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

PROPOSAL

INCLUDES ADDENDUM No. 3 DATED 12-13-16
INCLUDES ADDENDUM No. 2 DATED 11-29-16
INCLUDES ADDENDUM No. 1 DATED 10-13-16

DATE AND TIME OF BID OPENING: **DECEMBER 20, 2016 AT 2:00 PM**

CONTRACT ID	C203875
WBS	46478.3.1

FEDERAL-AID NO.	STATE FUNDED
COUNTY	TYRRELL, DARE
T.I.P. NO.	B-5936
MILES	2.828
ROUTE NO.	US 64
LOCATION	BRIDGE #7 OVER ALLIGATOR RIVER ON US-64.

TYPE OF WORK BRIDGE REHABILITATION

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 STRUCTURE PROPOSAL

5% BID BOND OR BID DEPOSIT REQUIRED

_____

PROPOSAL FOR THE CONSTRUCTION OF

CONTRACT No. C203875 IN TYRRELL-DARE 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. **C203875**; has carefully examined the plans and specifications, which are acknowledged to be part of the proposal, the special provisions, the proposal, the form of contract, and the forms of contract payment bond and contract performance bond; and thoroughly understands the stipulations, requirements and provisions. The undersigned bidder agrees to be bound upon his execution of the bid and subsequent award to him by the Board of Transportation in accordance with this proposal to provide the necessary contract payment bond and contract performance bond within fourteen days after the written notice of award is received by him. The undersigned Bidder further agrees to provide all necessary machinery, tools, labor, and other means of construction; and to do all the work and to furnish all materials, except as otherwise noted, necessary to perform and complete the said contract in accordance with *the 2012 Standard Specifications for Roads and Structures* by the dates(s) specified in the Project Special Provisions and in accordance with the requirements of the Engineer, and at the unit or lump sum prices, as the case may be, for the various items given on the sheets contained herein.

The Bidder shall provide and furnish all the materials, machinery, implements, appliances and tools, and perform the work and required labor to construct and complete State Highway Contract No. **C203875** in **Tyrrell County**, for the unit or lump sum prices, as the case may be, bid by the Bidder in his bid and according to the proposal, plans, and specifications prepared by said Department, which proposal, plans, and specifications show the details covering this project, and hereby become a part of this contract.

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

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

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

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

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

State Contract Officer

DocuSigned by:
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12/13/2016

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GENERAL

CONTRACT TIME AND LIQUIDATED DAMAGES:

(7-1-95) (Rev. 12-18-07) 108 SP1 G10 A

The date of availability for this contract is **January 30, 2017**.

The completion date for this contract is **May 23, 2019**.

Except where otherwise provided by the contract, observation periods required by the contract will not be a part of the work to be completed by the completion date and/or intermediate contract times stated in the contract. The acceptable completion of the observation periods that extend beyond the final completion date shall be a part of the work covered by the performance and payment bonds.

The liquidated damages for this contract are **Two Thousand Dollars ($ 2,000.00)** per calendar day.

INTERMEDIATE CONTRACT TIME NUMBER 1 AND LIQUIDATED DAMAGES:

(2-20-07) 108 SP1 G14 A

The Contractor shall complete the required work of installing, maintaining, and removing the traffic control devices for lane closures and restoring traffic to the existing traffic pattern. The Contractor shall not close or narrow a lane of traffic on **US-64** during the following time restrictions:

DAY AND TIME RESTRICTIONS

May 1st thru September 30th (Each Year)
Friday 6:00 a.m. thru Sunday 9:00 p.m.

In addition, the Contractor shall not close or narrow a lane of traffic on **US-64**, detain and/or alter the traffic flow on or during holidays, holiday weekends, special events, or any other time when traffic is unusually heavy, including the following schedules:

HOLIDAY AND HOLIDAY WEEKEND LANE CLOSURE RESTRICTIONS

1. For **unexpected occurrence** that creates unusually high traffic volumes, as directed by the Engineer.

2. For **New Year's Day**, between the hours of **6:00 A.M.** December 31st and **9:00 P.M.** January 2nd. If New Year's Day is on a Friday, Saturday, Sunday or Monday, then until **9:00 P.M.** the following Tuesday.

3. For **Easter**, between the hours of **6:00 A.M.** Thursday and **9:00 P.M.** Monday.

4. For **Memorial Day**, between the hours of **6:00 A.M.** Friday and **9:00 P.M.** Tuesday.

5. For **Independence Day**, between the hours of **6:00 A.M.** the day before Independence Day and **9:00 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 **9:00 P.M.** the Tuesday after Independence Day.

6. For **Labor Day**, between the hours of **6:00 A.M.** Friday and **9:00 P.M.** Tuesday.

7. For **Thanksgiving Day**, between the hours of **6:00 A.M.** Tuesday and **9:00 P.M.** Monday.

8. For **Christmas**, between the hours of **6:00 A.M.** the Friday before the week of Christmas Day and **9:00 P.M.** the following Tuesday after the week of Christmas Day.

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** (**$ 1,000.00**) per hour.

INTERMEDIATE CONTRACT TIME NUMBER 2 AND LIQUIDATED DAMAGES:
(6-18-13) 108 SP1 G14 L

The Contractor shall complete the work required of **Mechanical Equipment (Section: Stabilizing Machinery, Part A: Center Pivot Bearing Assembly and Part B: Balance Wheel Assemblies) for the Moveable Portion of Bridge #7,** as shown on Sheets **TMP-1B thru TMP-6** and shall place and maintain traffic on same.

The date of availability for this intermediate contract time is **the Wednesday the Contractor elects to begin work, no earlier than January 3, 2018 and no later than March 7, 2018**.

The completion date for this intermediate contract time is **the following Wednesday after and including the date the Contractor begins this work**.

The liquidated damages are **Five Thousand Dollars ($ 5,000.00)** per calendar day.

INTERMEDIATE CONTRACT TIME NUMBER 3 AND LIQUIDATED DAMAGES:
(2-20-07) (Rev. 6-18-13) 108 SP1 G14 H

The contractor shall complete **all work required for constructing electrical/mechanical upgrades and Control House renovations, pivot pier pile repair, epoxy overlay on the moveable span and adjacent approach span at each end of the moveable span.**

The date of availability for this intermediate contract time is the date the contractor elects to begin the work.

The completion date for this intermediate contract time is **August 31, 2018**.

The liquidated damages are **One Thousand Dollars** ($ **1,000.00**) per calendar day.

MANDATORY PRE-BID CONFERENCE (Prequalifying To Bid):
(7-18-06) (Rev. 3-25-13) SPI 1-14(Rev)

In order for all prospective bidders to have an extensive knowledge of the project, all prospective bidders shall attend a mandatory pre-bid conference on **Thursday November 3, 2016** at 10:00 am at:

Chief Engineer's Conference Room
NCDOT Equipment and Maintenance Facility
4809 Beryl Rd
Raleigh, NC 27606
(919)733-2220

The bidders shall also attend a mandatory site visit on **Friday November 4, 2016** at 10:00 a.m. weather permitting. Specifics for the site visit will be discussed at the mandatory pre-bid conference.

The pre-bid conference and site visit will include thorough discussions of the plans, contract pay items, special provisions, etc.

Only bidders who have attended and properly registered at the above scheduled pre-bid conference and site visit and who have met all other prequalification requirements will be considered prequalified to bid on this project. A bid received from a bidder who has not attended and properly registered at both the above scheduled pre-bid conference and site visit will not be accepted and considered for award.

Attendance at the pre-bid conference and site visit will not meet the requirements of proper registration unless the individual attending has registered at the pre-bid conference and site visit in accordance with the following:

(A) The individual has signed his name on the official roster no later than thirty (30) minutes after the above noted time for the beginning of the conference/site visit.

(B) The individual has written in the name and address of the company he or she represents.

(C) Only one company has been shown as being represented by the individual attending.

(D) The individual attending is an officer or permanent employee of the company they are representing.

Attendance at any prior pre-bid conference/site visit will not meet the requirement of this provision.

COORDINATION WITH THE U. S. COAST GUARD (SPECIAL)

At no time during work will the waterway be closed or narrowed to navigation without prior approval from the U.S. Coast Guard. The contractor is required to maintain close and regular contact with the Coast Guard, Sector North Carolina to keep them informed to activities in the waterway. The U.S. Coast Guard Sector North Carolina contacts are LT Derek Burrill at (910)-772-2230 or BM1 Poden Pedrus at (910) 772-2212 or email ncmarineevents@uscg.mil. The Contractor must also contact the 5th Coast Guard District Bridges Branch, Mr. Hal Pitts 757-398-6222 or email at Hal.R.Pitts@uscg.mil.

The Contractor shall bear full responsibility for all required coordination with the Coast Guard. Advance coordination with the Coast Guard for any anticipated disruptions to waterway traffic shall begin within 30 days following award of Contract and prior to commencing on-site activities. Approval for scheduled waterway disruptions shall be initiated approximately 180 days in advance, and confirmed no less than 30 days but no more than 45 days, in advance of the first disruption.

All work shall be conducted so that free navigation of the waterway is not unreasonably interfered with and the present navigable depths are not impaired. Timely notice of any and all events that affect navigation shall be given to the District Commander during the work on the channel span. The channel shall be promptly cleared of all obstructions placed therein or caused by the contractor.

MAJOR CONTRACT ITEMS:

(2-19-02) 104 SP1 G28

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

Line #		Description
19	—	Shotcrete Repairs
51	—	Pile Jackets
57	—	Epoxy Overlay System-Mechanically Distributed

NO SPECIALTY ITEMS:
(7-1-95) 108-6 SP1 G34

None of the items included in this contract will be specialty items (see Article 108-6 of the *2012 Standard Specifications*).

FUEL PRICE ADJUSTMENT:
(11-15-05) (Rev. 2-18-14) 109-8 SP1 G43

Revise the *2012 Standard Specifications* as follows:

Page 1-83, Article 109-8, Fuel Price Adjustments, add the following:

The base index price for DIESEL #2 FUEL is **$ 1.6237** per gallon. Where any of the following are included as pay items in the contract, they will be eligible for fuel price adjustment.

The pay items and the fuel factor used in calculating adjustments to be made will be as follows:

Description	Units	Fuel Usage Factor Diesel
Unclassified Excavation	Gal/CY	0.29
Borrow Excavation	Gal/CY	0.29
Class IV Subgrade Stabilization	Gal/Ton	0.55
Aggregate Base Course	Gal/Ton	0.55
Sub-Ballast	Gal/Ton	0.55
Asphalt Concrete Base Course, Type ____	Gal/Ton	2.90
Asphalt Concrete Intermediate Course, Type ____	Gal/Ton	2.90
Asphalt Concrete Surface Course, Type ____	Gal/Ton	2.90
Open-Graded Asphalt Friction Course	Gal/Ton	2.90
Permeable Asphalt Drainage Course, Type ____	Gal/Ton	2.90
Sand Asphalt Surface Course, Type ____	Gal/Ton	2.90
Aggregate for Cement Treated Base Course	Gal/Ton	0.55
Portland Cement for Cement Treated Base Course	Gal/Ton	0.55
__" Portland Cement Concrete Pavement	Gal/SY	0.245
Concrete Shoulders Adjacent to __" Pavement	Gal/SY	0.245

SCHEDULE OF ESTIMATED COMPLETION PROGRESS:
(7-15-08) (Rev. 5-17-16) 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:

Fiscal Year		Progress (% of Dollar Value)
2017	(7/01/16 - 6/30/17)	**26**% of Total Amount Bid
2018	(7/01/17 - 6/30/18)	**49**% of Total Amount Bid
2019	(7/01/18 - 6/30/19)	**25**% of Total Amount Bid

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

MINORITY BUSINESS ENTERPRISE AND WOMEN BUSINESS ENTERPRISE:
(10-16-07)(Rev. 7-19-16) 102-15(J) SP1 G66

Description

The purpose of this Special Provision is to carry out the North Carolina Department of Transportation's policy of ensuring nondiscrimination in the award and administration of contracts financed in whole or in part with State funds.

Definitions

Additional MBE/WBE Subcontractors - Any MBE/WBE submitted at the time of bid that will not be used to meet either the MBE or WBE goal. No submittal of a Letter of Intent is required, unless the additional participation is used for banking purposes.

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

Contract Goals Requirement - The approved MBE and WBE participation at time of award, but not greater than the advertised contract goals for each.

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

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

Minority Business Enterprise (MBE) - A firm certified as a Disadvantaged Minority-Owned Business Enterprise through the North Carolina Unified Certification Program.

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 MBE/WBE certification. The MBE/WBE program follows the same regulations as the federal Disadvantaged Business Enterprise (DBE) program 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.

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

Women Business Enterprise (WBE) - A firm certified as a Disadvantaged Women-Owned Business Enterprise through the North Carolina Unified Certification Program.

Forms and Websites Referenced in this Provision

Payment Tracking System - On-line system in which the Contractor enters the payments made to MBE and WBE 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 MBE/WBE firms working on the project. This form is for paper bid projects only. http://www.ncdot.org/doh/forms/files/DBE-IS.xls

RF-1 *MBE/WBE Replacement Request Form* - Form for replacing a committed MBE or WBE. 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 MBE/WBE subcontractor, manufacturer or regular dealer that affirms that a portion of said contract is going to be performed by the signed MBE/WBE 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 MBE and WBE Subcontractors Form - Form for entering MBE/WBE subcontractors on a project that will meet this MBE and WBE goals. This form is for paper bids only.
http://connect.ncdot.gov/municipalities/Bid%20Proposals%20for%20LGA%20Content/09%20MBE-WBE%20Subcontractors%20(State).docx
Subcontractor Quote Comparison Sheet - Spreadsheet for showing all subcontractor quotes in the work areas where MBEs and WBEs 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

MBE and WBE Goal

The following goals for participation by Minority Business Enterprises and Women Business Enterprises are established for this contract:

(A) Minority Business Enterprises **0.0** %

(1) *If the MBE goal is more than zero*, the Contractor shall exercise all necessary and reasonable steps to ensure that MBEs participate in at least the percent of the contract as set forth above as the MBE goal.

(2) *If the MBE goal is zero*, the Contractor shall make an effort to recruit and use MBEs during the performance of the contract. Any MBE participation obtained shall be reported to the Department.

(B) Women Business Enterprises **1.0** %

(1) *If the WBE goal is more than zero*, the Contractor shall exercise all necessary and reasonable steps to ensure that WBEs participate in at least the percent of the contract as set forth above as the WBE goal.

(2) *If the WBE goal is zero*, the Contractor shall make an effort to recruit and use WBEs during the performance of the contract. Any WBE 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 MBE and WBE certified shall be used to meet the MBE and WBE goals respectively. The Directory can be found at the following link. https://partner.ncdot.gov/VendorDirectory/default.html

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

Listing of MBE/WBE Subcontractors

At the time of bid, bidders shall submit all MBE and WBE participation that they anticipate to use during the life of the contract. Only those identified to meet the MBE goal and the WBE goal will be considered committed, even though the listing shall include both committed MBE/WBE subcontractors and additional MBE/WBE subcontractors. Any additional MBE/WBE subcontractor participation above the goal for which letters of intent are received will follow the banking guidelines found elsewhere in this provision. All other additional MBE/WBE subcontractor participation submitted at the time of bid will be used toward the Department's overall race-neutral goals. Only those firms with current MBE and WBE certification at the time of bid opening will be acceptable for listing in the bidder's submittal of MBE and WBE participation. The Contractor shall indicate the following required information:

(A) Electronic Bids

Bidders shall submit a listing of MBE and WBE participation in the appropriate section of Expedite, the bidding software of Bid Express®.

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

(2) Submit the contract line numbers of work to be performed by each MBE and WBE firm. When no figures or firms are entered, the bidder will be considered to have no MBE or WBE participation.

(3) The bidder shall be responsible for ensuring that the MBE and WBE are 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 MBE's or WBE's participation will not count towards achieving either the MBE or WBE goal.

(B) Paper Bids

(1) *If either the MBE or WBE goal is more than zero,*

(a) Bidders, at the time the bid proposal is submitted, shall submit a listing of MBE/WBE participation, including the names and addresses on *Listing of MBE and WBE 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 MBE and WBE participation for the contract.

(b) If bidders have no MBE or WBE participation, they shall indicate this on the *Listing of MBE and WBE 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 MBE and WBE 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 MBE/WBE 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 MBE's or WBE's participation will not count towards achieving the corresponding goal.

(2) *If either the MBE or WBE goal is zero,* entries on the *Listing of MBE and WBE Subcontractors* are not required for the zero goal, however any MBE or WBE participation that is achieved during the project shall be reported in accordance with requirements contained elsewhere in the special provision.

MBE or WBE Prime Contractor

When a certified MBE or WBE firm bids on a contract that contains MBE and WBE goals, the firm is responsible for meeting the goals or making good faith efforts to meet the goals, just like any other bidder. In most cases, a MBE or WBE bidder on a contract will meet one of the goals by virtue of the work it performs on the contract with its own forces. However, all the work that is performed by the MBE or WBE bidder and any other similarly certified subcontractors will count toward the goal. The MBE or WBE bidder shall list itself along with any MBE or WBE subcontractors, if any, in order to receive credit toward the goals.

For example, on a proposed contract, the WBE goal is 10%, and the MBE goal is 8%. A WBE bidder puts in a bid where they will perform 40% of the contract work and have a WBE subcontractor which will perform another 5% of the work. Together the two WBE firms submit on the *Listing of MBE and WBE Subcontractors* a value of 45% of the contract which fulfills the WBE goal. The 8% MBE goal shall be obtained through MBE participation with MBE certified subcontractors or documented through a good faith effort. It should be noted that you cannot combine the two goals to meet an overall value. The two goals shall remain separate.

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

Written Documentation – Letter of Intent

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

The documentation shall be received in the office of the State Contractor Utilization Engineer or at DBE@ncdot.gov no later than 12:00 noon of the sixth calendar day following opening of bids,

unless the sixth day falls on an official state holiday. In that situation, it is due in the office of the State Contractor Utilization Engineer no later than 12:00 noon on the next official state business day.

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

Submission of Good Faith Effort

If the bidder fails to meet or exceed either the MBE or the WBE goal, the apparent lowest responsive bidder shall submit to the Department documentation of adequate good faith efforts made to reach that specific goal(s).

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

Note: Where the information submitted includes repetitious solicitation letters, it will be acceptable to submit a representative letter along with a distribution list of the firms that were solicited. Documentation of MBE/WBE 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 MBE/WBE 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 MBE/WBE participation. Adequate good faith efforts also mean that the bidder actively and aggressively sought MBE/WBE 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 goals 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 MBEs/WBEs that are also prequalified subcontractors. The bidder must solicit this interest within at least 10 days prior to bid opening to allow the MBEs/WBEs to respond to the solicitation. Solicitation shall provide the opportunity to MBEs/WBEs within the Division and surrounding Divisions where the project is located. The bidder must determine with certainty if the MBEs/WBEs are interested by taking appropriate steps to follow up initial solicitations.

(B) Selecting portions of the work to be performed by MBEs/WBEs in order to increase the likelihood that the MBE and WBE goals will be achieved.

(1) Where appropriate, break out contract work items into economically feasible units to facilitate MBE/WBE 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 MBE/WBE goals when the work to be sublet includes potential for MBE/WBE participation (2^{nd} and 3^{rd} tier subcontractors).

