure UPS monitoring software from the TCC, and
- Configure monitoring software for remote notifications of power outage and use of battery power.

Repair or replace defective or failed equipment and retest.

H. Ethernet Radio Equipment

Test the Ethernet radios as follows:

- Check all ground, power, data, Ethernet and analog video connections,
- Run power up self-test on each piece of equipment,
- Run all available Vendor-supplied self-diagnostics,
- Check received signal strength, noise levels, bandwidth, and accuracy of test data transmission between each pair of nodes,
- Adjust hopping patterns as necessary to maximize the quality of the signal strength,
- If adjusting the hopping pattern does not significantly improve the quality of the signal strength, then adjust antenna as necessary to maximize the quality of the signal strength, and
- Test the transmission of data to ensure the transmission of data from the spread spectrum radios to the edge switches. Run the system diagnostics from end to end.

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Conduct tests as described below of the traffic signal and CCTV subsystems. Conduct approved device subsystem tests on the field equipment with the TCC 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.

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 TCC:

- 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 TCC 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 TCC and the TRTMC to ensure correct operation. Test the components of the CCTV central equipment from both the TCC and the Public Works Building as follows:

- Use the GUI interface and the PTZ control to select and view each camera on any monitor in the TCC and the Public Works Building;
- Use and the GUI interface and the PTZ control from the TCC and the Public Works Building 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 monitors with CATV access in the TCC 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 TCC;
- Utilizing each workstation, demonstrate the ability to select, control and view the camera images; and
- 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 VideoPro software and video wall management software from the TCC and the TRTMC to ensure correct operation. Test the components of the CCTV central equipment from both the TCC and the TRTMC as follows, with each software package (VideoPro and the video wall management software):

- 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; and
- Use the GUI interface and test the ability to select and place any camera on any area of the video wall.
- Select and display content on the video wall from the TV tuner and from the signal system.

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 TCC, 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.

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;

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- Local area network (LAN) operations; and
- Demonstrating that all features of the CCTV central software operates as called for with all field equipment.

45.4. 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 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 and Ethernet edge switches;
- Fiber-optic communications network;
- Ethernet radio equipment;
- LAN and the TCC and City Transportation Department 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.

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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 radio equipment, Ethernet switches, fiber-optic cable, CCTV monitors, network video recorder, video wall, 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, Ethernet radio equipment, fiber-optic cable, controllers and conflict monitors, and cabinets.

45.5. 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.

45.6. 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 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 |
|----------------------|--------------|-------|--|----------|-----------|--------|
| ROADWAY ITEMS | | | | | | |
| 0001 | 0000100000-N | 800 | MOBILIZATION | Lump Sum | L.S. | |
| 0002 | 2591000000-E | 848 | 4" CONCRETE SIDEWALK | 62 | SY | |
| 0003 | 4405000000-E | 1110 | WORK ZONE SIGNS (PORTABLE) | 800 | SF | |
| 0004 | 4410000000-E | 1110 | WORK ZONE SIGNS (BARRICADE MOUNTED) | 72 | SF | |
| 0005 | 4415000000-N | 1115 | FLASHING ARROW BOARD | 4 | EA | |
| 0006 | 4420000000-N | 1120 | PORTABLE CHANGEABLE MESSAGE SIGN | 4 | 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 | 4455000000-N | 1150 | FLAGGER | 600 | DAY | |
| 0011 | 4480000000-N | 1165 | TMA | 4 | EA | |
| 0012 | 4510000000-N | 1190 | LAW ENFORCEMENT | 500 | HR | |
| 0013 | 4516000000-N | 1180 | SKINNY DRUM | 100 | EA | |
| 0014 | 4697000000-E | 1205 | THERMOPLASTIC PAVEMENT MARKING LINES (8", 120 MILS) | 170 | LF | |
| 0015 | 4710000000-E | 1205 | THERMOPLASTIC PAVEMENT MARKING LINES (24", 120 MILS) | 66 | LF | |
| 0016 | 4725000000-E | 1205 | THERMOPLASTIC PAVEMENT MARKING SYMBOL (90 MILS) | 25 | EA | |
| 0017 | 4850000000-E | 1205 | REMOVAL OF PAVEMENT MARKING LINES (4") | 90 | LF | |
| 0018 | 4870000000-E | 1205 | REMOVAL OF PAVEMENT MARKING LINES (24") | 54 | LF | |
| 0019 | 7048500000-E | 1705 | PEDESTRIAN SIGNAL HEAD (16", 1 SECTION W/COUNTDOWN) | 4 | EA | |