(C) Providing interested certified MBEs/WBEs that are also prequalified subcontractors 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 MBEs/WBEs. It is the bidder's responsibility to make a portion of the work available to MBE/WBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available MBE/WBE subcontractors and suppliers, so as to facilitate MBE/WBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of MBEs/WBEs 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 MBEs/WBEs to perform the work.

(2) A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including MBE/WBE 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 MBEs/WBEs is not in itself sufficient reason for a bidder's failure to meet the contract MBE or WBE goals, 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 MBEs/WBEs if the price difference is excessive or unreasonable.

(E) Not rejecting MBEs/WBEs 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 MBEs/WBEs in obtaining bonding, lines of credit, or insurance as required by the recipient or bidder.

(G) Making efforts to assist interested MBEs/WBEs 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 MBEs/WBEs. Contact within 7 days from the bid opening the Business Development Manager in the Business Opportunity and Work Force Development Unit to give notification of the bidder's inability to get MBE or WBE quotes.

(I) Any other evidence that the bidder submits which shows that the bidder has made reasonable good faith efforts to meet the MBE and WBE 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 MBE and WBE goals.

(2) The bidders' past performance in meeting the MBE and WBE goals.

(3) The performance of other bidders in meeting the MBE and WBE goals. For example, when the apparent successful bidder fails to meet the goals, but others meet it, you may reasonably raise the question of whether, with additional reasonable efforts the apparent successful bidder could have met the goals. If the apparent successful bidder fails to meet the MBE and WBE goals, but meets or exceeds the average MBE and WBE 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 MBE and WBE goals can be met or that an adequate good faith effort has been made to meet the MBE and WBE goals.

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 MBE/WBE Participation Toward Meeting MBE/WBE Goals

(A) Participation

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

(B) Joint Checks

Prior notification of joint check use shall be required when counting MBE/WBE 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 MBE/WBE may enter into subcontracts. Work that a MBE subcontracts to another MBE firm may be counted toward the MBE contract goal requirement. The same holds for work that a WBE subcontracts to another WBE firm. Work that a MBE subcontracts to a non-MBE firm does <u>not</u> count toward the MBE contract goal requirement. Again, the same holds true for the work that a WBE subcontracts to a non-WBE firm. If a MBE or WBE 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 MBE or WBE is not performing a commercially useful function. The MBE/WBE may present evidence to rebut this presumption to the Department. The Department's decision on the rebuttal of this presumption may be subject to review by the Office of Inspector General, NCDOT.

(D) Joint Venture

When a MBE or WBE 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 MBE or WBE in the joint venture, that portion of the total dollar value being a distinct clearly defined portion of work that the MBE or WBE performs with its forces.

(E) Suppliers

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

(F) Manufacturers and Regular Dealers

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

(1) The fees or commissions charged by a MBE/WBE 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 MBE/WBE, 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) MBE/WBE Utilization

The Contractor may count toward its contract goal requirement only expenditures to MBEs and WBEs that perform a commercially useful function in the work of a contract. A MBE/WBE 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 MBE/WBE 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 MBE/WBE 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 MBE/WBE credit claimed for its performance of the work, and any other relevant factors.

(B) MBE/WBE Utilization in Trucking

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

(1) The MBE/WBE 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 the MBE or WBE goal.

(2) The MBE/WBE shall itself own and operate at least one fully licensed, insured, and operational truck used on the contract.

(3) The MBE/WBE 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 MBE may subcontract the work to another MBE firm, including an owner-operator who is certified as a MBE. The same holds true that a WBE may subcontract the work to another WBE firm, including an owner-operator who is certified as a WBE. When this occurs, the MBE or WBE who subcontracts work receives credit for the total value of the transportation services the subcontracted MBE or WBE provides on the contract. It should be noted that every effort shall be made by MBE and WBE contractors to subcontract to the same certification (i.e., MBEs to MBEs and WBEs to WBEs), in order to fulfill the goal requirement. This, however, may not always be possible due to the limitation of firms in the area. If the MBE or WBE firm shows a good faith effort has been made to reach out to similarly certified transportation service providers and there is no interest or availability, and they can get assistance from other certified providers, the Engineer will not hold the prime liable for meeting the goal.

(5) The MBE/WBE may also subcontract the work to a non-MBE/WBE firm, including from an owner-operator. The MBE/WBE who subcontracts the work to a non-MBE/WBE is entitled to credit for the total value of transportation services provided by the non-MBE/WBE subcontractor not to exceed the value of transportation services provided by MBE/WBE-owned trucks on the contract. Additional participation by non-MBE/WBE 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 MBE/WBE and the Contractor will not count towards the MBE/WBE contract requirement.

(6) A MBE/WBE may lease truck(s) from an established equipment leasing business open to the general public. The lease must indicate that the MBE/WBE 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 MBE/WBE, so long as the lease gives the MBE/WBE absolute priority for use of the leased truck. This type of lease may count toward the MBE/WBE's credit as long as the driver is under the MBE/WBE's payroll.

(7) Subcontracted/leased trucks shall display clearly on the dashboard the name of the MBE/WBE 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.

Banking MBE/WBE Credit

If the bid of the lowest responsive bidder exceeds $500,000 and if the committed MBE/WBE participation submitted by Letter of Intent exceeds the algebraic sum of the MBE or WBE goal by $1,000 or more, the excess will be placed on deposit by the Department for future use by the bidder. Separate accounts will be maintained for MBE and WBE participation and these may accumulate for a period not to exceed 24 months.

When the apparent lowest responsive bidder fails to submit sufficient participation by MBE firms to meet the contract goal, as part of the good faith effort, the Department will consider allowing the bidder to withdraw funds to meet the MBE goal as long as there are adequate funds available from the bidder's MBE bank account.

When the apparent lowest responsive bidder fails to submit sufficient participation by WBE firms to meet the contract goal, as part of the good faith effort, the Department will consider allowing the bidder to withdraw funds to meet the WBE goal as long as there are adequate funds available from the bidder's WBE bank account.

MBE/WBE Replacement

When a Contractor has relied on a commitment to a MBE or WBE firm (or an approved substitute MBE or WBE firm) to meet all or part of a contract goal requirement, the contractor shall not terminate the MBE/WBE 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 MBE/WBE subcontractor, a non-MBE/WBE subcontractor, or with the Contractor's own forces or those of an affiliate. A MBE/WBE 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 MBE/WBE firm five (5) calendar 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 MBE/WBE firm shall be submitted to the Engineer for approval on Form RF-1 *(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 MBE/WBE:

(A) Performance Related Replacement

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

If a replacement MBE/WBE is not found that can perform at least the same amount of work as the terminated MBE/WBE, 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 MBEs/WBEs that their interest is solicited in contracting the work defaulted by the previous MBE/WBE or in subcontracting other items of work in the contract.

(2) Efforts to negotiate with MBEs/WBEs for specific subbids including, at a minimum:

(a) The names, addresses, and telephone numbers of MBEs/WBEs who were contacted.
(b) A description of the information provided to MBEs/WBEs regarding the plans and specifications for portions of the work to be performed.

(3) A list of reasons why MBE/WBE quotes were not accepted.

(4) Efforts made to assist the MBEs/WBEs contacted, if needed, in obtaining bonding or insurance required by the Contractor.

(B) Decertification Replacement

(1) When a committed MBE/WBE 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 MBE/WBE 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 MBE/WBE is decertified prior to the Department receiving the SAF (*Subcontract Approval Form*) for the named MBE/WBE firm, the Contractor shall take all necessary and reasonable steps to replace the MBE/WBE

subcontractor with another similarly certified MBE/WBE subcontractor to perform at least the same amount of work to meet the MBE/WBE goal requirement. If a MBE/WBE 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 MBE/WBE, 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 MBE/WBE based upon the Contractor's commitment, the MBE/WBE shall participate in additional work to the same extent as the MBE/WBE 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 MBEs/WBEs 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 MBE/WBE, the Contractor shall seek participation by MBEs/WBEs 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 MBE/WBE, the Contractor shall seek additional participation by MBEs/WBEs equal to the reduced MBE/WBE 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 MBE/WBE subcontractor. The Department reserves the right to require copies of actual subcontract agreements involving MBE/WBE 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 MBE/WBE 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 MBE/WBE credit.

Reporting Minority and Women Business Enterprise Participation

The Contractor shall provide the Engineer with an accounting of payments made to all MBE and WBE 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 MBEs/WBEs, 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-MBE/WBE 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 Payment Tracking System.

Failure to Meet Contract Requirements

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

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).

SUBSURFACE INFORMATION:

(7-1-95) 450 SP1 G112 A

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

LOCATING EXISTING UNDERGROUND UTILITIES:

(3-20-12) 105 SP1 G115

Revise the *2012 Standard Specifications* as follows:

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

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

VALUE ENGINEERING PROPOSAL:

(05-19-15) 104 SP01 G116

Revise the *2012 Standard Specifications* as follows:

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

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

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

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

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

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

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

To facilitate the preparation of revisions to contract drawings, the Contractor may purchase reproducible copies of drawings for his use through the Department's Value Management Unit. The preparation of new design drawings by or for the Contractor shall be coordinated with the appropriate Design Branch through the State Value Management Engineer. The Contractor shall provide, at no charge to the Department, one set of reproducible drawings of the approved design needed to implement the VEP. Drawings (hard copy and electronic) which are sealed by an engineer licensed in the State of North Carolina shall be submitted to the State Value Management Engineer no later than ten (10) business days after acceptance of a VEP unless otherwise permitted.

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

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

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

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

RESOURCE CONSERVATION AND ENV. SUSTAINABLE PRACTICES:

(5-21-13) (Rev. 5-19-15) 104-13 SP1 G118

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

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

Report the quantities of reused or recycled materials either incorporated in the project or diverted from landfills and any practice that minimizes the environmental impact on the project annually on the Project Construction Reuse and Recycling Reporting Form. The Project Construction

Reuse and Recycling Reporting Form and a location tool for local recycling facilities are available at:
http://connect.ncdot.gov/resources/Environmental/Pages/North-Carolina-Recycling-Locations.aspx.

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

DOMESTIC STEEL:

(4-16-13) 106 SP1 G120

Revise the *2012 Standard Specifications* as follows:

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

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

TWELVE MONTH GUARANTEE:

(7-15-03) 108 SP1 G145

(A) The Contractor shall guarantee materials and workmanship against latent and patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve months following the date of final acceptance of the work for maintenance and shall replace such defective materials and workmanship without cost to the Department. The Contractor will not be responsible for damage due to faulty design, normal wear and tear, for negligence on the part of the Department, and/or for use in excess of the design.

(B) Where items of equipment or material carry a manufacturer's guarantee for any period in excess of twelve months, then the manufacturer's guarantee shall apply for that particular piece of equipment or material. The Department's first remedy shall be through the manufacturer although the Contractor is responsible for invoking the warranted repair work with the manufacturer. The Contractor's responsibility shall be limited to the term of the manufacturer's guarantee. NCDOT would be afforded the same warranty as provided by the Manufacturer.

This guarantee provision shall be invoked only for major components of work in which the Contractor would be wholly responsible for under the terms of the contract. Examples would include pavement structures, bridge components, and sign structures. This provision will not be used as a mechanism to force the Contractor to return to the project to make repairs or perform

additional work that the Department would normally compensate the Contractor for. In addition, routine maintenance activities (i.e. mowing grass, debris removal, ruts in earth shoulders,) are not parts of this guarantee.

Appropriate provisions of the payment and/or performance bonds shall cover this guarantee for the project.

To ensure uniform application statewide the Division Engineer will forward details regarding the circumstances surrounding any proposed guarantee repairs to the Chief Engineer for review and approval prior to the work being performed.

OUTSOURCING OUTSIDE THE USA:

(9-21-04) (Rev. 5-16-06) SP1 G150

All work on consultant contracts, services contracts, and construction contracts shall be performed in the United States of America. No work shall be outsourced outside of the United States of America.

Outsourcing for the purpose of this provision is defined as the practice of subcontracting labor, work, services, staffing, or personnel to entities located outside of the United States.

The North Carolina Secretary of Transportation shall approve exceptions to this provision in writing.

IRAN DIVESTMENT ACT:

(5-17-16) SP01 G151

As a result of the Iran Divestment Act of 2015 (Act), Article 6E, N.C. General Statute § 147-86.55, the State Treasurer published the Final Divestment List (List) which includes the Final Divestment List-Iran, and the Parent and Subsidiary Guidance-Iran. These lists identify companies and persons engaged in investment activities in Iran and will be updated every 180 days. The List can be found at https://www.nctreasurer.com/inside-the-department/OpenGovernment/Pages/Iran-Divestment-Act-Resources.aspx

By submitting the Offer, the Contractor certifies that, as of the date of this bid, it is not on the then-current List created by the State Treasurer. The Contractor must notify the Department immediately if, at any time before the award of the contract, it is added to the List.

As an ongoing obligation, the Contractor must notify the Department immediately if, at any time during the contract term, it is added to the List. Consistent with § 147-86.59, the Contractor shall not contract with any person to perform a part of the work if, at the time the subcontract is signed, that person is on the then-current List.

During the term of the Contract, should the Department receive information that a person is in violation of the Act as stated above, the Department will offer the person an opportunity to respond and the Department will take action as appropriate and provided for by law, rule, or contract.

GIFTS FROM VENDORS AND CONTRACTORS:

(12-15-09) 107-1 SP1 G152

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

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

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

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

LIABILITY INSURANCE:

(5-20-14) SP1 G160

Revise the *2012 Standard Specifications* as follows:

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

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

EMPLOYMENT:

(11-15-11) (Rev. 1-17-12) 108, 102 SP1 G184

Revise the *2012 Standard Specifications* as follows:

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

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

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

STATE HIGHWAY ADMINISTRATOR TITLE CHANGE:

(9-18-12) SP1 G185

Revise the *2012 Standard Specifications* as follows:

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

SUBLETTING OF CONTRACT:

(11-18-2014) 108-6 SP1 G186

Revise the *2012 Standard Specifications* as follows:

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

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

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

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

PROJECT SPECIAL PROVISIONS

ROADWAY

ASPHALT PAVEMENTS - SUPERPAVE:

(6-19-12) (Rev. 8-16-16) 605, 609, 610, 650 SP6 R01

Revise the *2012 Standard Specifications* as follows:

Page 6-3, Article 605-7, APPLICATION RATES AND TEMPERATURES, replace this article, including Table 605-1, with the following:

Apply tack coat uniformly across the existing surface at target application rates shown in Table 605-1.

TABLE 605-1
APPLICATION RATES FOR TACK COAT

Existing Surface	Target Rate (gal/sy)
	Emulsified Asphalt
New Asphalt	0.04 ± 0.01
Oxidized or Milled Asphalt	0.06 ± 0.01
Concrete	0.08 ± 0.01

Apply tack coat at a temperature within the ranges shown in Table 605-2. Tack coat shall not be overheated during storage, transport or at application.

TABLE 605-2
APPLICATION TEMPERATURE FOR TACK COAT

Asphalt Material	Temperature Range
Asphalt Binder, Grade PG 64-22	350 - 400°F
Emulsified Asphalt, Grade RS-1H	130 - 160°F
Emulsified Asphalt, Grade CRS-1	130 - 160°F
Emulsified Asphalt, Grade CRS-1H	130 - 160°F
Emulsified Asphalt, Grade HFMS-1	130 - 160°F
Emulsified Asphalt, Grade CRS-2	130 - 160°F

Page 6-6, Subarticle 607-5(A), Milled Asphalt Pavement, line 25, add the following to the end of the paragraph:

Areas to be paid under these items include mainline, turn lanes, shoulders, and other areas milled in conjunction with the mainline and any additional equipment necessary to remove pavement in the area of manholes, water valves, curb, gutter and other obstructions.

Page 6-6, Subarticle 607-5(C), Incidental Milling, lines 42-48, replace the paragraph with the following:

Incidental Milling to be paid will be the actual number of square yards of surface milled where the

Contractor is required to mill butt joints, irregular areas and intersections milled as a separate operation from mainline milling and re-mill areas that are not due to the Contractor's negligence whose length is less than 100 feet. Measurement will be made as provided in Subarticle 607-5(A) for each cut the Contractor is directed to perform. Where the Contractor elects to make multiple cuts to achieve the final depth, no additional measurement will be made. Compensation will be made at the contract unit price per square yard for *Incidental Milling*.

Page 6-7, Article 609-3, FIELD VERIFICATION OF MIXTURE AND JOB MIX FORMULA ADJUSTMENTS, lines 35-37, delete the second sentence of the second paragraph.

Page 6-18, Article 610-1 DESCRIPTION, lines 40-41, delete the last sentence of the last paragraph.

Page 6-19, Subarticle 610-3(A), Mix Design-General, line 5, add the following as the first paragraph:

Warm mix asphalt (WMA) is allowed for use at the Contractor's option in accordance with the NCDOT Approved Products List for WMA Technologies available at:

https://connect.ncdot.gov/resources/Materials/MaterialsResources/Warm%20Mix%20Asphalt%20Approved%20List.pdf

Page 6-20, Subarticle 610-3(C), Job Mix Formula (JMF), lines 47-48, replace the last sentence of the third paragraph with the following:

The JMF mix temperature shall be within the ranges shown in Table 610-1 unless otherwise approved.

Page 6-21, Subarticle 610-3(C) Job Mix Formula (JMF), replace Table 610-1 with the following:

TABLE 610-1
MIXING TEMPERATURE AT THE ASPHALT PLANT

Binder Grade	JMF Mix Temperature
PG 58-28; PG 64-22	250 - 290ºF
PG 70-22	275- 305ºF
PG 76-22	300- 325ºF

Page 6-21, Subarticle 610-3(C) Job Mix Formula (JMF), lines 1-2, in the first sentence of the first paragraph, delete "and compaction". Lines 4-7, delete the second paragraph and replace with the following:

When RAS is used, the JMF mix temperature shall be established at 275ºF or higher.

Page 6-22, Article 610-4, WEATHER, TEMPERATURE AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES, lines 15-17, replace the second sentence of the first paragraph with the following:

Do not place asphalt material when the air or surface temperatures, measured at the location of the paving operation away from artificial heat, do not meet Table 610-5.

Page 6-23, Article 610-4, WEATHER, TEMPERATURE AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES, replace Table 610-5 with the following:

TABLE 610-5
PLACEMENT TEMPERATURES FOR ASPHALT

Asphalt Concrete Mix Type	Minimum Surface and Air Temperature
B25.0B, C	35°F
I19.0B, C, D	35°F
SF9.5A, S9.5B	40°F[A]
S9.5C, S12.5C	45°F[A]
S9.5D, S12.5D	50°F

A. For the final layer of surface mixes containing recycled asphalt shingles (RAS), the minimum surface and air temperature shall be 50ºF.

Page 6-23, Subarticle 610-5(A), General, lines 33-34, replace the last sentence of the third paragraph with the following:

Produce the mixture at the asphalt plant within ±25 ºF of the JMF mix temperature. The temperature of the mixture, when discharged from the mixer, shall not exceed 350ºF.

Page 6-26, Article 610-7, HAULING OF ASPHALT MIXTURE, lines 22-23, in the fourth sentence of the first paragraph replace “so as to overlap the top of the truck bed and” with “to”. Line 28, in the last paragraph, replace “+15 ºF to -25 ºF of the specified JMF temperature.” with “±25 ºF of the specified JMF mix temperature.”

Page 6-26, Article 610-8, SPREADING AND FINISHING, **line 34**, add the following new paragraph:

As referenced in Section 9.6.3 of the *HMA/QMS Manual*, use the automatic screed controls on the paver to control the longitudinal profile. Where approved by the Engineer, the Contractor has the option to use either a fixed or mobile string line.

Page 6-29, Article 610-13, FINAL SURFACE TESTING AND ACCEPTANCE, line 39, add the following after the first sentence in the first paragraph:

Smoothness acceptance testing using the inertial profiler is not required on ramps, loops and turn lanes.

Page 6-30, Subarticle 610-13(A), Option 1 – Inertial Profiler, lines 15-16, replace the fourth sentence of the fourth paragraph with the following:

The interval at which relative profile elevations are reported shall be 2”.

Page 6-30, Subarticle 610-13(A), Option 1 – Inertial Profiler, lines 25-28, replace the ninth paragraph with the following:

Operate the profiler at any speed as per the manufacturer's recommendations to collect valid data.

Page 6-30, Subarticle 610-13(A), Option 1 – Inertial Profiler, lines 30-31, delete the third sentence of the tenth paragraph.

Page 6-31, Subarticle 610-13(A), Option 1 – Inertial Profiler, lines 11-13, replace the first sentence of the third paragraph with the following:

After testing, transfer the profile data from the profiler portable computer's hard drive to a write once storage media (Flash drive, USB, DVD-R or CD-R) or electronic media approved by the Engineer.

Page 6-31, Subarticle 610-13(A), Option 1 – Inertial Profiler, lines 17-18, replace the first sentence of the fourth paragraph with the following:

Submit a report with the documentation and electronic data of the evaluation for each section to the Engineer within 10 days after completion of the smoothness testing. The report shall be in the tabular format for each 0.10 segment or a portion thereof with a summary of the MRI values and the localized roughness areas including corresponding project station numbers or acceptable reference points. Calculate the pay adjustments for all segments in accordance with the formulas in Sections (1) and (2) shown below. The Engineer shall review and approval all pay adjustments unless corrective action is required.

Page 6-31, Subarticle 610-13(A)(1), Acceptance for New Construction, lines 36-37, replace the third paragraph with the following:

The price adjustment will apply to each 0.10-mile section or prorated for a portion thereof, based on the Mean Roughness Index (MRI), the average IRI values from both wheel paths.

Page 6-32, Subarticle 610-13(A)(2), Localized Roughness, lines 12-16, replace the first paragraph with the following:

Areas of localized roughness shall be identified through the "Smoothness Assurance Module (SAM)" provided in the ProVAL software. Use the SAM report to optimize repair strategies by analyzing the measurements from profiles collected using inertial profilers. The ride quality threshold for localized roughness shall be 165 in/mile for any sections that are 15 ft. to 100 ft. in length at the continuous short interval of 25 ft. Submit a continuous roughness report to identify each section with project station numbers or reference points outside the threshold and identify all localized roughness, with the signature of the Operator included with the submitted IRI trace and electronic files.

Page 6-32, Subarticle 610-13(A)(2), Localized Roughness, line 21, add the following new paragraph:

If the Engineer does not require corrective action, the pay adjustment for each area of localized roughness shall be based on the following formula:

PA = (165 – LR#) 5

Where:

PA = Pay Adjustment (dollars)
LR# = The Localized Roughness number determined from SAM report for the ride quality threshold

Page 6-41, Subarticle 650-3(B), Mix Design Criteria, replace Table 650-1 with the following:

TABLE 650-1
OGAFC GRADATION CRITERIA

Sieve Size (mm)	*Type FC-1*	*Type FC-1 Modified*	*Type FC-2 Modified*
19.0	-	-	100
12.5	100	100	80 - 100
9.50	75 - 100	75 - 100	55 - 80
4.75	25 - 45	25 - 45	15 - 30
2.36	5 - 15	5 - 15	5 - 15
0.075	1.0 - 3.0	1.0 - 3.0	2.0 - 4.0

ASPHALT BINDER CONTENT OF ASPHALT PLANT MIXES:

(11-21-00) (Rev. 7-17-12) 609 SP6 R15

The approximate asphalt binder content of the asphalt concrete plant mixtures used on this project will be as follows:

Asphalt Concrete Base Course	Type B 25.0__	4.4%
Asphalt Concrete Intermediate Course	Type I 19.0__	4.8%
Asphalt Concrete Surface Course	Type S 4.75A	6.8%
Asphalt Concrete Surface Course	Type SA-1	6.8%
Asphalt Concrete Surface Course	Type SF 9.5A	6.7%
Asphalt Concrete Surface Course	Type S 9.5__	6.0%
Asphalt Concrete Surface Course	Type S 12.5__	5.6%

The actual asphalt binder content will be established during construction by the Engineer within the limits established in the *2012 Standard Specifications.*

PRICE ADJUSTMENT - ASPHALT BINDER FOR PLANT MIX:

(11-21-00) 620 SP6 R25

Price adjustments for asphalt binder for plant mix will be made in accordance with Section 620 of the *2012 Standard Specifications.*

The base price index for asphalt binder for plant mix is **$ 317.50** per ton.

This base price index represents an average of F.O.B. selling prices of asphalt binder at supplier's terminals on **November 1, 2016**.

FINAL SURFACE TESTING NOT REQUIRED:
(5-18-04) (Rev. 2-16-16) 610 SP6 R45

Final surface testing is not required on this project in accordance with Section 610-13, *Final Surface Testing and Acceptance*.

MATERIALS:
(2-21-12) (Rev. 3-15-16) 1000, 1002, 1005, 1016, 1018, 1024, 1050, 1074, 1078, 1080, 1081, 1086, 1084, 1087, 1092 SP10 R01

Revise the *2012 Standard Specifications* as follows:

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

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

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

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

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

(1) A source change in coarse aggregate, fine aggregate or cement.

(2) A pozzolan class or type change (e.g. Class F fly ash to Class C fly ash).

(3) A quantitative change in coarse aggregate (applies to an increase or decrease greater than 5%), fine aggregate (applies to an increase or decrease greater than 5%), water (applies to an increase only), cement (applies to a decrease only), or pozzolan (applies to an increase or decrease greater than 5%).

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

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

Item	**Section**
Type IL Blended Cement	1024-1

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

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

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

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

TABLE 1000-1
REQUIREMENTS FOR CONCRETE

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

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

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

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

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

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

(H) Handling and Storing Test Panels

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

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

TABLE 1005-1
AGGREGATE GRADATION - COARSE AGGREGATE

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

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

Page 10-39, Article 1016-3, CLASSIFICATIONS , lines 27-32, replace with the following:

Select material is clean, unweathered durable, blasted rock material obtained from an approved source. While no specific gradation is required, the below criteria will be used to evaluate the materials for visual acceptance by the Engineer:

(A) At least 50% of the rock has a diameter of from 1.5 ft to 3 ft,

(B) 30% of the rock ranges in size from 2" to 1.5 ft in diameter, and

(C) Not more than 20% of the rock is less than 2" in diameter. No rippable rock will be permitted.

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

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

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

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

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

TABLE 1024-1
POZZOLANS FOR USE IN PORTLAND CEMENT CONCRETE

Pozzolan	Rate
Class F Fly Ash	20% - 30% by weight of required cement content with 1.0 lb Class F fly ash per lb of cement replaced
Ground Granulated Blast Furnace Slag	35%-50% by weight of required cement content with 1.0 lb slag per lb of cement replaced
Microsilica	4%-8% by weight of required cement content with 1.0 lb microsilica per lb of cement replaced

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

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

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

All fencing material and accessories shall meet Section 106.

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

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

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

TABLE 1078-1
REQUIREMENTS FOR CONCRETE

Property	**28 Day Design Compressive Strength 6,000 psi or less**	**28 Day Design Compressive Strength greater than 6,000 psi**
Maximum Water/Cementitious Material Ratio	0.45	0.40
Maximum Slump without HRWR	3.5"	3.5"
Maximum Slump with HRWR	8"	8"
Air Content (upon discharge into forms)	5 + 2%	5 + 2%

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

(B) At least 3 panels prepared as specified in 5.5.10 of AASHTO M 300, Bullet Hole Immersion Test.

(C) At least 3 panels of 4"x6"x1/4" for the Elcometer Adhesion Pull Off Test, ASTM D4541.

(D) A certified test report from an approved independent testing laboratory for the Salt Fog Resistance Test, Cyclic Weathering Resistance Test, and Bullet Hole Immersion Test as specified in AASHTO M 300.

(E) A certified test report from an approved independent testing laboratory that the product has been tested for slip coefficient and meets AASHTO M253, Class B.

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

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

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

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

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

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

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

TABLE 1081-1
PROPERTIES OF MIXED EPOXY RESIN SYSTEMS

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

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

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

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

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

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

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

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

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

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

1081-4 EPOXY RESIN ADHESIVE FOR BONDING TRAFFIC MARKINGS

(A) General

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

(B) Classification

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

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

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

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

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

(C) Requirements

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

(D) Prequalification

Refer to Subarticle 1081-1(E).

(E) Acceptance

Refer to Subarticle 1081-1(F).

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

Steel sheet piles detailed for permanent applications shall be hot rolled and meet ASTM A572 or ASTM A690 unless otherwise required by the plans. Steel sheet piles shall be coated as required

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

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

The epoxy shall meet Article 1081-4.

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

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

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

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

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

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

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

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

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

GROUT PRODUCTION AND DELIVERY:

(3-17-15) 1003 SP10 R20

Revise the *2012 Standard Specifications* as follows:

Replace Section 1003 with the following:

SECTION 1003
GROUT PRODUCTION AND DELIVERY

1003-1 DESCRIPTION

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

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

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

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

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

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

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

1003-2 MATERIALS

Refer to Division 10.

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

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

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

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

TABLE 1003-1
AGGREGATE REQUIREMENTS FOR TYPE 5 GROUT

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

1003-3 COMPOSITION AND DESIGN

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

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

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

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

Perform laboratory tests in accordance with the following test procedures:

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

A. Applicable to grout with aggregate.
B. Applicable to Neat Cement Grout.
C. American National Standards Institute/American Petroleum Institute Recommended Practice.
D. Procedure A (Rapid Freezing and Thawing in Water) required.
E. Moist room storage required.

1003-4 GROUT REQUIREMENTS

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

TABLE 1003-2 GROUT REQUIREMENTS					
Type of Grout	**Minimum Compressive Strength at**		**Height Change at 28 days**	**Flow[A]/Slump[B]**	**Minimum Durability Factor**
	3 days	**28 days**			
1	3,000 psi	–	–	10 – 30 sec	–
2	Table 1[C]			Fluid Consistency[C]	–
3	5,000 psi	–	0 – 0.2%	Per Accepted Grout Mix Design/ Approved Packaged Grout	80
4[D]	600 psi	1,500 psi	–	10 – 26 sec	–
5	–	500 psi	–	1 – 3"	–

A. Applicable to Type 1 through 4 grouts.
B. Applicable to Type 5 grout.
C. ASTM C1107.
D. Use Type 4 grout with proportions by volume of 1 part cement and 3 parts fly ash.

1003-5 TEMPERATURE REQUIREMENTS

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

1003-6 ELAPSED TIME FOR PLACING GROUT

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

TABLE 1003-3 ELAPSED TIME FOR PLACING GROUT (with continuous agitation)		
Air or Grout Temperature, Whichever is Higher	**Maximum Elapsed Time**	
	No Retarding Admixture Used	**Retarding Admixture Used**
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below	60 minutes	1 hr. 45 minutes

1003-7 MIXING AND DELIVERY

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

STANDARD SPECIAL PROVISION
AVAILABILITY OF FUNDS – TERMINATION OF CONTRACTS

(5-20-08) Z-2

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

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

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

STANDARD SPECIAL PROVISION
NCDOT GENERAL SEED SPECIFICATION FOR SEED QUALITY

(5-17-11) Z-3

Seed shall be sampled and tested by the North Carolina Department of Agriculture and Consumer Services, Seed Testing Laboratory. When said samples are collected, the vendor shall supply an independent laboratory report for each lot to be tested. Results from seed so sampled shall be final. Seed not meeting the specifications shall be rejected by the Department of Transportation and shall not be delivered to North Carolina Department of Transportation warehouses. If seed has been delivered it shall be available for pickup and replacement at the supplier's expense.

Any re-labeling required by the North Carolina Department of Agriculture and Consumer Services, Seed Testing Laboratory, that would cause the label to reflect as otherwise specified herein shall be rejected by the North Carolina Department of Transportation.

Seed shall be free from seeds of the noxious weeds Johnsongrass, Balloonvine, Jimsonweed, Witchweed, Itchgrass, Serrated Tussock, Showy Crotalaria, Smooth Crotalaria, Sicklepod, Sandbur, Wild Onion, and Wild Garlic. Seed shall not be labeled with the above weed species on the seed analysis label. Tolerances as applied by the Association of Official Seed Analysts will NOT be allowed for the above noxious weeds except for Wild Onion and Wild Garlic.

Tolerances established by the Association of Official Seed Analysts will generally be recognized. However, for the purpose of figuring pure live seed, the found pure seed and found germination percentages as reported by the North Carolina Department of Agriculture and Consumer Services, Seed Testing Laboratory will be used. Allowances, as established by the NCDOT, will be recognized for minimum pure live seed as listed on the following pages.

The specifications for restricted noxious weed seed refers to the number per pound as follows:

Restricted Noxious **Weed**	Limitations per Lb. Of Seed	Restricted Noxious **Weed**	Limitations per Lb. of Seed
Blessed Thistle	4 seeds	Cornflower (Ragged Robin)	27 seeds
Cocklebur	4 seeds	Texas Panicum	27 seeds
Spurred Anoda	4 seeds	Bracted Plantain	54 seeds
Velvetleaf	4 seeds	Buckhorn Plantain	54 seeds
Morning-glory	8 seeds	Broadleaf Dock	54 seeds
Corn Cockle	10 seeds	Curly Dock	54 seeds
Wild Radish	12 seeds	Dodder	54 seeds
Purple Nutsedge	27 seeds	Giant Foxtail	54 seeds
Yellow Nutsedge	27 seeds	Horsenettle	54 seeds
Canada Thistle	27 seeds	Quackgrass	54 seeds
Field Bindweed	27 seeds	Wild Mustard	54 seeds
Hedge Bindweed	27 seeds		

Seed of Pensacola Bahiagrass shall not contain more than 7% inert matter, Kentucky Bluegrass, Centipede and Fine or Hard Fescue shall not contain more than 5% inert matter whereas a maximum of 2% inert matter will be allowed on all other kinds of seed. In addition, all seed shall not contain more than 2% other crop seed nor more than 1% total weed seed. The germination rate as tested by the North Carolina Department of Agriculture shall not fall below 70%, which includes both dormant and hard seed. Seed shall be labeled with not more than 7%, 5% or 2% inert matter (according to above specifications), 2% other crop seed and 1% total weed seed.

Exceptions may be made for minimum pure live seed allowances when cases of seed variety shortages are verified. Pure live seed percentages will be applied in a verified shortage situation. Those purchase orders of deficient seed lots will be credited with the percentage that the seed is deficient.

FURTHER SPECIFICATIONS FOR EACH SEED GROUP ARE GIVEN BELOW:

Minimum 85% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 restricted noxious weed seed per pound. Seed less than 83% pure live seed will not be approved.

Sericea Lespedeza
Oats (seeds)

Minimum 80% pure live seed; maximum 1% total weed seed; maximum 2% total other crop; maximum 144 restricted noxious weed seed per pound. Seed less than 78% pure live seed will not be approved.

Tall Fescue (all approved varieties)
Kobe Lespedeza
Korean Lespedeza
Weeping Lovegrass
Carpetgrass
Bermudagrass
Browntop Millet
German Millet – Strain R
Clover – Red/White/Crimson

Minimum 78% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 restricted noxious weed seed per pound. Seed less than 76% pure live seed will not be approved.

Common or Sweet Sundangrass

Minimum 76% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 restricted noxious weed seed per pound. Seed less than 74% pure live seed will not be approved.

Rye (grain; all varieties)
Kentucky Bluegrass (all approved varieties)
Hard Fescue (all approved varieties)
Shrub (bicolor) Lespedeza

Minimum 70% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 144 noxious weed seed per pound. Seed less than 70% pure live seed will not be approved.

Centipedegrass
Crownvetch
Pensacola Bahiagrass
Creeping Red Fescue
Japanese Millet
Reed Canary Grass
Zoysia

Minimum 70% pure live seed; maximum 1% total weed seed; maximum 2% total other crop seed; maximum 5% inert matter; maximum 144 restricted noxious weed seed per pound.

Barnyard Grass
Big Bluestem
Little Bluestem
Bristly Locust
Birdsfoot Trefoil
Indiangrass
Orchardgrass
Switchgrass
Yellow Blossom Sweet Clover

STANDARD SPECIAL PROVISION

ERRATA

(1-17-12) (Rev. 04-21-15) Z-4

Revise the *2012 Standard Specifications* as follows:

Division 2

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

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

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

Division 3

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

Division 4

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

Division 6

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

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

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

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

Division 7

Page 7-1, Article 700-3, CONCRETE HAULING EQUIPMENT, line 33, replace "competion" with "completion".

Division 8

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

Division 10

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

Division 12

Page 12-7, Table 1205-3, add "FOR THERMOPLASTIC" to the end of the title.
Page 12-8, Subarticle 1205-5(B), line 13, replace "Table 1205-2" with "Table 1205-4".
Page 12-8, Table 1205-4 and 1205-5, replace "THERMOPLASTIC" in the title of these tables with "POLYUREA".
Page 12-9, Subarticle 1205-6(B), line 21, replace "Table 1205-4" with "Table 1205-6".
Page 12-11, Subarticle 1205-8(C), line 25, replace "Table 1205-5" with "Table 1205-7".

Division 15

Page 15-4, Subarticle 1505-3(F) Backfilling, line 26, replace "Subarticle 235-4(C)" with "Subarticle 235-3(C)".
Page 15-6, Subarticle 1510-3(B), after line 21, replace the allowable leakage formula with the following: $\mathbf{W=LD\sqrt{P} \div 148{,}000}$
Page 15-6, Subarticle 1510-3(B), line 32, delete "may be performed concurrently or" and replace with "shall be performed".
Page 15-17, Subarticle 1540-3(E), line 27, delete "Type 1".

Division 17

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

Revise the *2012 Roadway Standard Drawings* as follows:

1633.01 Sheet 1 of 1, English Standard Drawing for Matting Installation, replace "1633.01" with "1631.01".

STANDARD SPECIAL PROVISION

PLANT AND PEST QUARANTINES

(Imported Fire Ant, Gypsy Moth, Witchweed, And Other Noxious Weeds)

(3-18-03) (Rev. 10-15-13) Z-04a

Within Quarantined Area

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

Originating in a Quarantined County

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

Contact

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

Regulated Articles Include

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

STANDARD SPECIAL PROVISION

MINIMUM WAGES

(7-21-09) Z-5

FEDERAL: The Fair Labor Standards Act provides that with certain exceptions every employer shall pay wages at the rate of not less than SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

STATE: The North Carolina Minimum Wage Act provides that every employer shall pay to each of his employees, wages at a rate of not less than SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

The minimum wage paid to all skilled labor employed on this contract shall be SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

The minimum wage paid to all intermediate labor employed on this contract shall be SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

The minimum wage paid to all unskilled labor on this contract shall be SEVEN DOLLARS AND TWENTY FIVE CENTS ($7.25) per hour.

This determination of the intent of the application of this act to the contract on this project is the responsibility of the Contractor.

The Contractor shall have no claim against the Department of Transportation for any changes in the minimum wage laws, Federal or State. It is the responsibility of the Contractor to keep fully informed of all Federal and State Laws affecting his contract.