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| Line # | Item Number | Sec # | Description | Quantity | Unit Cost | Amount |
|--------|--------------|-------|--|----------|-----------|--------|
| 0020 | 7060000000-E | 1705 | SIGNAL CABLE | 53,020 | LF | |
| 0021 | 7120000000-E | 1705 | VEHICLE SIGNAL HEAD (12", 3 SECTION) | 285 | EA | |
| 0022 | 7132000000-E | 1705 | VEHICLE SIGNAL HEAD (12", 4 SECTION) | 97 | EA | |
| 0023 | 7144000000-E | 1705 | VEHICLE SIGNAL HEAD (12", 5 SECTION) | 8 | EA | |
| 0024 | 7180000000-N | 1706 | BACKPLATE | 2 | EA | |
| 0025 | 7204000000-N | 1705 | LOUVER | 4 | EA | |
| 0026 | 7252000000-E | 1710 | MESSENGER CABLE (1/4") | 47,895 | LF | |
| 0027 | 7264000000-E | 1710 | MESSENGER CABLE (3/8") | 5,637 | LF | |
| 0028 | 7279000000-E | 1715 | TRACER WIRE | 52,120 | LF | |
| 0029 | 7301000000-E | 1715 | DIRECTIONAL DRILL (***** (1, 2")) | 1,100 | LF | |
| 0030 | 7301000000-E | 1715 | DIRECTIONAL DRILL (***** (2, 2")) | 12,870 | LF | |
| 0031 | 7312000000-N | 1716 | JUNCTION BOX (***** (SPECIAL-SIZED) | 38 | EA | |
| 0032 | 7324000000-N | 1716 | JUNCTION BOX (STANDARD SIZE) | 86 | EA | |
| 0033 | 7348000000-N | 1716 | JUNCTION BOX (OVER-SIZED, HEAVY DUTY) | 78 | EA | |
| 0034 | 7360000000-N | 1720 | WOOD POLE | 13 | EA | |
| 0035 | 7372000000-N | 1721 | GUY ASSEMBLY | 334 | EA | |
| 0036 | 7384000000-E | 1722 | ***" RISER WITH ***** (1.25", HEAT SHRINK TUBING) | 11 | EA | |
| 0037 | 7384000000-E | 1722 | ***" RISER WITH ***** (2", HEAT SHRINK TUBING) | 77 | EA | |

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| Line # | Item Number | Sec # | Description | Quantity | Unit Cost | Amount |
|--------|--------------|-------|---|----------|-----------|--------|
| 0038 | 7396000000-E | 1722 | 1/2" RISER WITH WEATHERHEAD | 4 | EA | |
| 0039 | 7408000000-E | 1722 | 1" RISER WITH WEATHERHEAD | 27 | EA | |
| 0040 | 7420000000-E | 1722 | 2" RISER WITH WEATHERHEAD | 75 | EA | |
| 0041 | 7444000000-E | 1725 | INDUCTIVE LOOP SAWCUT | 6,360 | LF | |
| 0042 | 7456000000-E | 1726 | LEAD-IN CABLE (*****) (14-2) | 66,985 | LF | |
| 0043 | 7516000000-E | 1730 | COMMUNICATIONS CABLE (**FIBER) (12) | 64,905 | LF | |
| 0044 | 7516000000-E | 1730 | COMMUNICATIONS CABLE (**FIBER) (24) | 139,430 | LF | |
| 0045 | 7516000000-E | 1730 | COMMUNICATIONS CABLE (**FIBER) (36) | 91,080 | LF | |
| 0046 | 7516000000-E | 1730 | COMMUNICATIONS CABLE (**FIBER) (48) | 38,830 | LF | |
| 0047 | 7528000000-E | 1730 | DROP CABLE | 84,655 | LF | |
| 0048 | 7540000000-N | 1731 | SPLICE ENCLOSURE | 161 | EA | |
| 0049 | 7552000000-N | 1731 | INTERCONNECT CENTER | 208 | EA | |
| 0050 | 7566000000-N | 1733 | DELINEATOR MARKER | 3 | EA | |
| 0051 | 7575142200-N | SP | NEW ELECTRICAL SERVICE | 10 | EA | |
| 0052 | 7575160000-E | 1734 | REMOVE EXISTING COMMUNICATIONS CABLE | 35,220 | LF | |
| 0053 | 7575180000-N | 1735 | CABLE TRANSFER | 10 | EA | |
| 0054 | 7613000000-N | SP | SOIL TEST | 19 | EA | |
| 0055 | 7614100000-E | SP | DRILLED PIER FOUNDATION | 171 | CY | |
| 0056 | 7636000000-N | 1745 | SIGN FOR SIGNALS | 13 | EA | |