STANDARD SPECIAL PROVISION

AWARD OF CONTRACT

(6-28-77)(Rev 2/16/2016) Z-6

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

TITLE VI AND NONDISCRIMINATION

I. Title VI Assurance

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:

(1) Compliance with Regulations: The contractor shall comply with the Regulation relative to nondiscrimination in Federally-assisted programs of the Department of Transportation (hereinafter, "DOT") Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

(2) 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 either directly or indirectly in the discrimination prohibited by section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.

(3) 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 Regulations relative to nondiscrimination on the grounds of race, color, or national origin.

(4) Information and Reports: The contractor shall provide all information and reports required by the Regulations or 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 North Carolina Department of Transportation (NCDOT) or the Federal Highway Administration (FHWA) to be pertinent to ascertain compliance with such Regulations, orders and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish this information the contractor shall so certify to the NCDOT, or the FHWA as appropriate, and shall set forth what efforts it has made to obtain the information.

(5) Sanctions for Noncompliance: In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, the NCDOT shall impose such contract sanctions as it or the FHWA may determine to be appropriate, including, but not limited to:

(a) Withholding of payments to the contractor under the contract until the contractor complies, and/or

(b) Cancellation, termination or suspension of the contract, in whole or in part.

(6) Incorporation of Provisions: The contractor shall include the provisions of paragraphs (1) through (6) in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto.

The contractor shall take such action with respect to any subcontractor procurement as the NCDOT or the FHWA may direct as a means of enforcing such provisions including sanctions for noncompliance: provided, however, that, in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the contractor may request the NCDOT to enter into such litigation to protect the interests of the NCDOT, and, in addition, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

II. Title VI Nondiscrimination Program

Title VI of the 1964 Civil Rights Act, 42 U.S.C. 2000d, provides that: "No person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." The broader application of nondiscrimination law is found in other statutes, executive orders, and regulations (see Section III, Pertinent Nondiscrimination Authorities), which provide additional protections based on age, sex, disability and religion. In addition, the 1987 Civil Rights Restoration Act extends nondiscrimination coverage to all programs and activities of federal-aid recipients and contractors, including those that are not federally-funded.

Nondiscrimination Assurance

The North Carolina Department of Transportation (NCDOT) hereby gives assurance that no person shall on the ground of race, color, national origin, sex, age, and disability, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity conducted by the recipient, as provided by Title VI of the Civil Rights Act of 1964, the Civil Rights Restoration Act of 1987, and any other related Civil Rights authorities, whether those programs and activities are federally funded or not.

Obligation

During the performance of this contract, the Contractor and its subcontractors are responsible for complying with NCDOT's Title VI Program. The Contractor must ensure that NCDOT's Notice of Nondiscrimination is posted in conspicuous locations accessible to all employees and subcontractors on the jobsite, along with the Contractor's own Equal Employment Opportunity (EEO) Policy Statement. The Contractor shall physically incorporate this "**TITLE VI AND NONDISCRIMINATION**" language, in its entirety, into all its subcontracts on federally-assisted and state-funded NCDOT-owned projects, and ensure its inclusion by subcontractors into all subsequent lower tier subcontracts. The Contractor and its subcontractors shall also physically incorporate the **FHWA-1273**, in its entirety, into all subcontracts and subsequent lower tier subcontracts on **Federal-aid highway** construction contracts only. The Contractor is also

responsible for making its subcontractors aware of NCDOT's Discrimination Complaints Process, as follows:

FILING OF COMPLAINTS

1. **Applicability** – These complaint procedures apply to the beneficiaries of the NCDOT's programs, activities, and services, including, but not limited to, members of the public, contractors, subcontractors, consultants, and other sub-recipients of federal and state funds.
2. **Eligibility** – Any person or class of persons who believes he/she has been subjected to discrimination or retaliation prohibited by any of the Civil Rights authorities, based upon race, color, sex, age, national origin, or disability, may file a written complaint with NCDOT's Civil Rights office. The law prohibits intimidation or retaliation of any sort. The complaint may be filed by the affected individual or a representative, and must be in writing.
3. **Time Limits and Filing Options** – A complaint must be filed no later than 180 calendar days after the following:
   - The date of the alleged act of discrimination; or
   - The date when the person(s) became aware of the alleged discrimination; or
   - 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 other discrimination complaints may be submitted to the following entities:
   - **North Carolina Department of Transportation**, Office of Equal Opportunity & Workforce Services (EOWS), External Civil Rights Section, 1511 Mail Service Center, Raleigh, NC 27699-1511; 919-508-1808 or toll free 800-522-0453
   - **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

     Federal Highway Administration, North Carolina Division Office, 310 New Bern Avenue, Suite 410, Raleigh, NC 27601, 919-747-7010

     Federal Highway Administration, Office of Civil Rights, 1200 New Jersey Avenue, SE, 8th Floor, E81-314, Washington, DC 20590, 202-366-0693 / 366-0752

     Federal Transit Administration, Office of Civil Rights, ATTN: Title VI Program Coordinator, East Bldg. 5th Floor – TCR, 1200 New Jersey Avenue, SE, Washington, DC 20590

     Federal Aviation Administration, Office of Civil Rights, 800 Independence Avenue, SW, Washington, DC 20591, 202-267-3258
   - **US Department of Justice**, Special Litigation Section, Civil Rights Division, 950 Pennsylvania Avenue, NW, Washington, DC 20530, 202-514-6255 or toll free 877-218-5228
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 EOWS at the phone number above 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, sex, age, or disability. The term "basis" refers to the complainant's membership in a protected group category. Contact this office to receive a Discrimination Complaint Form.

Protected Categories	Definition	Examples	Applicable Statutes and Regulations	
			FHWA	FTA
Race	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	Title VI of the Civil Rights Act of 1964; 49 CFR Part 21; Circular 4702.1B
Color	Color of skin, including shade of skin within a racial group	Black, White, brown, yellow, etc.		
National Origin	Place of birth. Citizenship is not a factor. Discrimination based on language or a person's accent is also covered.	Mexican, Cuban, Japanese, Vietnamese, Chinese		
Sex	Gender	Women and Men	1973 Federal-Aid Highway Act	Title IX of the Education Amendments of 1972
Age	Persons of any age	21 year old person	Age Discrimination Act of 1975	
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	

III. 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:

- 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.
- 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);
- Federal-Aid Highway Act of 1973, (23 U.S.C. § 324 *et seq*.), (prohibits discrimination on the basis of sex);
- 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;

- The Age Discrimination Act of 1975, as amended, (42 U.S.C. § 6101 *et seq*.), (prohibits discrimination on the basis of age);
- 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);
- 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);
- 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;
- The Federal Aviation Administration's Non-discrimination statute (49 U.S.C. § 47123) (prohibits discrimination on the basis of race, color, national origin, and sex);
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which ensures discrimination 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;
- 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);
- 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).
- 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);
- 49 CFR Part 26, regulation to ensure nondiscrimination in the award and administration of DOT-assisted contracts in the Department's highway, transit, and airport financial assistance programs, as regards the use of Disadvantaged Business Enterprises (DBEs);
- Form FHWA-1273, "Required Contract Provisions," a collection of contract provisions and proposal notices that are generally applicable to *all Federal-aid construction projects* and must be made a part of, and physically incorporated into, *all federally-assisted contracts*, as well as appropriate subcontracts and purchase orders, particularly Sections II (Nondiscrimination) and III (Nonsegregated Facilities).

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

NAME CHANGE FOR NCDENR

(1-19-16) Z-11

Description

Wherever in the 2012 Standard Specifications, Project Special Provisions, Standard Special Provisions, Permits or Plans that reference is made to “NCDENR” or “North Carolina Department of Environment and Natural Resources”, replace with “NCDEQ” or “North Carolina Department of Environmental Quality” respectively, as the case may be.

Project Special Provisions
Erosion Control

STABILIZATION REQUIREMENTS:

(3-11-16) S-2

Stabilization for this project shall comply with the time frame guidelines as specified by the NCG-010000 general construction permit effective August 3, 2011 issued by the North Carolina Department of Environment and Natural Resources Division of Water Quality. Temporary or permanent ground cover stabilization shall occur within 7 calendar days from the last land-disturbing activity, with the following exceptions in which temporary or permanent ground cover shall be provided in 14 calendar days from the last land-disturbing activity:

- Slopes between 2:1 and 3:1, with a slope length of 10 ft. or less
- Slopes 3:1 or flatter, with a slope of length of 50 ft. or less
- Slopes 4:1 or flatter

The stabilization timeframe for High Quality Water (HQW) Zones shall be 7 calendar days with no exceptions for slope grades or lengths. High Quality Water Zones (HQW) Zones are defined by North Carolina Administrative Code 15A NCAC 04A.0105 (25). Temporary and permanent ground cover stabilization shall be achieved in accordance with the provisions in this contract and as directed.

SEEDING AND MULCHING: (East Crimp)

The kinds of seed and fertilizer, and the rates of application of seed, fertilizer, and limestone, shall be as stated below. During periods of overlapping dates, the kind of seed to be used shall be determined. All rates are in pounds per acre.

All Roadway Areas

March 1 - August 31		**September 1 - February 28**	
50#	Tall Fescue	50#	Tall Fescue
10#	Centipede	10#	Centipede
25#	Bermudagrass (hulled)	35#	Bermudagrass (unhulled)
500#	Fertilizer	500#	Fertilizer
4000#	Limestone	4000#	Limestone

Waste and Borrow Locations

March 1 – August 31		**September 1 - February 28**	
75#	Tall Fescue	75#	Tall Fescue
25#	Bermudagrass (hulled)	35#	Bermudagrass (unhulled)
500#	Fertilizer	500#	Fertilizer
4000#	Limestone	4000#	Limestone

Note: 50# of Bahiagrass may be substituted for either Centipede or Bermudagrass only upon Engineer’s request.

Approved Tall Fescue Cultivars

06 Dust	Escalade	Justice	Scorpion
2nd Millennium	Essential	Kalahari	Serengeti
3rd Millennium	Evergreen 2		Shelby
Apache III	Falcon IV	Kitty Hawk 2000	Sheridan
Avenger	Falcon NG	Legitimate	Signia
Barlexas	Falcon V	Lexington	Silver Hawk
Barlexas II	Faith	LSD	Sliverstar
Bar Fa	Fat Cat	Magellan	Shenandoah Elite
Barrera	Festnova	Matador	Sidewinder
Barrington	Fidelity	Millennium SRP	Skyline
Barrobusto	Finelawn Elite	Monet	Solara
Barvado	Finelawn Xpress	Mustang 4	Southern Choice II
Biltmore	Finesse II	Ninja 2	Speedway
Bingo	Firebird	Ol' Glory	Spyder LS
Bizem	Firecracker LS	Olympic Gold	Sunset Gold
Blackwatch	Firenza	Padre	Taccoa
Blade Runner II	Five Point	Patagonia	Tanzania
Bonsai	Focus	Pedigree	Trio
Braveheart	Forte	Picasso	Tahoe II
Bravo	Garrison	Piedmont	Talladega
Bullseye	Gazelle II	Plantation	Tarheel
Cannavaro	Gold Medallion	Proseeds 5301	Terrano
Catalyst	Grande 3	Prospect	Titan ltd
Cayenne	Greenbrooks	Pure Gold	Titanium LS
Cessane Rz	Greenkeeper	Quest	Tracer
Chipper	Gremlin	Raptor II	Traverse SRP
Cochise IV	Greystone	Rebel Exeda	Tulsa Time
Constitution	Guardian 21	Rebel Sentry	Turbo
Corgi	Guardian 41	Rebel IV	Turbo RZ
Corona	Hemi	Regiment II	Tuxedo RZ
Coyote	Honky Tonk	Regenerate	Ultimate
Darlington	Hot Rod	Rendition	Venture
Davinci	Hunter	Rhambler 2 SRP	Umbrella
Desire	Inferno	Rembrandt	Van Gogh
Dominion	Innovator	Reunion	Watchdog
Dynamic	Integrity	Riverside	Wolfpack II
Dynasty	Jaguar 3	RNP	Xtremegreen
Endeavor	Jamboree	Rocket	

On cut and fill slopes 2:1 or steeper Centipede shall be applied at the rate of 5 pounds per acre and add 20# of Sericea Lespedeza from January 1 - December 31.

Fertilizer shall be 10-20-20 analysis. A different analysis of fertilizer may be used provided the 1-2-2 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as a 10-20-20 analysis and as directed.

All areas seeded and mulched shall be tacked with asphalt. Crimping of straw in lieu of asphalt tack shall not be allowed on this project.

CRIMPING STRAW MULCH:

Crimping shall be required on this project adjacent to any section of roadway where traffic is to be maintained or allowed during construction. In areas within six feet of the edge of pavement, straw is to be applied and then crimped. After the crimping operation is complete, an additional application of straw shall be applied and immediately tacked with a sufficient amount of undiluted emulsified asphalt.

Straw mulch shall be of sufficient length and quality to withstand the crimping operation.

Crimping equipment including power source shall be subject to the approval of the Engineer providing that maximum spacing of crimper blades shall not exceed 8".

Project Special Provisions
Structures
Table of Contents

DocuSigned by:
Robbie Weisz 12/2/2016
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STRUCTURE PROJECT SPECIAL PROVISIONS

SCOPE OF WORK

This work shall consist of furnishing all labor, equipment, and materials to overlay the existing bridge deck with epoxy overlay system, bridge deck joint replacement, shotcrete repairs on superstructure and substructure, epoxy resin injection on substructure, and pile repairs. Work includes: existing bridge deck surface preparation, concrete deck repairs ,overlaying the prepared bridge deck with an epoxy overlay system, existing joint demolition and reconstruction; installation of silicone joint seals, pile jacketing and rejacketing, milling of roadway approaches, asphalt paving approaches, pavement markings , temporary work platforms, seeding and mulching all grassed areas disturbed, disposal of waste material and all incidental items necessary to complete the project as specified and shown on the plans. No separate payment will be made for portable lighting as the cost of such is incidental to the work being performed.

Work will be performed on the existing bridges at the following locations in Tyrrell County:

1.) Bridge #7 – US 64 over Alligator River

Contractor shall provide all necessary access; provide all traffic control; understructure platforms, scaffolding, ladders, etc.; provide all staging areas, material storage, waste disposal, provide environmental controls to limit loss of materials from sawing equipment, and chipping equipment; and all else necessary to complete the work.

The contractor shall be responsible for fulfilling all requirements of the NCDOT Standard Specifications for Roads and Structures dated January 2012, except as otherwise specified herein.

SECURING OF VESSELS (10-12-01)

Secure vessels in accordance with Section 107 of the Standard Specifications and the following provision.

When utilizing barges, tugboats or other vessels, take all necessary precautions to ensure that such vessels are securely anchored or moored when not in active operation. Take all necessary measures to ensure that the vessels are operated in a manner that avoids damage to or unnecessary contact with bridges and other highway structures and attachments. If severe weather conditions are anticipated, or should be anticipated through reasonable monitoring of weather forecasts, take additional measures to protect bridges and other highway structures and attachments from extreme conditions. The Contractor is strictly liable for damages to any bridge or other highway structure or attachment caused by a vessel owned or controlled by the Contractor. The Contractor is also liable to third parties for property damages and loss of revenue caused by vessels under the Contractor’s control.

MAINTENANCE OF WATER TRAFFIC (12-5-12)

The Contractor will be required to maintain water traffic in a manner satisfactory to both the Engineer and the U.S. Coast Guard and in conformance with the conditions of the Bridge Permit issued by the U.S. Coast Guard. The Contractor shall provide and maintain navigational lights in conformance with the requirements of the U.S. Coast Guard on both temporary and permanent work and shall carry on all operations in connection with the construction of the project in such a manner as to avoid damage or delay to water traffic.

WORK IN, OVER OR ADJACENT TO NAVIGABLE WATERS (12-5-12)

All work in, over, or adjacent to navigable waters shall be in accordance with the special provisions and conditions contained in the permits obtained by the Department from the U.S. Coast Guard, U.S. Army Corps of Engineers, or other authority having jurisdiction. The work shall have no adverse effect on navigation of the waterway including traffic flow, navigational depths, and horizontal and vertical clearances without approval from the authorities granting the permits.

The Contractor shall prepare drawings necessary to obtain any permits which may be required for his operations which are not included in the Department's permit including but not limited to excavation and dumping, constructing wharves, piers, ramps, and other structures connecting to bank or shore, and drawings for constructing falsework, cofferdams, sheeting, temporary bridges, and any other construction within the waterway. Submittals shall show locations of such work with respect to the navigational opening. The Contractor shall coordinate the submittal of drawings with the Engineer.

All construction shall progress and be maintained in a safe and timely manner. Temporary construction facilities shall be removed completely and promptly upon discontinuation of their useful purpose. Navigational lights, signals, or facilities shall be provided and maintained by the Contractor on temporary or permanent construction or vessels until such facilities are no longer needed as determined by the Engineer or permitting agency.

The Contractor shall immediately notify the appropriate authorities and take corrective measures as needed when any situation occurs that imposes a threat to the public. He shall also immediately correct any acts or occurrences that contradict or violate any requirements in the plans, special provisions, or permits when corrective measures can be performed in a safe manner. The Contractor shall notify the appropriate authorities when such corrective measures cannot be performed in a safe manner.

All costs incurred by the Contractor in complying with the above requirements shall be included in the prices bid for the various pay items and no additional payment will be made.

BRIDGE JOINT REMOVAL (SPECIAL)

DESCRIPTION

This provision addresses the removal of existing joint material to facilitate the installation of new silicone joint seals at the locations noted in the contract plans.

REMOVAL AND PREPARATION

Prior to any construction, take the necessary precautions to ensure debris from joint construction is not allowed to fall below the bridge deck.

Remove existing joint material by methods approved by the Engineer.

MEASUREMENT AND PAYMENT

Bridge Joint Removal will be measured and paid for at the contract unit price bid per linear foot and will be full compensation for removal, containment and disposal of existing joint material and shall include the cost of labor, tools, equipment and incidentals necessary to complete the work.

Pay Item	Pay Unit
Bridge Joint Removal	Linear Feet

EPOXY OVERLAY SYSTEM-MECHANICALLY DISTRIBUTED (SPECIAL)

GENERAL

This work shall consist of furnishing and mechanically distributing an epoxy overlay system, over the concrete bridge deck in accordance with the contract documents and consists of a minimum of two (2) layers of hybrid polymer resins with a special blend of extremely hard aggregate designed to provide a 3/8 inch thick overlay for the purpose of crack treatment, complete waterproofing, and providing a non-skid surface. The overlay system shall be formulated and applied to withstand continuous heavy traffic, extreme changes in weather conditions, and deformations due to structure loading and temperature changes.

PERFORMANCE GUARANTEE

The Contractor shall provide a warranty bond to the Department, guaranteeing the wearing surface for a period of 36 months against the following defects: delamination of the epoxy overlay from the deck surface, and skid resistance less than 40 as measured by AASHTO T242. The performance bond will be invoked if 25 square feet of the deck surface meets the defect criteria prior to the end of the warranty. The guarantee period will start on the date of Department final acceptance of the project. At the end of the guarantee period, the warranty bond will be invoked if any part of deck surface meets the defect criteria, regardless of quantity.

The Contractor shall replace defective materials and workmanship at no cost to the Department. The Contractor will not be responsible for damage due to normal wear and tear, negligence on the part of the Department, or use in excess of the design.

The warranty bond amount shall be the bid quantity of epoxy overlay multiplied by the statewide average unit bid price for the epoxy overlay. The guarantee period of 36 months and bond value shall be specified in the warranty bond provided to the Department prior to final acceptance of the project.

MATERIALS

This two-part epoxy polymer overlay system shall be on the NCDOT Approved Products List (APL) and be free of any fillers or volatile solvents and shall be formulated to provide a simple volumetric mixing ratio of two components such as one to one or two to one by volume. The epoxy overlay system shall be formulated to provide flexibility in the system without any sacrifice of the hardness, chemical resistance or strength of the system. Use of external/conventional flexibilizers will not be accepted. Flexibility shall be by interaction of elastomers which chemically link during the process of curing so the flexibility of the molecule is least affected during the low temperature conditions that are confronted in actual use.

Epoxy

When the two component system is mixed at the appropriate ratio, the cured resin shall conform to the following requirements:

EPOXY PROPERTIES		
Property	**Requirement**	**Test Method**
Viscosity-Poises at 77°F ± 2°F	7-25	ASTM D2393 (Spindle No.3 at 20 rpm)
Pot Life	15-45 minutes @ 75° F	ASTM C881
Min. Tensile Strength at 7 days	2000 psi	ASTM D638
Tensile Elongation at 7 days	30-70%	ASTM D638
Min. Compressive Strength @ 3 hrs.	1,000 psi	ASTM C109
Min. Compressive Strength @ 24 hrs.	5000 psi	ASTM C109
Min. adhesion strength @ 24 hrs.	250 psi @ 75° F	ASTM C1583
Max. Water Absorption	1%	ASTM D570

Aggregate

Aggregate used for all layers shall be non-friable, non-polishing, clean and free from surface moisture. The aggregate shall be flint rock, 100% fractured, thoroughly washed and kiln dried to a maximum moisture content of 0.2% by weight, measured in accordance with ASTM C566.

The fracture requirements shall be at least one mechanically fractured face and will apply to materials retained on a U.S. No. 10 sieve. Aggregate shall conform to the following requirements:

AGGREGATE PROPERTIES		
Property	**Value**	**Test Method**
Moisture Content, max.	0.2% by weight	AASHTO T255
Mohs Hardness, min.	7	
Soundness Loss, 5 cycles in Sodium Sulfate, max.	5.4%	AASHTO T104
Micro-Deval, max.	10%	AASHTO TP58

AGGREGATE GRADATION	
Sieve	**Percent Passing**
No. 4	100
No. 8	30-75
No. 16	Max. 5
No. 30	Max. 1

SURFACE PREPARATION

Remove all existing overlays if applicable, and all loose, disintegrated, unsound or contaminated concrete from the bridge deck. Prepare the bridge deck prior to applying the overlay system, in accordance with the manufacturer's recommendations, the special provision *Concrete Deck Repair for Epoxy Overlay*, and this provision.

Prior to overlay placement and upon completion of the deck repairs, clean the entire deck surface by steel shotblasting and other means to remove asphaltic material, oils, dirt, rubber, curing compounds, pavement markings, paint carbonation, laitance, weak surface mortar and other materials that may interfere with the bonding or curing of the overlay. Do not begin shotblasting until all grinding or milling operations are completed. Use sandblasting equipment on areas that cannot be reached by the shotblasting operation. If expansion joints are not being replaced or have been replaced prior to shotblasting they shall be protected from damage from the shotblasting operation. Pavement markings shall be considered clean when the concrete has exposed aggregate showing through the paint stripe. Deck drains and areas of curb or railing above the proposed surface shall be protected from the shotblasting operation. Mortar that is soundly bonded to the coarse aggregate shall have open pores to be considered adequate for bond.

Prior to placement of epoxy, remove and capture all shotblasting media, unsound concrete, dust, dirt, and other loose material from the shotblasting operation, and dry all moisture from the bridge deck.

Prior to overlay placement and upon completion of surface preparation, perform bond testing of the epoxy overlay material in accordance with ASTM C1583 on two pre-selected 3’ x 3’ test patches. Test locations will be determined by the Engineer. The tensile rupture strength shall be at least 250 psi, or the depth of failure into the concrete deck shall be ¼” or greater over a minimum of 50% of the location area. Install test sections with the same materials, equipment, personnel, timing and sequence of operations and curing time that will be used for the installation of the overlay.

If the cleaning method, materials and installation procedure do not produce acceptable test results, the contractor must remove failed test patches, make the necessary adjustments, and retest all patches at no additional cost to the Department until satisfactory test results are obtained.

Test locations shall be removed to the original concrete substrate prior to placement of the deck overlay.

Epoxy based overlays shall not be placed on hydraulic cement concrete that is less than 28 days old. Patching and cleaning operations shall be inspected and approved prior to placing each layer of the overlay. Any contamination of the deck or intermediate courses, after initial cleaning, shall be removed.

The deck shall be completely dry at the time of application of the epoxy concrete overlay. Deck drains shall be closed off during application of epoxy overlay.

EQUIPMENT

Equipment shall consist of no less than an epoxy distribution system, an aggregate spreader, application squeegees, a vacuum truck, and a source of lighting if work is to be performed at night. Provide a vacuum capable of picking up dust and other loose material from the shotblasting operation. Provide air compressors equipped with oil/water separator capable of drying all moisture from the bridge deck. Care shall be taken and methods used to fully capture and collect shotblasting media, unsound concrete, dust, dirt, and other loose material. The distribution system, which may be comprised of multiple components, shall accurately measure and mix the epoxy resin and hardening agent, and shall uniformly and accurately apply the epoxy materials at the specified rate to the bridge deck in such a manner as to cover 100% of the work area. The use of hand held machine mixing equipment or hand mixing equipment is prohibited. Squeegees may be used for additional spreading and adjustments after the epoxy material is placed. The aggregate spreader shall be propelled in such a manner as to uniformly and accurately apply the aggregate to cover 100% of the epoxy material. Aggregate shall be sprinkled or dropped vertically in a manner such that the level of the epoxy mixture is not disturbed.

APPLICATION

Handling and mixing of the epoxy resin and hardening agent shall be performed in a safe manner to achieve the desired result in accordance with the manufacturer's recommendations as approved and as directed by the Engineer. Epoxy overlay materials shall not be placed when

weather or surface conditions are such that the material cannot be properly handled, placed, spread and cured within the specified requirements of traffic control.

The application rates of the liquid and stone in the 2 layers shall be as recommended by the manufacturer, but not less than the following rate of application.

TABLE 4		
APPLICATION RATES		
Course	**Min. Epoxy Rate (Gal./100 SF)**	**Min. Aggregate Rate (Lbs./Sq.Yd)**
1	2.5	10
2	5	14

The final overlay thickness shall be a minimum of 3/8". Once the epoxy mixture has been prepared, immediately and uniformly apply it to the surface of the bridge deck. There shall be no longitudinal joints of the epoxy overlay in the wheel path. The temperature of the bridge deck surface and all epoxy and aggregate components shall be 60°F or above at the time of application. Epoxy shall not be applied if the air temperature is expected to drop below 55°F within 8 hours after application or if air temperatures would cause the gel time to be less than 10 minutes. Consult with the manufacturer when placing overlay at temperatures above 90°F. The dry aggregate shall be applied in such a manner as to completely cover the epoxy mixture so that no wet spots appear and before it begins to gel. First course applications that do not receive enough aggregate prior to gel shall be removed and replaced. A second course insufficiently covered with aggregate may be left in place, but will require additional applications before opening to traffic. After each course is fully cured, all loose aggregate shall be removed by vacuuming or brooming. Traffic shall not be allowed on the first course of the overlay. Traffic and equipment shall not be permitted on the overlay surface during the curing period. The minimum curing periods shall be as follows:

Course: Average temperature of deck, epoxy and aggregate components in °F

	60-64	65-69	70-74	75-79	80-84	85+
Course 1	4 hrs.	3 hrs.	2.5 hrs.	2 hrs.	1.5 hrs.	1 hr.
Course 2	6.5 hrs.*	5 hrs.	4 hrs.	3 hrs.	3 hrs.	3 hrs.

*Course 2 shall be cured for 8 hrs. if the air temperature drops below 60°F during the curing period.

The Contractor shall plan and execute the work to provide the curing periods as specified herein, or manufacturer proposed curing periods may be submitted to the Engineer for review and approval.

Do not apply epoxy overlay courses over modular joints, metal expansion joints, or foam joint seals. A bond breaker shall be placed on all expansion joints.

In the event the Contractor's operation damages the epoxy overlay, the Contractor shall remove the damaged areas by saw-cutting in rectangular sections perpendicular to the top of

the concrete deck surface and replacing the various courses in accordance with this Specification at no additional cost to the Department.

Prior to acceptance, perform one bond test on each span or every 300 square yards, whichever is smaller, in accordance with ASTM C1583 on 3' x 3' test patches. Test locations will be determined by the Engineer. The tensile rupture strength test results shall be at least 250 psi, or the depth of failure into the concrete deck shall be ¼" or greater over a minimum of 50% of the test location area. Unacceptable test results will require removal and replacement of overlay as directed by the Engineer at no cost to the Department. Test locations shall be repaired with approved repair materials.

MEASUREMENT & PAYMENT

Epoxy Overlay System – Mechanically Distributed will be measured and paid for at the contract unit price per square feet. The price shall include surface preparation, furnishing and placing the overlay system by means of mechanical distribution, providing a 36 month warranty bond, all tools, labor, materials, bond strength testing and any incidentals necessary to complete the work.

Payment will be made under:

Pay Item	**Pay Unit**
Generic Structure Item (Epoxy Overlay System-Mechanically Distributed)	Square Feet

CONCRETE DECK REPAIR FOR EPOXY OVERLAY (SPECIAL)

GENERAL

This provision addresses concrete deck repairs prior to placing an epoxy overlay. Work shall begin within 60 days of notification. After surface preparation, the Engineer sounds the deck using a chain drag or other acceptable means and marks areas to be repaired.

MATERIALS

Concrete deck repair material shall be epoxy based material with a minimum modulus of elasticity of 2500 ksi. The repair material must be on the NCDOT Approved Product List (APL) and recommended by the manufacturer for use with an epoxy overlay system. Materials containing cement mortar are acceptable; however, a 28 day curing period will be required before placing the epoxy overlay. The curing period may be adjusted if approved by the epoxy overlay manufacturer and the Engineer. Submit the proposed repair material and schedule of repairs to the Engineer for approval prior to beginning the work.

CLASS II SURFACE PREPARATION (PARTIAL DEPTH)

Saw cut a perimeter surrounding the repair to a depth not less than 1 inch and remove all loose, unsound and contaminated material by chipping with hand tools to an average depth of approximately one-half the deck thickness, but no less than 3/4 inch below the top mat of steel.
At joint locations remove by chipping with hand tools all loose, unsound concrete or elastomeric headers adjacent to the joint. Use a small chipping hammer (15 lb. class) to prepare the edges of the repair area to limit micro fractures.

In overhangs, removing concrete areas greater than 0.60 ft2/ft length of bridge will require overhang support. Submit the overhang support method to the Engineer for approval.

If the condition of the concrete at joint edges is such that deep spalls or sheer faces result, notify the Engineer prior to completing repair.

Clean, repair or replace rusted or loose reinforcing steel. Care shall be taken not to cut, stretch, or damage any exposed reinforcing steel. Thoroughly clean the newly exposed surface. Use a bonding agent in accordance with the manufacturer's recommendations.

APPLICATION

Refill areas where concrete is removed with repair material up to the finished deck surface and cure in accordance with the material manufacturer's recommendations. Provide a raked finish.

MEASUREMENT & PAYMENT

Concrete Deck Repair for Epoxy Overlay will be measured and paid for at the contract unit price per square feet for the appropriate areas repaired. The price shall include materials, labor, equipment, tools and any incidentals necessary to complete the work.

Reinforcing Steel added to supplement or replace deteriorated steel will be measured and paid for at the contract unit price bid per pound of steel used in the completed and accepted work. Reinforcing steel needed to repair cut or otherwise damaged bars during concrete removal shall be supplied and installed at the Contractors expense.

Payment will be made under:

Pay Item	**Pay Unit**
Concrete Deck Repair for Epoxy Overlay	Square Feet
Reinforcing Steel	Pound

EPOXY RESIN INJECTION (12-5-12)

1.0 GENERAL

For repairing cracks, an approved applicator is required to perform the epoxy resin injection. Make certain the supervisor and the workmen have completed an instruction program in the methods of restoring concrete structures utilizing the epoxy injection process and have a record of satisfactory performance on similar projects.

The applicator furnishes all materials, tools, equipment, appliances, labor and supervision required when repairing cracks with the injection of an epoxy resin adhesive.

2.0 SCOPE OF WORK

Using Epoxy Resin Injection, repair all cracks 30 mils wide or greater in the end bent caps, interior bent columns and caps, and in the superstructure deck.

Repair the column cracks to the top of the footings. Make the underwater repairs when water surface elevation is low and the water is still. For underwater repairs, use manufacturer recommended materials.

Repair any crack, void, honeycomb or spall area unsuitable for repair by injection with epoxy mortar.

3.0 COOPERATION

Cooperate and coordinate with the Technical Representative of the epoxy resin manufacturer for satisfactory performance of the work.

Have the Technical Representative present when the job begins and until the Engineer is assured that his service is no longer needed.

The expense of having this representative on the job is the Contractor's responsibility and no direct payment will be made for this expense.

4.0 TESTING

The North Carolina Department of Transportation Materials and Tests Unit will obtain cores from the repaired concrete for testing. If the failure plane is located at the repaired crack, a minimum compressive strength of 3000 psi is required of these cores.

5.0 MATERIAL PROPERTIES

Provide a two-component structural epoxy adhesive for injection into cracks or other voids. Provide modified epoxy resin (Component "A") that conforms to the following requirements:

	Test Method	Specification Requirements
Viscosity @ 40 ± 3°F, cps	Brookfield RVT Spindle No. 4 @ 20 rpm	6000 - 8000
Viscosity @ 77 ± 3°F, cps	Brookfield RVT Spindle No. 2 @ 20 rpm	400 - 700
Epoxide Equivalent Weight	ASTM D1652	152 - 168
Ash Content, %	ASTM D482	1 max.

Provide the amine curing agent (Component "B") used with the epoxy resin that meets the following requirements:

	Test Method	Specification Requirements
Viscosity @ 40 ± 3°F, cps	Brookfield RVT Spindle No. 2 @ 20 rpm	700 - 1400
Viscosity @ 77 ± 3°F, cps	Brookfield RVT Spindle No. 2 @ 20 rpm	105 - 240
Amine Value, mg KOH/g	ASTM D664*	490 - 560
Ash Content, %	ASTM D482	1 max.
* Method modified to use perchloric acid in acetic acid.		

Certify that the Uncured Adhesive, when mixed in the mix ratio that the material supplier specifies, has the following properties:

Pot Life (60 gram mass)
- @ 77 ± 3°F - 15 minutes minimum
- @ 100 ± 3°F - 5 minutes minimum

Certify that the Adhesive, when cured for 7 days at 77 ± 3°F unless otherwise specified, has the following properties:

	Test Method	Specification Requirements
Ultimate Tensile Strength	ASTM D638	7000 psi (min.)
Tensile Elongation at Break	ASTM D638	4% max.
Flexural Strength	ASTM D790	10,000 psi (min.)
Flexural Modulus	ASTM D790	3.5×10^5 psi

Compressive Yield Strength	ASTM D695	11,000 psi (min.)
Compressive Modulus	ASTM D695	2.0 - 3.5 x 10^5 psi
Heat Deflection Temperature Cured 28 days @ 77 ± 3°F	ASTM D648*	125°F min. 135°F min.
Slant Shear Strength, 5000 psi (34.5 MPa) compressive strength concrete	AASHTO T237	
Cured 3 days @ 40°F wet concrete		3500 psi (min.)
Cured 7 days @ 40°F wet concrete		4000 psi (min.)
Cured 1 day @ 77°F dry concrete		5000 psi (min.)
* Cure test specimens so that the peak exothermic temperature of the adhesive does not exceed 77°F.		

Use an epoxy bonding agent, as specified for epoxy mortar, as the surface seal (used to confine the epoxy resin during injection).

6.0 EQUIPMENT FOR INJECTION

Use portable positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack. Use electric or air powered pumps that provide in-line metering and mixing.

Use injection equipment with automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 ± 5 psi and equipped with a manual pressure control override.

Use equipment capable of maintaining the volume ratio for the injection adhesive as prescribed by the manufacturer. A tolerance of ± 5% by volume at any discharge pressure up to 200 psi is permitted.

Provide injection equipment with sensors on both the Component A and B reservoirs that automatically stop the machine when only one component is being pumped to the mixing head.

7.0 PREPARATION

Follow these steps prior to injecting the epoxy resin:

Remove all dirt, dust, grease, oil, efflorescence and other foreign matter detrimental to the bond of the epoxy injection surface seal system from the surfaces adjacent to the cracks or other areas of application. Acids and corrosives are not permitted.

Provide entry ports along the crack at intervals not less than the thickness of the concrete at that location.

Apply surface seal material to the face of the crack between the entry ports. For through cracks, apply surface seal to both faces.

Allow enough time for the surface seal material to gain adequate strength before proceeding with the injection.

8.0 EPOXY INJECTION

Begin epoxy adhesive injection in vertical cracks at the lower entry port and continue until the epoxy adhesive appears at the next higher entry port adjacent to the entry port being pumped.

Begin epoxy adhesive injection in horizontal cracks at one end of the crack and continue as long as the injection equipment meter indicates adhesive is being dispensed or until adhesive shows at the next entry port.

When epoxy adhesive appears at the next adjacent port, stop the current injection and transfer the epoxy injection to the next adjacent port where epoxy adhesive appeared.

Perform epoxy adhesive injection continuously until cracks are completely filled.

If port to port travel of epoxy adhesive is not indicated, immediately stop the work and notify the Engineer.

9.0 FINISHING

When cracks are completely filled, allow the epoxy adhesive to cure for sufficient time to allow the removal of the surface seal without any draining or runback of epoxy material from the cracks.

Remove the surface seal material and injection adhesive runs or spills from concrete surfaces.

Finish the face of the crack flush to the adjacent concrete, removing any indentations or protrusions caused by the placement of entry ports.

10.0 BASIS OF PAYMENT

Payment for epoxy resin injection will be at the contract unit price per linear foot for “Epoxy Resin Injection”. Such payment will be full compensation for all materials, tools, equipment, labor, and for all incidentals necessary to complete the work.

SHOTCRETE REPAIRS (SPECIAL)

GENERAL

The work covered by this Special Provision consists of removing deteriorated concrete from the structure in accordance with the limits, depth and details shown on the plans, described herein and as established by the Engineer. This work also includes removing and disposing all loose debris, cleaning and repairing reinforcing steel and applying shotcrete.

The location and extent of repairs shown on the plans are general in nature. The Engineer shall determine the extent of removal in the field based on an evaluation of the condition of the exposed surfaces.

Any portion of the structure that is damaged from construction operations shall be repaired to the Engineer's satisfaction, at no extra cost to the Department.