County : Alamance

| Line # | Item Number | Sec # | Description | Quantity | Unit Cost | Amount |
|--------|--------------|-------|---|----------|-----------|--------|
| 0057 | 7642100000-N | 1743 | TYPE I POST WITH FOUNDATION | 2 | EA | |
| 0058 | 7684000000-N | 1750 | SIGNAL CABINET FOUNDATION | 50 | EA | |
| 0059 | 7686000000-N | 1752 | CONDUIT ENTRANCE INTO EXISTING FOUNDATION | 14 | EA | |
| 0060 | 7687000000-N | 1752 | MODIFY FOUNDATION FOR CONTROLLER CABINET | 6 | EA | |
| 0061 | 7696000000-N | 1751 | CONTROLLERS WITH CABINET (***** (2070LX, 332) | 133 | EA | |
| 0062 | 7696000000-N | 1751 | CONTROLLERS WITH CABINET (***** (2070LX, 336S) | 67 | EA | |
| 0063 | 7708000000-N | 1751 | DETECTOR CARD (***** (MODEL 222) | 946 | EA | |
| 0064 | 7901000000-N | 1753 | CABINET BASE EXTENDER | 72 | EA | |
| 0065 | 7901010000-N | 1753 | CABINET BASE ADAPTER | 7 | EA | |
| 0066 | 7960000000-N | SP | METAL POLE FOUNDATION REMOVAL | 1 | EA | |
| 0067 | 7972000000-N | SP | METAL POLE REMOVAL | 1 | EA | |
| 0068 | 7980000000-N | SP | GENERIC SIGNAL ITEM 2.4 GHZ ETHERNET RADIO | 2 | EA | |
| 0069 | 7980000000-N | SP | GENERIC SIGNAL ITEM 5/8" X 10' GROUNDING ELECTRODE | 62 | EA | |
| 0070 | 7980000000-N | SP | GENERIC SIGNAL ITEM CCTV CABINET (336A) | 6 | EA | |
| 0071 | 7980000000-N | SP | GENERIC SIGNAL ITEM CCTV CABINET (NEMA) | 1 | EA | |
| 0072 | 7980000000-N | SP | GENERIC SIGNAL ITEM CCTV CABINET DISCONNECT | 2 | EA | |
| 0073 | 7980000000-N | SP | GENERIC SIGNAL ITEM CCTV CAMERA ASSEMBLY | 40 | EA | |