MATERIAL REQUIREMENTS

Use prepackaged shotcrete conforming to the requirements of ASTM C1480, the applicable sections of the Standard Specifications and the following:

Test Description	Test Method	Age (Days)	Specified Requirements
Silica Fume (%)	ASTM C1240	-	10 (Max.)
Water/Cementitious Materials Ratio	-	-	0.40 (Max.)
Air Content - As Shot (%)	ASTM C231	-	4 ± 1
Slump - As Shot (Range in inches)	ASTM C143	-	2 - 3
Minimum Compressive Strength (psi)	ASTM C39	7 28	3,000 5,000
Minimum Bond Pull-off Strength (psi)	ASTM C1583	28	145
Rapid Chloride Permeability Tests (range in coulombs)	ASTM C1202	-	100 - 1000

Admixtures are not allowed unless approved by the Engineer. Store shotcrete in an environment where temperatures remain above 40°F and less than 95°F

All equipment must operate in accordance with the manufacturer's specifications and material must be placed within the recommended time.

QUALITY CONTROL

A. Qualification of Shotcrete Contractor

The shotcrete Contractor shall provide proof of experience by submitting a description of jobs similar in size and character that have been completed within the last 5 years. The name, address and telephone number of references for the submitted projects shall also be furnished. Failure to provide appropriate documentation will result in the rejection of the proposed shotcrete contractor.

B. Qualification of Nozzleman

The shotcrete Contractor's nozzleman shall be certified by the American Concrete Institute (ACI). Submit proof of certification to the Engineer prior to beginning repair work. The nozzleman shall maintain certification at all times while work is being performed for the Department. Failure to provide and maintain certification will result in the rejection of the proposed nozzleman.

TEMPORARY WORK PLATFORM

Prior to beginning any repair work, provide details for a sufficiently sized temporary work platform at each repair location. Design steel members to meet the requirements of the American Institute of Steel Construction Manual. Design timber members in accordance with the "National Design Specification for Stress-Grade Lumber and Its Fastenings" of the National Forest Products Association. Submit the platform design and plans for review and approval. The design and plans shall be sealed and signed by a North Carolina registered Professional Engineer. Do not install the platform until the design and plans are approved. Drilling holes in the superstructure for the purpose of attaching the platform is prohibited. Upon completion of work, remove all anchorages in the substructure and repair the substructure at no additional cost to the Department.

SURFACE PREPARATION

Prior to starting the repair operation, delineate all surfaces and areas assumed to be deteriorated by visually examining and sounding the concrete surface with a hammer or other approved method. The Engineer is the sole judge in determining the limits of deterioration.

Prior to removal, introduce a shallow saw cut approximately ½" in depth around the repair area at right angles to the concrete surface. Remove all deteriorated concrete 1 inch below the reinforcing steel with a 17 lb (maximum) pneumatic hammer with points that do not exceed the width of the shank or with hand picks or chisels as directed by the Engineer. Do

not cut or remove the existing reinforcing steel. Unless specifically directed by the Engineer, do not remove concrete deeper than 1 inch below the reinforcing steel.

Abrasive blast all exposed concrete surfaces and existing reinforcing steel in repair areas to remove all debris, loose concrete, loose mortar, rust, scale, etc. Use a wire brush to clean all exposed reinforcing steel and prestressed strands. After sandblasting examine the reinforcing steel to ensure at least 90% of the original diameter remains. If there is more than 10% reduction in the rebar diameter, splice in and securely tie supplemental reinforcing bars as directed by the Engineer. Note and provide detailed documentation, including location, and severity, of all damage to prestressed strands that exceeds 10% section loss. If five or more strands are damaged, notify the Engineer prior to placement of repair material.

Provide welded stainless wire fabric at each repair area larger than one square foot if the depth of the repair exceeds 2 inches from the "As Built" outside face. Provide a minimum 4" x 4" - 12 gage stainless welded wire fabric unless otherwise shown on the plans. Rigidly secure the welded wire fabric to existing steel or to 3/16" diameter stainless hook fasteners adequately spaced to prevent sagging. Encase the welded wire fabric in shotcrete a minimum depth of 1½ inches.

The contractor has the option to use synthetic fiber reinforcement as an alternate to welded wire fabric if attaching welded wire fabric is impractical or if approved by the Engineer. Welded wire fabric and synthetic fiber reinforcement shall not be used in the same repair area.

Thoroughly clean the repair area of all dirt, grease, oil or foreign matter, and remove all loose or weakened material before applying shotcrete. Saturate the repair area with clean water the day before applying shotcrete. Bring the wetted surface to a saturated surface dry (SSD) condition prior to applying shotcrete and maintain this condition until the application begins. Use a blowpipe to facilitate removal of free surface water. Only oil-free compressed air is to be used in the blowpipe.

The time between removal of deteriorated concrete and applying shotcrete shall not exceed 5 days. If the time allowance exceeds 5 days, prepare the surface at the direction of the Engineer before applying shotcrete.

APPLICATION AND SURFACE FINISH

Apply shotcrete only when the surface temperature of the repair area is greater than 40°F and less than 95°F. Do not apply shotcrete to frosted surfaces. Maintain shotcrete at a minimum temperature of 40°F for 3 days after placement.

Apply shotcrete in layers. The properties of the applied shotcrete determine the proper thickness of each layer or lift.

The nozzleman should hold the nozzle 3 to 4 feet from the surface being covered in a position that ensures the shotcrete strikes at right angles to the surface being covered without excessive impact. The nozzleman shall maintain the water amount at a practicable minimum, so the mix properly adheres to the repair area. Water content should not become high enough

to cause the mix to sag or fall from vertical or inclined surfaces, or to separate in horizontal layers.

Use shooting wires or guide strips that do not entrap rebound sand. Use guide wires to provide a positive means of checking the total thickness of the shotcrete applied. Remove the guide wires prior to the final finish coat.

To avoid leaving sand pockets in the shotcrete, blow or rake off sand that rebounds and does not fall clear of the work, or which collects in pockets in the work. Do not reuse rebound material in the work.

If a work stoppage longer than 2 hours takes place on any shotcrete layer prior to the time it has been built up to required thickness, saturate the area with clean water and use a blowpipe as outlined previously, prior to continuing with the remaining shotcrete course. Do not apply shotcrete to a dry surface.

Finish all repaired areas, including chamfered edges, as close as practicable to their original "As Built" dimensions and configuration. Provide a minimum 2" of cover for reinforcing steel exposed during repair. Slightly build up and trim shotcrete to the final surface by cutting with the leading edge of a sharp trowel. Use a rubber float to correct any imperfections. Limit work on the finished surface to correcting imperfections caused by trowel cutting.

Immediately after bringing shotcrete surfaces to final thickness, thoroughly check for sags, bridging, and other deficiencies. Repair any imperfections at the direction of the Engineer.

Prevent finished shotcrete from drying out by maintaining 95% relative humidity at the repair and surrounding areas by fogging, moist curing or other approved means for seven days.

MATERIAL TESTING & ACCEPTANCE

Each day shotcreting takes place, the nozzleman shall shoot one 18" x 18" x 3" test panel in the same position as the repair work that is being done to demonstrate the shotcrete is being applied properly. Store, handle and cure the test panel in the same manner as the repaired substructure.

Approximately 72 hours after completing the final shotcrete placement, thoroughly test the surface with a hammer. At this time, the repair area should have sufficient strength for all sound sections to ring sharply. Remove and replace any unsound portions prior to the final inspection of the work. No additional compensation will be provided for removal and replacement of unsound shotcrete.

After 7 days, core three 3" diameter samples from each test panel and from the repaired structure as directed by the Engineer. Any cores taken from the structure shall penetrate into the existing structure concrete at least 2 inches. Cores shall be inspected for delamination, sand pockets, tested for bond strength and compressive strength. If a core taken from a repaired structure unit indicates unsatisfactory application or performance of the shotcrete, take additional cores from the applicable structure unit(s) for additional evaluation and testing as directed by the Engineer. Any repair work failing to meet the requirements of this

provision will be rejected and the Contractor shall implement a remediation plan to correct the deficiency at no additional cost to the Department. No extra payment will be provided for drilling extra cores. Patch all core holes in repaired structure units to the satisfaction of the Engineer. All material testing, core testing and sampling will be done by the Materials and Tests Unit of North Carolina Department of Transportation.

MEASUREMENT AND PAYMENT

Shotcrete Repairs will be measured and paid for at the contract unit price bid per cubic foot and will be full compensation for removal, containment and disposal off-site of unsound concrete including the cost of materials, labor, tools, equipment and incidentals necessary to complete the repair work. Depth will be measured from the original outside concrete face. The Contractor and Engineer will measure quantities after removal of unsound concrete and before application of repair material. Payment will also include the cost of sandblasting, surface cleaning and preparation, cleaning of reinforcing steel, placement of new steel, cost of temporary work platform, testing for soundness, curing of shotcrete and taking core samples from the test panels and substructure units.

Payment will be made under:

Pay Item	Pay Unit
Shotcrete Repairs	Cubic Feet

EPOXY MORTAR REPAIRS (SPECIAL)

1.0 MATERIAL PROPERTIES

Use a two-component paste epoxy bonding agent for the epoxy mortar conforming to the following requirements:

Density, lbs/gal	10.5
Specific Gravity	1.3
Minimum Application Temperature, °F	50
Application Temperature Range, °F	60 to 105
Shelf Life	1 year (min.)

	@ 60°F	@ 85°F	@ 105°F
Potlife, hr., 1 gallon	2½	1	½
Open Time[1], minimum: hr.	4	1¾	¾
Non-sag Thickness, inches (ASTM D2730)	1	¾	½
Initial Cure[2], days (AASHTO T237)	10	6	3

Cure Time[3], days (ASTM D695)	20	10	7

Typical Mechanical Properties[4]	
Tensile Strength, psi Elongation at Break (ASTM D638)	1,500 4%
Compressive Yield Strength, psi Compressive Modulus, psi (ASTM D695)	8,000 4.0×10^5
Heat Deflection Temperature[5], °F (ASTM D648)	105
Slant Shear Strength, psi Damp to Damp Concrete (AASHTO T237)	5,000 100% Concrete Failure

1. From start of mixing to completion of repair
2. 5,000 psi minimum
3. Isothermal cure to eliminate effect of exotherm
4. Cure schedule 7 days @ 77°F, test temperature 77°F
5. 128°F after 28 day cure

2.0 SURFACE PREPARATION

Prior to the application of epoxy mortar, thoroughly clean surfaces to be repaired and remove all loose materials. Remove grease, wax, and oil contaminants by scrubbing with an industrial grade detergent or degreasing compound followed by a mechanical cleaning. Remove weak or deteriorated concrete to sound concrete by bush hammering, gritblasting, scarifying, waterblasting, or other approved methods. Remove dirt, dust, laitance and curing compounds by gritblasting, sanding, or etching with 15% hydrochloric acid.

Acid etch only if approved by the Engineer. Follow acid etching by scrubbing and flushing with copious amounts of clean water. Check the cleaning using moist pH paper. Water cleaning is complete when the paper reads 10 or higher.

Follow all mechanical cleaning with vacuum cleaning.

3.0 APPLICATION

When surface preparation is completed, apply epoxy mortar to the areas specified in the contract plans and established by the Engineer. Repair deep surface irregularities such as severe spalling with a 1:1 sand-epoxy mix. Use graded silica sand that is washed, kiln-dried, and bagged. Repair shallow surface irregularities with the epoxy bonding agent. The finishing of those areas receiving the sand-epoxy mix with the epoxy bonding agent is permitted.

Apply epoxy mortar to damp surfaces only when approved. In such instances, remove all free water by air-blasting.

After applying the epoxy mortar, remove excessive material and provide a smooth, flush surface. Remove the epoxy material in accordance with the supplier's instructions.

TEMPORARY WORK PLATFORM

Prior to beginning any repair work, provide details for a sufficiently sized temporary work platform at each repair location. Design steel members to meet the requirements of the American Institute of Steel Construction Manual. Design timber members in accordance with the "National Design Specification for Stress-Grade Lumber and Its Fastenings" of the National Forest Products Association. Submit the platform design and plans for review and approval. The design and plans shall be sealed and signed by a North Carolina registered Professional Engineer. Do not install the platform until the design and plans are approved. Drilling holes in the superstructure for the purpose of attaching the platform is prohibited. Upon completion of work, remove all anchorages in the substructure and repair the substructure at no additional cost to the Department.

4.0 MEASUREMENT AND PAYMENT

Payment for Epoxy Mortar Repairs will be at the contract unit price per cubic foot for "Epoxy Mortar Repairs". Such payment will be full compensation for furnishing all material, labor, the cost of surface cleaning and preparation, cleaning of reinforcing steel, cost of temporary work platform and tools and equipment necessary for performing this work complete in place and accepted. Depth will be measured from the original outside concrete face. The Contractor and Engineer will measure quantities after removal of unsound concrete and before application of repair material.

Payment will be made under:

Pay Item	Pay Unit
Epoxy Mortar Repairs	Cubic Feet

CLEANING AND PAINTING EXISTING BEARINGS WITH HRCSA

DESCRIPTION

These items of work shall consist of cleaning, preparation, and field application of the specified paint system to existing steel bridge bearings and for all labor, materials, tools and equipment necessary, to complete the work to the limits shown on the plans, described in these special provisions, or as directed by the Engineer.

On bridge 880007, the bearings (including bearing plates, fill plates, anchor rods and nuts, embedded plates on girder, and any other associated metal components that support each girder at each bent) shall be cleaned as required in this special provision, using hand tools, power tools, and high pressure water equipment. Using dry compressed air, connections and crevices will be dried completely. Rust penetrant will be applied to all open connections, crevices, pack rust and scale rust areas. A paint system with a co-polymerized high ratio of 'active' calcium sulfonate (HRCSA) will be used as a stripe coat at all connections/crevices and as a topcoat over the bearings.

CERTIFICATION

The existing paint systems include toxic substances such as red lead oxide, which are considered hazardous if improperly removed. The contractor shall be currently SSPC QP 2, Category A certified, and have successfully completed lead paint removal and field painting on similar structures within 18 months prior to this bid.

The apparent low bidder shall submit a list of projects for which QP 2 work was performed within the last 18 months including owner contact information and submit to the Assistant State Structures Engineer (Operations) a "Lead Abatement Affidavit" by 12:00 noon of the third day following the opening of bids. This form may be downloaded from: **http://www.ncdot.gov/projects/ncbridges/#stats**.

The Engineer will evaluate the work history to verify all lead abatement work was completed in accordance with contract specifications, free of citation from safety or environmental agencies. Lead abatement work shall include, but not be limited to: abrasive blasting; waste handling, storage and disposal; worker safety during lead abatement activities (fall protection, PPE, etc.); and containment. This requirement is in addition to the contractor pre-qualification requirements covered by Article 102-2 of the *2012 Standard Specifications*.

TWELVE-MONTH OBSERVATION PERIOD

The Contractor maintains responsibility for the coating system for a 12 month observation period beginning upon the satisfactory completion of all the work required in the plans or as directed by the Engineer. The Contractor shall guarantee the coating system under the payment and performance bond (refer to Article 109-10 of the *2012 Standard Specifications*). To successfully complete the observation period, the coating system shall meet the following requirements after 12 months service:

(A) No visible rust, contamination or application defect is observed in any coated area.
(B) Painted surfaces have a uniform color and gloss.
(C) Painted surfaces have an adhesion that meets an ASTM D3359, 3A rating.

Final acceptance is made only after the paint system meets the above requirements.

SUBMITTALS

Submit all of the following to the Engineer for review and approval before scheduling the pre-construction meeting. Allow 40 calendar days for review and approval, or acceptance, of working drawings, from the date they are received, until they are returned by the Engineer.

(A) Work schedule which shall be kept up to date, with a copy of the revised schedule being provided to the Engineer in a timely manner,

(B) Containment Drawings in accordance with SSPC Guide 6, Class 2W sealed by a Professional Engineer licensed by the State of North Carolina,

(C) Bridge wash water sampling and disposal plan,

(D) Subcontractor identification,

(E) Lighting plan for night work in accordance with Section 1413 of the *2012 Standard Specifications*. Lighting shall be equipped with explosion-proof fixtures,

(F) Traffic control plan with NCDOT certified supervisors, flaggers and traffic control devices,

(G) Health and safety plan addressing at least the required topics as specified by the SSPC QP 1 and QP 2 program and including hazard communication, respiratory health, emergency procedures, and local hospital and treatment facilities with directions and phone numbers, disciplinary criteria for workers who violate the plan and accident investigation. The plan shall address the following: hazardous materials, personal protective equipment, general health and safety, occupational health and environmental controls, fire protection and prevention, signs signals, and barricades, materials handling, storage, use, and disposal, hand and power tools, welding and cutting, electrical, scaffolds, fall protection, cranes, derricks, hoists, elevators, and conveyors, ladders, toxic and hazardous substances, airless injection and HPWJ.

(H) Provide the Engineer a letter of certification that all employees performing work on the project have blood lead levels that are below the OSHA action level.

(I) Provide the Engineer with Competent Person qualifications and summary of work experience.

(J) Environmental Compliance Plan

(K) Quality Control Plan (Project Specific) with quality control qualifications and summary of work experience.

(L) Bridge and Public Protection Plan (Overspray, Utilities, etc. - Project/Task Specific)

(M) Soluble salt removing chemical for use during high pressure water cleaning

- (1) Product Data Sheet

(N) Coating Material

- (1) NCDOT HICAMS Test Reports (testing performed by NCDOT Materials and Tests Unit),
- (2) Product Data Sheets,
- (3) Material Safety Data Sheets,
- (4) Product Specific Repair Procedures, and
- (5) Acceptance letters from paint manufacturers for work practices that conflict with Project Special Provisions and/or paint manufactures product data sheets.

PRE-CONSTRUCTION MEETING

Submittals shall be reviewed and approved by the Engineer prior to scheduling the pre-construction meeting. Allow no less than 2 weeks for a review process. When requesting a pre-construction meeting, contact the Engineer at least 7 working days in advance of the desired pre-construction date. The contractor's project supervisor, Competent person, quality control personnel, coating manufacturer's representative, and certified traffic control supervisor shall be in attendance at the pre-construction meeting in order for the Contractor and NCDOT team to establish responsibilities for various personnel during project duration and to establish realistic timeframes for problem escalation.

CONTAINMENT PLAN

If a containment plan for Painting of Existing Structure is submitted for a bridge that will have its bearings cleaned and painted with HRCSA, the containment plan for that structural steel painting operation will suffice for cleaning and painting existing bearings with HRCSA. If the structural steel of a bridge is not to be cleaned and painted, and no containment plan has been submitted for that bridge, if that bridge will have its bearings cleaned and painted with HRCSA, a containment plan for cleaning and painting existing bearings with HRCSA shall be submitted for review and approval.

No work shall begin until the Contractor furnishes the Engineer with a containment plan for surface preparation and coating operations and the Engineer reviews and approves, in writing, the acceptability of said plan. Allow a minimum of two weeks for review of the plan. Such plan shall meet or exceed the requirements of Class 2W containment in accordance with SSPC Guide 6. Enclosure drawings and loads supported by the containment structure shall be prepared, signed and sealed by a Professional Engineer licensed by the State of North Carolina.

In the containment plan describe how debris is contained and collected. Describe the type of tarpaulin, bracing materials and the maximum designed wind load. Describe the paint and debris collection system and how a negative pressure of 0.03 inches of water column is maintained inside the enclosure while cleaning and painting operations are being conducted. Describe how the airflow inside the containment structure is designed to meet all applicable OSHA Standards. Describe how wash water will be contained and paint chips separated. Describe how water run-off from rain will be routed by or through the enclosure. Describe what physical containment will be provided during painting application to protect the public and areas not to be painted.

WASH WATER SAMPLING AND DISPOSAL PLAN

No work shall begin until the Contractor furnishes the Engineer with a containment plan for surface preparation and coating operations and the Engineer reviews and approves in writing said plan. All wash water shall be collected and sampled prior to disposal. Representative sampling and testing methodology shall conform to 15A NCAC 02B.0103, "Analytical Procedures". Wash water shall be tested for pollutants listed in 15A NCAC 02B.0211(3), 15A NCAC 02T.0505(b)(1) and 15A NCAC 2T.0905(h). Depending on the test results,

wash water disposal methods shall be described in the disposal plan. Wash water shall be disposed of in accordance with all current Federal and State regulations. See link for NCDOT Guidelines for Managing Bridge Wash Water: **http://www.ncdot.gov/projects/ncbridges/#stats**.

WASTE HANDLING OF PAINT AND DEBRIS

Comply with all Federal, State and local regulations. Failure to comply with the regulations could result in fines and loss of qualified status with NCDOT.

Comply with the Resource Conservation and Recovery Act (RCRA - 40 CFR 261 - 265) and the Occupational Safety and Health Act (OSHA - 29 CFR 1910 - 1926) regulations for employee training, and for the handling, storage, labeling, recordkeeping, reporting, inspections and disposal of all hazardous waste generated during paint removal.

A summary of Generator Requirements is available at the above NCDOT web link which cites the specific regulations for each Generator category. Quantities of waste by weight and dates of waste generation shall be recorded. Waste stored at the project site shall be properly labeled. All waste, hazardous or non-hazardous, requires numbered shipping manifests.

The North Carolina Department of Environmental Quality (NCDEQ) have adopted RCRA as the North Carolina Hazardous Waste Management Rules and are responsible for enforcement. The "Hazardous Waste Compliance Manual for Generators of Hazardous Waste" is published by the Compliance Branch of the Division of Waste Management of NCDEQ, and can be found at:

https://deq.nc.gov/about/divisions/waste-management/waste-management-rules/hazardous-waste-rules

Use a company from the below list of approved waste management companies. Immediately after award of the contract, arrange for waste containers, sampling, testing, transportation and disposal of all waste. No work shall begin until the Contractor furnishes the Engineer with a written waste disposal plan. Any alternative method for handling waste shall be pre-approved by the Engineer.

Southern Logistics, Inc.
312 Orville Wright Dr., Greensboro, NC 27409
(Phone 336-662-0292)
A&D Environmental
PO Box 484, High Point, NC 27261
(Phone 336-434-7750)
Poseidon Environmental Services, Inc.
837 Boardman-Canfield Rd #209, Youngstown, OH
(Phone 330-726-1560)
Clean Harbors Reidsville, LLC

208 Watlington Industrial Drive, Reidsville, NC 27320
(Phone 336-342-6106)

All removed paint and debris shall be tested for lead following the SW-846 TCLP Method 1311 Extraction, as required in 40 CFR 261, Appendix 11, to determine whether it shall be disposed of as hazardous waste. Furnish the Engineer certified test reports showing TCLP results and Iron analysis of the paint chips stored on site, with disposal in accordance with "Flowchart on Lead Waste Identification and Disposal" at:

https://ncdenr.s3.amazonaws.com/s3fs-public/document-library/Lead%20Disposal.pdf

All sampling shall be done in presence of the Engineer's representative.

The Competent Person shall obtain composite samples from each barrel of the wash water and waste generated by collecting two or more portions taken at regularly spaced intervals during accumulation. Combine the portions into one sample for testing purposes. Acquire samples after 10% or before 90% of the barrel has accumulated. The intent is to provide samples that are representative of widely separated portions, but not the beginning and end of wash water or waste accumulation.

Perform sampling by passing a receptacle completely through the discharge stream or by completely diverting the discharge into a sample container. If discharge of the wash water or waste is too rapid to divert the complete discharge stream, discharge into a container or transportation unit sufficiently large to accommodate the flow and then accomplish the sampling in the same manner as described above.

Comply with the NCDEQ Hazardous Waste Compliance Manual for Generators of Hazardous Waste. Record quantities of waste by weight and dates of waste generation. Until test results are received, store all waste, and label as "NCDOT Bridge Paint Removal Waste - Pending Analysis" and include the date generated and contact information for the Division HazMat Manager or Project Engineer. Store waste containers in an enclosed, sealed and secured storage container protected from traffic from all directions. Obtain approval for the protection plan for these containers from the Engineer. If adequate protection cannot be obtained by use of existing guardrail, provide the necessary supplies and equipment to maintain adequate protection. Once test results are received and characterized, label waste as either "Hazardous Waste - Pending Disposal" or "Paint Waste - Pending Disposal".

Once the waste has been collected, and the quantities determined, prepare the appropriate shipping documents and manifests and present them to the Engineer. The Engineer will verify the type and quantity of waste and obtain a Provisional EPA ID number from the:

NC Hazardous Waste Section
North Carolina Department of Environment & Natural Resources
1646 Mail Service Center
Raleigh, NC 27699
Phone (919) 508-8400, Fax (919) 715-4061

At the time of shipping, the Engineer will sign, date and add the ID number in the appropriate section on the manifest. The maximum on-site storage time for collected waste shall be 90 days. All waste whether hazardous or non-hazardous will require numbered shipping manifests. The cost for waste disposal (including lab and Provisional EPA ID number) is included in the bid price for this contract. Note NC Hazardous Waste Management Rules (15A NCAC 13A) for more information. Provisional EPA ID numbers may be obtained at this link:

http://deq.nc.gov/about/divisions/waste-management/waste-management-permits/hazardous-waste-section-permits/provisional-hazardous-waste-notification

Testing labs shall be certified in accordance with North Carolina State Laboratory Public Health Environmental Sciences. List of certified laboratories may be obtained at this link:

https://slphreporting.ncpublichealth.com/EnvironmentalSciences/Certification/CertifiedLaboratory.asp

All test results shall be documented on the lab analysis as follows:

1. For leachable lead:
   a. Soils/Solid/Liquid- EPA 1311/200.7/6010

Area sampling will be performed for the first 2 days at each bridge location. The area sample will be located within five feet of the containment and where the highest probability of leakage will occur (access door, etc.). Results from the area sampling will be given to the Engineer within 72 hours of sampling (excluding weekends). If the results of the samples exceed 20 µg/m^3 corrective measures shall be taken and monitoring shall be continued until 2 consecutive sample results are less than 20 µg/m^3.

TWA may suspend the work if there are visible emissions outside the containment enclosure or pump monitoring results exceeding the level of 30 µg/m^3.

Where schools, housing and/or buildings are within 500 feet of the containment, the Contractor shall perform initial TSP-Lead monitoring for the first 10 days of the project during water cleaning and containment removal. Additional monitoring will be required during water cleaning 2 days per month thereafter. Results of the TSP monitoring at any location shall not exceed 1.5 µg/m^3.

EQUIPMENT MOBILIZATION

The equipment used in any travel lanes and paved shoulder shall be mobile equipment on wheels that has the ability to move on/off the roadway in less than 30 minutes. All work conducted in travel lanes shall be from truck or trailer supported platforms and all equipment shall be self-propelled or attached to a tow vehicle at all times.

SUBLETTING OF CONTRACT

Only contractors certified to meet SSPC QP 2, Category A, and have successfully completed lead paint removal and field painting on all similar structures within 18 months prior to this bid are qualified for this work. Work is only sublet by approval of the Engineer.

MATERIAL

PENETRANT AND PAINT SYSTEM

The paint system to be used shall be a High Ratio Co-Polymerized Calcium Sulfonate (HRCSA) coating system. Characteristics of submitted products shall meet or exceed those of the requirements listed within this specification.

The structure is to be coated with a High Ratio, Co-Polymerized Calcium Sulfonate (HRCSA) corrosion mitigation system. Any Contractor-proposed coating system shall meet the following requirements:

a. The proposed coating system shall be an HRCSA coating as defined by these specifications and shall be submitted for approval.
    1. Primer/Topcoat (Minimum 9.5% active sulfonate) must maintain a 9-11 to 1 ratio Total Base Number to Active Sulfonate, i.e., total base number of 85 to 104 to 9.5% Active Sulfonate, as determined by Percent Active Sulfonate Content by Cationic Titration (Hyamine) testing, Procedure No. 817/4.9/T1409A.
    2. Formulations with greater than 27% Alkyd or co-polymer are not valid HRCSA.
    3. Zero VOC, 100% Solids Penetrant/Sealer approved by HRCSA manufacturer (Minimum 15% active sulfonate, a total base number of 135 to 165, must maintain a 9-11 to 1 ratio Active Sulfonate to Total Base Number as determined by Total Base Number Determination testing, Procedure No. 817/4.9/T1401.
b. The proposed coating system shall be certified in writing by the coating manufacturer that the HRCSA Primer/Topcoat and the HRCSA Penetrant Sealer meets the HRCSA generic specification and has been verified by the testing titration protocols indicated above. The Engineer may choose to perform verification testing using the same protocols on materials delivered to the job site.
c. The proposed coating formulation shall have independent laboratory tests showing that the HRCSA coating, as supplied, has been tested to ASTM D5894 with a 24 hour freeze thaw cycle and has passed a minimum 5000 hours with no rust creepage at the scribe. The manufacturer shall certify that the currently manufactured

formulation used is the same as the formulation that was tested, and can supply supporting documentation.

Lighting shall be equipped with explosion-proof fixtures.

The accumulation of empty paint cans, combustibles, and other debris will not be permitted.

MSDS sheets for all materials shall be maintained on file and provided to the Engineer prior to receipt of the material from the manufacturers.

If required, paint shall be mixed with mechanical mixers in accordance with the paint manufacturer's recommendations.

The primer, stripe, and other coats may be thinned only if recommended by the manufacturer, done in compliance with the manufacturer's instructions, approved by the Engineer, and mixed in the presence of the Engineer. If recommended by the manufacturer and approved by the Engineer, a measuring cup, have graduation in ounces, shall be used in the addition of thinner to any paint. No "eye balling" during addition of thinner to paint will be allowed. Paint mixed with thinner by "eye balling" will be subject to rejection by the Engineer as ruined material.

PENETRANT AND PAINT STORAGE

Do not expose penetrant and paint materials to rain, excessive condensation, long periods of direct sunlight, or temperatures above 100°F or below 40°F. In addition, the Contractor shall place a device which records the high, low, and current temperatures inside the storage location. Follow the manufacturer's storage requirements if more restrictive than the above requirements. Any material found to be damaged or beyond its expiration date shown on the container shall be immediately removed from the project site and will be considered as ruined material.

TESTING OF PAINT SAMPLES:

Engineer reserves the right to conduct tests of the materials at any time, and any number of times during the period of field painting.

The Engineer will sample the paint(s) being used. A representative size sample of each component of paint(s) at the construction site will be transferred to metal containers, identified, sealed, and certified in the presence of the Contractor.

Tests on paint samples may be performed by the Owner in order to confirm the manufacturer's test results submitted with each batch of material.

If the laboratory test results show that the material being used does not comply with the requirements specified in this Special Provision, the Contractor will be directed to stop painting work and remove non-complying paint; pay for testing; re-paint surfaces coated

with rejected paint; or remove rejected paint from previously painted surfaces if, upon re-painting with specified paint, the two coatings are not compatible.

CONSTRUCTION METHODS

CLEANING AND REMOVAL OF PACK RUST

Removal of pack rust shall be done by hand tool cleaning to meet requirements of SSPC-SP 2, or by power tool cleaning to meet requirements of SSPC-SP 3, or a combination of these methods. Any black oxide scale shall be removed, unless otherwise directed by the Engineer. Pay particular attention to crevice areas when removing pack rust and rust scale. Exercise care to avoid nicking or gouging the steel during removal. Remove all rust scale and loose pack rust, followed by high pressure water cleaning.

HIGH PRESSURE WATER CLEANING (HPWC)

The structure (or portions of it to be coated) shall be cleaned with water at a minimum pressure of 5,000 psi and a maximum of 9,500 psi, at 5 gallons per minute, with a rotating tip, at a maximum 4 inch standoff distance from the steel surface, held as perpendicular to the steel surface as possible.

All water to be used in the surface preparation shall be potable water.

Ambient wash water temperature is allowed; hot water is not necessary.

The wash water shall include a soluble salt removing chemical at a minimum ratio of 100:1 and in compliance with manufacturer recommendations.

Care should be taken to ensure that the potable wash water does not have a level of chloride exceeding 15 ppm when tested. If higher, the level of soluble salt removing chemical should be proportionally increased as per manufactures recommendation.

It should be expected that the surfaces of the steel (and connections) are contaminated with soluble salts (e.g. Chlorides, Sulfates, or Nitrates). Using an acceptable sample method in accordance with SSPC Guide 15, ensure that soluble slat levels on the surfaces do not exceed allowable soluble salt limits listed below:

Chloride - NVC3 3 $\mu g/cm^2$
Sulfate - NVS10 10 $\mu g/cm^2$
Nitrate - NVN10 10 $\mu g/cm^2$

The frequency of testing shall be 2 tests per span after all surface preparation has been completed and immediately prior to painting. Select test areas representing the greatest amount of corrosion in the span as determined by the Engineers' representative. Additional testing may be required if significant amounts of chloride are detected.

The surface cleaning shall meet the requirements of SSPC-WJ4, to remove loose paint and loose rust. SSPC SP2 or SP3 (hand or power tool cleaning) may be used in inaccessible areas or when water cleaning is not possible.

In some cases, after HPWC, there may be areas of tightly adhered black oxide that were not removed. All black oxide scale shall be removed, unless otherwise directed by the Engineer.

If there is a question of whether all loose paint has been removed, adhesion testing of the remaining "tightly adhered" paint shall be done in accordance with ASTM D 4541-02 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers, with a minimum value of 300 psi.

Care should be taken to ensure all crevice corroded and pack rusted joints connections and corrosion frozen bearings are flushed with water containing a soluble salt removing chemical, at a minimum pressure of 5,000 psi, at 5 gallons per minute, to ensure removal of all loose materials and to flush out any contaminant.

COMPRESSED AIR DRYING

All joints, connections, and bearings shall be blown dry with clean, dry, oil free, high pressure (100 psi) compressed air, regardless if the areas appear to be dry. Use the white blotter test in accordance with ASTM D4285 to verify the cleanliness of the compressed air used for blowout of "Limited Access" areas and drying. Conduct the test at least once per shift for each compressor system. Sufficient freedom from oil and moisture is confirmed if soiling and/or discoloration are not visible on the paper. If air contamination is evidenced, change filters, clean traps, add moisture separators or filters, or make adjustments as necessary to achieve clean, dry air.

All surfaces shall be inspected at this point. Surface preparation found to be deficient will be repeated at the Contractor's expense as directed by the Engineer. Once areas are agreed to be satisfactory, the Contractor may proceed with penetrating sealer application.

PENETRATING SEALER

Penetrating sealer may be applied by brush, roller, or airless spray method as recommended by the manufacturer. The mixing amount and method of mixing for the sealer components must be in accordance with the manufacturer's instruction. Wet coat sufficiently to completely cover and penetrate the steel surface, but do not apply heavy coat. Use coat thickness as recommended by the manufacturer. Apply liberally to crevices and joints and/or spaces where a gap has been created between plates and around bolts, nuts and washers. Allow material to soak into spaces. Brush out any excess material, so as to not retard curing of the topcoat or result in an unaesthetically pleasing surface.

The penetrating sealer shall be applied within 24-hours after completion of the cleaning operations and before flash-rusting occurs. No bare steel surface prepared for penetrating sealer application shall be left uncoated long enough to allow the formation of rust. Cleaned areas upon which rust has formed shall be re-cleaned in accordance with the cleaning requirement at no additional cost. The presence of rust shall be determined by the Engineer.

The receiving steel surface shall be clean and absolutely dry. The permissible steel surface temperature and the ambient temperature shall be as recommended by the sealer manufacturer. However, in no case, shall the penetrating sealer be applied when the steel surface or the ambient temperatures is below 36°F or above 104°F, or the relative humidity exceeds 99% or a 3.6°F (2°C) temperature-Dew Point temperature spread.

Drying time is temperature, humidity, and film thickness dependent. Use manufacturer's recommended drying schedule to estimate the drying time of the penetrating sealer for application of the other coatings. If the manufacturer's recommendations allow, the use of forced air pressure to dry the surface will be permitted.

HRCSA – STRIPING AND TOPCOAT

No application of any stripe/primer shall be allowed until cleaning and preparation of the substrate has been approved by the Engineer. See drawings to determine exact location of structure components to be painted.

The permissible steel surface temperature and the ambient temperature shall be as recommended by the coating manufacturer. However, in no case, shall the coating be applied when the steel surface or the ambient temperatures is below 36°F or above 104°F, or the relative humidity exceeds 99% or a 3.6°F (2°C) temperature-Dew Point temperature spread

The Contractor shall provide paintbrushes, rollers, and spray equipment to conduct the work as specified in this Section.

The Contractor shall also provide specialized equipment as required for the painting of limited access areas and for other difficult-to-clean areas. Specialized equipment may include, but is not limited to:

- Pole guns for spray painting
- Mitts, daubers, or other methods to supplement brush application

Stripe painting will be required on the following surfaces that have been cleaned: edges of plates, angles, lattice, connections (rivets and bolt heads) or other shapes, corners, crevices, back-to-back angles, and built-up edges. The surfaces of existing steel members to which new steel may be connected (faying surfaces) shall also be cleaned and painted as herein described. The stripe coat shall have a band width of at least 4 in. (101.6 mm) to each side of the adjoining edges and is to completely coat the interior of all crevices. All stripe painting should be applied by spray, but immediately afterwards it may be 'brushed in' using a brush. No other method of paint application will be allowed for stripe painting.

Paint for intermediate coat or topcoat may be applied using spray, brush, or roll methods.

Spray painting will be permitted only within a containment that will contain all of the sprayed material, as approved by the Engineer. Complete protection from paint spatter, spillage, overspray, wind-blown paint, or similar releases of paint shall be provided. Covers, tarps, mesh, and similar materials shall be placed around the work area to protect public and private property, pedestrian, vehicular, marine, or other traffic, all portions of the bridge, highway appurtenances, waterways, and similar surrounding areas and property, upon, beneath, or

adjacent to the structure.

Apply HRCSA as directed by the manufacturer. Wait time between the stripe coats, intermediate coats, and the topcoat shall be as per the manufacturer's recommendations. The following paint schedule shall be used unless special exceptions are submitted and approved according to manufacturer recommendations prior to the start of this work.

Application Location	Description	Film Thickness
SPOT	Liberally apply a stripe coat to crevice corroded and pack rusted bearings and connections, provide extra material to bolts, nuts and any gaps around rivets.	15-18 mils (wet) 10-12 mils (dry)
SPOT	Over exposed metal areas and areas of tightly adhered contaminant free rust or flash rust apply a spot prime with 5 to 7 mils DFT of Topcoat, including areas mentioned in previous SPOT application	7-10 mils (wet) 5-7 mils (dry)

Prior to placing the subsequent coats, the Contractor will ensure that the prior coat is clean of all foreign matter, such as grease, dirt, bird waste, etc., before application of the subsequent coat.

Sealer, stripe, spots, and finish coats shall be applied in sufficient quantity so as to produce the minimum specified Dry Film Thicknesses (DFT). Care should be taken to not over apply the primer/topcoat, especially on flat surfaces. Maximum 25 mils DFT.

Active calcium sulfonate coatings cure slowly, so wet film measurements may be used as criteria for **preliminary** acceptance of the coating. Wet film thickness (WFT) measurements shall be determined as the job progresses and corrections shall be made during paint application.