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| Line # | Item Number | Sec # | Description | Quantity | Unit Cost | Amount |
|--------|--------------|-------|--|-----------|-----------|--------|
| 0074 | 7980000000-N | SP | GENERIC SIGNAL ITEM CCTV METAL POLE | 19 EA | | |
| 0075 | 7980000000-N | SP | GENERIC SIGNAL ITEM CCTV TEST CABINET | 1 EA | | |
| 0076 | 7980000000-N | SP | GENERIC SIGNAL ITEM CCTV WOOD POLE | 3 EA | | |
| 0077 | 7980000000-N | SP | GENERIC SIGNAL ITEM COMMUNICATIONS RACK | 2 EA | | |
| 0078 | 7980000000-N | SP | GENERIC SIGNAL ITEM COMPUTER WORKSTATION | 4 EA | | |
| 0079 | 7980000000-N | SP | GENERIC SIGNAL ITEM CONSOLES | 2 EA | | |
| 0080 | 7980000000-N | SP | GENERIC SIGNAL ITEM DIGITAL DISPLAY MONITOR | 10 EA | | |
| 0081 | 7980000000-N | SP | GENERIC SIGNAL ITEM DIGITAL DISPLAY MONITOR (RELO- CATE) | 4 EA | | |
| 0082 | 7980000000-N | SP | GENERIC SIGNAL ITEM ETHERNET CORE SWITCH | 1 EA | | |
| 0083 | 7980000000-N | SP | GENERIC SIGNAL ITEM ETHERNET EDGE SWITCH | 209 EA | | |
| 0084 | 7980000000-N | SP | GENERIC SIGNAL ITEM FIREWALL | 1 EA | | |
| 0085 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH 2.4 GHZ ETHERNET RADIO | 1 EA | | |
| 0086 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH 2018 ENHANCED CONFLICT MONITOR | 10 EA | | |
| 0087 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH 2070 CONTROLLER TESTER | 2 EA | | |
| 0088 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH 2070LX CONTROLLER | 10 EA | | |
| 0089 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH 332 CABINET | 7 EA | | |

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| Line # | Item Number | Sec # | Description | Quantity | Unit Cost | Amount |
|--------|--------------|-------|---|-----------|-----------|--------|
| 0090 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH 336S CABINET | 3 EA | | |
| 0091 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH CCTV CABINET | 1 EA | | |
| 0092 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH CCTV CAMERA ASSEMBLY | 1 EA | | |
| 0093 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH CONFLICT MONITOR TESTER | 2 EA | | |
| 0094 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH DETECTOR CARD (MODEL 222) | 48 EA | | |
| 0095 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH ETHERNET EDGE SWITCH | 11 EA | | |
| 0096 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH FIBER-OPTIC POWER METER | 2 EA | | |
| 0097 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH OPTICAL LIGHT GENERA- TOR | 4 EA | | |
| 0098 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH VIDEO MONITOR | 1 EA | | |
| 0099 | 7980000000-N | SP | GENERIC SIGNAL ITEM FURNISH VISUAL FAULT LOCATOR | 2 EA | | |
| 0100 | 7980000000-N | SP | GENERIC SIGNAL ITEM GUY ASSEMBLY (AERIAL) | 63 EA | | |
| 0101 | 7980000000-N | SP | GENERIC SIGNAL ITEM GUY ASSEMBLY (SIDEWALK) | 38 EA | | |
| 0102 | 7980000000-N | SP | GENERIC SIGNAL ITEM HEAT SHRINK TUBING KIT | 130 EA | | |
| 0103 | 7980000000-N | SP | GENERIC SIGNAL ITEM ITS SERVER | 8 EA | | |
| 0104 | 7980000000-N | SP | GENERIC SIGNAL ITEM KVM SWITCH | 1 EA | | |

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| Line # | Item Number | Sec # | Description | Quantity | Unit Cost | Amount |
|--------|--------------|-------|--|-----------|-----------|--------|
| 0105 | 7980000000-N | SP | GENERIC SIGNAL ITEM LAPTOP COMPUTER | 8 EA | | |
| 0106 | 7980000000-N | SP | GENERIC SIGNAL ITEM MODIFY EXISTING ELECTRICAL SERVICE | 124 EA | | |
| 0107 | 7980000000-N | SP | GENERIC SIGNAL ITEM MODIFY EXISTING SPLICE | 1 EA | | |
| 0108 | 7980000000-N | SP | GENERIC SIGNAL ITEM NETWORK VIDEO RECORDER | 1 EA | | |
| 0109 | 7980000000-N | SP | GENERIC SIGNAL ITEM PTZ JOYSTICK | 3 EA | | |
| 0110 | 7980000000-N | SP | GENERIC SIGNAL ITEM SMALL FORM FACTOR COMPUTER | 3 EA | | |
| 0111 | 7980000000-N | SP | GENERIC SIGNAL ITEM TERMINAL SPLICE CABINET | 9 EA | | |
| 0112 | 7980000000-N | SP | GENERIC SIGNAL ITEM TYPE 332 TEST CONTROLLER WITH CABINET | 1 EA | | |
| 0113 | 7980000000-N | SP | GENERIC SIGNAL ITEM TYPE 336 TEST CONTROLLER WITH CABINET | 1 EA | | |
| 0114 | 7980000000-N | SP | GENERIC SIGNAL ITEM UPS (TCC) | 1 EA | | |
| 0115 | 7980000000-N | SP | GENERIC SIGNAL ITEM WIRELESS ACCESS POINT | 1 EA | | |
| 0116 | 7980000000-N | SP | GENERIC SIGNAL ITEM WORKSTATION MONITOR | 19 EA | | |
| 0117 | 7985000000-N | SP | GENERIC SIGNAL ITEM CCTV SOFTWARE (MODIFY) | Lump Sum | L.S. | |
| 0118 | 7985000000-N | SP | GENERIC SIGNAL ITEM MAINTENANCE MANAGEMENT SYSTEM SOFTWARE | Lump Sum | L.S. | |
| 0119 | 7985000000-N | SP | GENERIC SIGNAL ITEM NETWORK MANAGEMENT SOFTWARE (MODIFY) | Lump Sum | L.S. | |

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| Line # | Item Number | Sec # | Description | Quantity | Unit Cost | Amount |
|--------|--------------|-------|---|-------------|-----------|--------|
| 0120 | 7985000000-N | SP | GENERIC SIGNAL ITEM SIGNAL SYSTEM SOFTWARE | Lump Sum | L.S. | |
| 0121 | 7985000000-N | SP | GENERIC SIGNAL ITEM SIGNAL TIMING DATABASE CONVERSION SOFTWARE | Lump Sum | L.S. | |
| 0122 | 7985000000-N | SP | GENERIC SIGNAL ITEM SYSTEM SUPPORT SOFTWARE & DEVICES | Lump Sum | L.S. | |
| 0123 | 7985000000-N | SP | GENERIC SIGNAL ITEM TCC BUILDING MODIFICATIONS | Lump Sum | L.S. | |
| 0124 | 7985000000-N | SP | GENERIC SIGNAL ITEM TRAINING | Lump Sum | L.S. | |
| 0125 | 7985000000-N | SP | GENERIC SIGNAL ITEM VIDEO MANAGEMENT SOFTWARE | Lump Sum | L.S. | |
| 0126 | 7985000000-N | SP | GENERIC SIGNAL ITEM VIDEO WALL SOFTWARE | Lump Sum | L.S. | |
| 0127 | 7990000000-E | SP | GENERIC SIGNAL ITEM AERIAL CABLE PROTECTOR | 190 LF | | |
| 0128 | 7990000000-E | SP | GENERIC SIGNAL ITEM BACK PULL FIBER-OPTIC CABLE | 2,660 LF | | |
| 0129 | 7990000000-E | SP | GENERIC SIGNAL ITEM ETHERNET CABLE | 7,185 LF | | |
| 0130 | 7990000000-E | SP | GENERIC SIGNAL ITEM SERVICE CONDUCTORS | 405 LF | | |
| 0131 | 7990000000-E | SP | GENERIC SIGNAL ITEM UNDERGROUND CONDUIT (1, 1") | 75 LF | | |
| 0132 | 7990000000-E | SP | GENERIC SIGNAL ITEM UNDERGROUND CONDUIT (1, 2") | 5,637 LF | | |
| 0133 | 7990000000-E | SP | GENERIC SIGNAL ITEM UNDERGROUND CONDUIT (2, 2") | 9,100 LF | | |