Dry film thicknesses shall be determined using SSPC-PA2 – using a digital film thickness gage and a shim – after the coating has cured sufficiently to allow accurate measurements. (Note: Depending upon ambient air conditions, it may take more than one week before DFT measurements can be taken.)

Areas failing to meet the specified WFT range shall be over-coated with the same paint to produce at least the total WFT required.

Paint applied containing unauthorized thinners, paint applied to contaminated surfaces, and paint applied contrary to this Specification shall result in the re-cleaning and re-painting of the surface. The work of re-cleaning, re-painting, or over-coating, if required, shall be performed within 10 days following notification by the Engineer and shall be done by the Contractor to the satisfaction of the Engineer, at no additional cost to the Owner.

INSPECTION

Each layer of application shall be verified by both Quality Control (QC) and Quality Assurance (QA).

QUALITY CONTROL INSPECTOR

The Contractor shall provide a quality control inspector in accordance with the SSPC QP guidelines to ensure that all processes, pack rust removal, and each coating application are in accordance with the requirements of the contract. The inspector shall have written authority to perform QC duties to include continuous improvement of all QC internal procedures. The presence of the Engineer or inspector at the work site shall in no way lessen the contractor's responsibility for conformity with the contract.

QUALITY ASSURANCE INSPECTOR

The quality assurance inspector, which may be a Department employee or a designated representative of the Department, shall observe, document, assess, and report that the Contractor is complying with all of the requirements of the contract. Inspectors employed by the Department are authorized to inspect and/ or test all work performed and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector is not authorized to alter or waive the requirements of the contract. Each stage in preparing the structure to be coated, which includes, but not limited to washing, pack rust removal, sealing, and application paint system, shall be inspected and approved by the Engineer or his authorized representative.

INSPECTION ACCESS

The Contractor shall furnish all necessary OSHA-approved apparatus such as ladders, scaffolds, and platforms as required for the Engineer or his inspector to have reasonable and safe access to all parts of the work. The contractor shall illuminate the surfaces to be inspected to a minimum of 50-foot candles of light. All access points shall be illuminated to a minimum of 20-foot candles of light.

INSPECTION INSTRUMENTS

At a minimum, furnish the following calibrated instruments and conduct the following quality control tests:

- Sling Psychrometer - ASTM E337 - bulb type and tables
- Inspection Mirror
- Surface Temperature Thermometer 30°F to 150°F
- Air Thermometer, pocket type, 30°F to 100°F
- Illuminated Magnifier
- Hypodermic Needle Pressure Gauge
- Surface Condition Standards - SSPC VIS 1-3 and 4
- Wet Film Thickness Gage - ASTM D4414

- Dry Film Thickness Gage - SSPC-PA2 Modified
- Calibration Standards (NIST Traceable)
- Surface Contamination Analysis Kit or (Chloride, Nitrate, and Sulfate Level Test Kit) SSPC Technology Guide 15

QUALITY CONTROL

Maintain a daily quality control record in accordance with Article 442-13 of the *2012 Standard Specifications* and make such records available at the job site for review by the inspector and submit to the Engineer as directed. In addition to the information required on M&T-610, submit all Dry Film Thickness (DFT) or Wet Film Thickness (WFT) readings on a form equivalent to M&T-611.

Film thickness shall be measured at no less than six random spots per bearing (each of four bearing plate edges and two readings on top of the sole plate). Also, film thickness shall be measured at no less than six random spots per span on diaphragms/"K" frames.

Each spot is an average of three to five individual gage readings as defined in SSPC PA-2. No spot average shall be less than 80% of minimum film thickness for each layer applied; this does not apply to stripe coat application. These non-conforming areas shall be corrected by the Contractor prior to applying successive coats.

Areas failing to meet the specified film thickness range shall be over-coated with the same paint to produce at least the total film thickness required.

REPAIR OF DAMAGED COATINGS

All damaged coatings, new or existing, shall be repaired prior to project completion and acceptance in accordance with the above specifications for Re-Coating and Over-coating and as directed by the Engineer, at no additional cost to the Owner.

COATING MANUFACTURER'S REPRESENTATIVE

Unless waived by the Engineer, the Contractor shall make arrangements for a representative of the coating manufacturer to be present on-site as work begins, at a minimum, and as necessary as work progresses, to work together with the Contractor and representatives of the owner and to provide comments and guidance, so that the cleaning, application, and inspection procedures are done properly.

MEASUREMENT AND PAYMENT

Painting Containment for Bridge No. 7 will be paid for at the contract lump sum price which price will be full compensation for all collection, handling, storage, air monitoring, and disposal of debris and wash water, all personal protective equipment, and all personal hygiene requirements, and all equipment, material and labor necessary to fully contain the

paint and water; daily collection of debris into specified containers; and any measures necessary to ensure conformance to all safety and environments regulations as directed by the Engineer.

Cleaning and Painting Existing Bearings with HRCSA Bridge No. 7 will be paid for at the contract lump sum price which will be full compensation for all labor, materials and equipment necessary to complete the work. All work shall be done in a manner satisfactory to the Engineer.

Payment will be made under:

Pay Item	**Pay Unit**
Painting Containment for Bridge No. 7	Lump Sum
Cleaning and Painting Existing Bearings with HRCSA Bridge No. 7	Each

PILE JACKETS (SPECIAL)

Description

This specification establishes the minimum requirements for furnishing installing permanent outer pile forms, standoffs, steel reinforcement bands and steel bracing collars for the installation of pile jackets for pile repair. It is intended to ensure that the supplier's forms and installation/reinforcing details shall allow the forms to be filled with concrete without failure, and provide durable, corrosion resistant pile protection.

Materials

Forms:

The form shall be fabricated from fiberglass and polyester resins, or other inert materials that are compatible with Portland cement and produce a form with equal levels of corrosion resistance and durability. The inside face of the forms shall have a texture equal to that provided by sandblasting, and shall have no bond inhibiting agents in contact with cementitious materials. Forms shall include polymer standoffs of sufficient number and spacing to maintain a minimum space of 2" between the reinforcing steel and the jacket. Provide forms with dimensions in accordance with the sizing chart shown in the plans. For pumped applications provide ports in accordance with the plans. The minimum allowable thickness of the forms is 1/8". Upon opening to place around a pile, the form shall be capable of returning to its original shape without assistance or damage. It shall have an interlocking joint along one side, which will permit the form to be assembled and sealed in place around the pile. Contractor shall submit form details to the Engineer for approval prior to beginning work.

Transverse joints (if any) shall be of overlapping configuration.

The material furnished must meet the following physical property requirements:

(a) Water Absorption (ASTM-D570) ….……1% Maximum
(b) Ultimate Tensile Strength (ASTM-D638)* …… 9,000 psi Minimum
(c) Flexural Strength (ASTM-D796)* …… 16,000 psi Minimum
(d) Flexural Modulus of Elasticity (ASTM-D790) …..... 700,000 psi Minimum
(e) Barcol Hardness (ASTM-D2583) ……..……30 – 40
(f) Color …….. Similar to Federal Color Standard 595 Number 36622 – the color shall be integral in the form material.
(g) Accelerated Weathering … The fabricated form material shall be subjected to a 500 hour exposure test in a Twin-Carbon-ARC-Weather-Ometer (ASTM G-23, Type D) at an operating temperature of 145°F. Said test to be made at twenty minute cycles consisting of seventeen minutes of light and three minutes of water spray plus light. At the end of the exposure test the exposed samples shall not show any chipping, flaking or peeling. The test panels shall be prepared from the materials meeting the physical property requirements above, and they shall be in accordance with the manufacturer's recommendations.

"*"= On original specimen whose flat surfaces are not machined to disturb the fiberglass.

Epoxy Gel Sealant

Use an approved marine epoxy gel to adhere the outer jacket seams. The epoxy paste must be a two component epoxy compound, capable of being applied underwater. The ratio of resin component to hardener component is 1:1 by volume. To assist in evaluating the thoroughness of job site mixing, each component must be of sharply contrasting color.

Concrete

Concrete shall meet the requirements of the *Standard Specs* for Class A Concrete. Use a pea gravel mix suitable for pumped applications. An anti-washout admixture may be used for in water applications. Concrete mix design shall be submitted for approval prior to beginning work.

Reinforcement Bands

Provide reinforcement bands similar to that shown in the plans. The bands shall be reusable, and shall be equipped with quick release fasteners.

Submit details and calculations showing design loads and the placement of the bands on the pile form necessary to reinforce the form against failure from the concrete pressure, or any other loading the form may experience, including its use on battered piles.

Steel Bracing Collar

For forms to be supported on temporary falsework provide a steel bracing collar which will reinforce the bottom of the form and allow connection to the falsework.

Construction Methods

Prior to jacket installation, remove existing jacket if applicable and all delaminated or loose concrete and thoroughly clean pile of marine growth, oil, grease, mud, rust, and any other deleterious material which might prevent proper bonding between the concrete and the pile. Accomplish pile preparation and cleaning by hand or small pneumatic tool (17lb class or less) chipping, grit blasting, high pressure water blasting, or by divers using powered rotary abraders. Any method that produces the quality of cleaning necessary to meet the bond requirements of this specification may be considered. When necessary, perform the pile cleaning in 2 phases where active marine growth occurs. In the first phase, a maximum of 7 days before the encapsulation, remove marine growth, oil, grease, rust, and broken concrete, etc. In the second phase, a maximum of 48 hrs before placement of concrete in the outer pile jacket, perform a final surface preparation, removing all remaining deleterious substances including micro-organisms.

Contractor shall establish mean low water (MLW) elevation and set bottom of jacket a minimum of 2’ below that elevation.

Place the jacket assembly and position it around the pile in such a manner as to assure that no damage to stand-offs and rebar cage occur. Ensure there will be no detrimental movement of the joints while joint adhesive is curing. The placement of the jacket is to be determined by the location of the affected pile and in accordance with the contract drawings.

Seal the longitudinal and transverse seams, if any, with marine epoxy paste as described above.

Place concrete using a pump or tremie. Free fall placement of concrete will not be allowed if any part of the jacket is submerged below water. For above water applications free fall placement will only be allowed for jacket lengths up to 10’. Cope the top of the repair to drain water.

No tainted water above pH 9.0 will be allowed to discharge from the work site. Monitoring of pH levels inside and outside of the jacket is required during the pumping operation. Perimeter monitoring site should be no more than 10 ft down flow from the work area. If the pH of the water within the jacket exceeds then pump to a container and hold until the pH level returns to 9.0.

Concrete shall attain a minimum strength of 3000 psi prior to removing form work.

Submittals

Submit shop drawings and calculations to the Engineer for approval prior to start of fabrication. Submittal shall include form dimensions, standoffs, pump ports (where applicable), reinforcing cage installation, reinforcement bands, collars, temporary

falsework, methods to seal the form, form installation, and sequence of concrete placement.

Material Certification
For materials to be used, the Supplier shall furnish a certificate to the Engineer attesting that the materials meet all the requirements contained herein and that they conform in all respects to the materials subjected to the tests required. Copies of current test reports shall be attached to the certificate. No test report for tests made more than one year prior to shipment will be accepted for the form material.

Measurement and Payment
Pile Jackets will be measured and paid for at the contract unit price bid per linear foot of concrete encased pile jacket and will be full compensation for removal, containment and disposal off-site of unsound concrete including the cost of materials, labor, tools, equipment and incidentals necessary to accomplish removal; cleaning the pile, furnishing and installation of reinforcement, jacket installation, falsework; furnishing and placement of concrete including pumping equipment, pH monitoring, pollution control, turbidity curtains, and all else required to repair existing deteriorated concrete or deteriorated steel H-Piles using pile jackets.

Rejackets will be measured and paid for at the contract unit price bid per linear foot of concrete encased pile jacket and will be full compensation for removal, containment and disposal off-site of existing pile jackets, unsound concrete including the cost of materials, labor, tools, equipment and incidentals necessary to accomplish removal; cleaning the pile, furnishing and installation of reinforcement, jacket installation, falsework; furnishing and placement of concrete including pumping equipment, pH monitoring, pollution control, turbidity curtains, and all else required to repair existing deteriorated concrete or deteriorated steel H-Piles using pile jackets.

Payment will be made under:

Pay Item	Pay Unit
Pile Jackets	Linear Feet
Rejackets	Linear Feet

SILICONE JOINT SEALANT (SPECIAL)

1.0 SEALS

Silicone joint sealant with backer rod shall be on the NCDOT Approved Products List under product group Structures and product category Maint: Replacement & Repair and be under the approved product status. Additionally, it shall be approved for use on joints with at least a 3” joint opening and provide a seal with a working range of 50% compression and extension. Sealant shall be cold applied, troweable or self leveling as per joint manufacturer recommendations for joint opening.

2.0 SEAL INSTALLATION

Install the silicone joint sealant according to the manufacturer's procedures and recommendations and as recommended below. Do not install the joint seal if the ambient air or surface temperature is below 45°F. Have a manufacturer's certified trained factory representative present during the installation of the first seal of the project.

3.0 BASIS OF PAYMENT

Payment for all silicone joint sealant with backer rod will be at contract unit price per linear foot "Silicone Joint Sealant". Prices and payment will be full compensation for furnishing all material, including backer rod, labor, tools and equipment necessary for installing these units in place and accepted.
Payment will be made under:

Pay Item	Pay Unit
Silicone Joint Sealant	Linear Feet

FALSEWORK AND FORMWORK (4-5-12)

1.0 DESCRIPTION

Use this Special Provision as a guide to develop temporary works submittals required by the Standard Specifications or other provisions; no additional submittals are required herein. Such temporary works include, but are not limited to, falsework and formwork.

Falsework is any temporary construction used to support the permanent structure until it becomes self-supporting. Formwork is the temporary structure or mold used to retain plastic or fluid concrete in its designated shape until it hardens. Access scaffolding is a temporary structure that functions as a work platform that supports construction personnel, materials, and tools, but is not intended to support the structure. Scaffolding systems that are used to temporarily support permanent structures (as opposed to functioning as work platforms) are considered to be falsework under the definitions given. Shoring is a component of falsework such as horizontal, vertical, or inclined support members. Where the term "temporary works" is used, it includes all of the temporary facilities used in bridge construction that do not become part of the permanent structure.

Design and construct safe and adequate temporary works that will support all loads imposed and provide the necessary rigidity to achieve the lines and grades shown on the plans in the final structure.

2.0 MATERIALS

Select materials suitable for temporary works; however, select materials that also ensure the safety and quality required by the design assumptions. The Engineer has authority to reject material on the basis of its condition, inappropriate use, safety, or nonconformance with the plans. Clearly identify allowable loads or stresses for all materials or manufactured devices

on the plans. Revise the plan and notify the Engineer if any change to materials or material strengths is required.

3.0 DESIGN REQUIREMENTS

A. Working Drawings

Provide working drawings for items as specified in the contract, or as required by the Engineer, with design calculations and supporting data in sufficient detail to permit a structural and safety review of the proposed design of the temporary work.

On the drawings, show all information necessary to allow the design of any component to be checked independently as determined by the Engineer.

When concrete placement is involved, include data such as the drawings of proposed sequence, rate of placement, direction of placement, and location of all construction joints. Submit the number of copies as called for by the contract.

When required, have the drawings and calculations prepared under the guidance of, and sealed by, a North Carolina Registered Professional Engineer who is knowledgeable in temporary works design.

If requested by the Engineer, submit with the working drawings manufacturer's catalog data listing the weight of all construction equipment that will be supported on the temporary work. Show anticipated total settlements and/or deflections of falsework and forms on the working drawings. Include falsework footing settlements, joint take-up, and deflection of beams or girders.

As an option for the Contractor, overhang falsework hangers may be uniformly spaced, at a maximum of 36 inches, provided the following conditions are met:

Member Type (PCG)	Member Depth, (inches)	Max. Overhang Width, (inches)	Max. Slab Edge Thickness, (inches)	Max. Screed Wheel Weight, (lbs.)	Bracket Min. Vertical Leg Extension, (inches)
II	36	39	14	2000	26
III	45	42	14	2000	35
IV	54	45	14	2000	44
MBT	63	51	12	2000	50
MBT	72	55	12	1700	48

Overhang width is measured from the centerline of the girder to the edge of the deck slab.

For Type II, III & IV prestressed concrete girders (PCG), 45-degree cast-in-place half hangers and rods must have a minimum safe working load of 6,000 lbs.

For MBT prestressed concrete girders, 45-degree angle holes for falsework hanger rods shall be cast through the girder top flange and located, measuring along the top of the member, 1'-2 ½" from the edge of the top flange. Hanger hardware and rods must have a minimum safe working load of 6,000 lbs.

The overhang bracket provided for the diagonal leg shall have a minimum safe working load of 3,750 lbs. The vertical leg of the bracket shall extend to the point that the heel bears on the girder bottom flange, no closer than 4 inches from the bottom of the member. However, for 72-inch members, the heel of the bracket shall bear on the web, near the bottom flange transition.

Provide adequate overhang falsework and determine the appropriate adjustments for deck geometry, equipment, casting procedures and casting conditions.

If the optional overhang falsework spacing is used, indicate this on the falsework submittal and advise the girder producer of the proposed details. Failure to notify the Engineer of hanger type and hanger spacing on prestressed concrete girder casting drawings may delay the approval of those drawings.

Falsework hangers that support concentrated loads and are installed at the edge of thin top flange concrete girders (such as bulb tee girders) shall be spaced so as not to exceed 75% of the manufacturer's stated safe working load. Use of dual leg hangers (such as Meadow Burke HF-42 and HF-43) are not allowed on concrete girders with thin top flanges. Design the falsework and forms supporting deck slabs and overhangs on girder bridges so that there will be no differential settlement between the girders and the deck forms during placement of deck concrete.

When staged construction of the bridge deck is required, detail falsework and forms for screed and fluid concrete loads to be independent of any previous deck pour components when the mid-span girder deflection due to deck weight is greater than ¾".

Note on the working drawings any anchorages, connectors, inserts, steel sleeves or other such devices used as part of the falsework or formwork that remains in the permanent structure. If the plan notes indicate that the structure contains the necessary corrosion protection required for a Corrosive Site, epoxy coat, galvanize or metalize these devices. Electroplating will not be allowed. Any coating required by the Engineer will be considered incidental to the various pay items requiring temporary works.

Design falsework and formwork requiring submittals in accordance with the 1995 AASHTO *Guide Design Specifications for Bridge Temporary Works* except as noted herein.

1. Wind Loads

Table 2.2 of Article 2.2.5.1 is modified to include wind velocities up to 110 mph. In addition, Table 2.2A is included to provide the maximum wind speeds by county in North Carolina.

Table 2.2 - Wind Pressure Values

Height Zone feet above ground	Pressure, lb/ft^2 for Indicated Wind Velocity, mph				
	70	80	90	100	110
0 to 30	15	20	25	30	35
30 to 50	20	25	30	35	40
50 to 100	25	30	35	40	45
over 100	30	35	40	45	50

2. Time of Removal

The following requirements replace those of Article 3.4.8.2.

Do not remove forms until the concrete has attained strengths required in Article 420-16 of the Standard Specifications and these Special Provisions.

Do not remove forms until the concrete has sufficient strength to prevent damage to the surface.

Table 2.2A - Steady State Maximum Wind Speeds by Counties in North Carolina

COUNTY	25 YR (mph)	COUNTY	25 YR (mph)	COUNTY	25 YR (mph)
Alamance	70	Franklin	70	Pamlico	100
Alexander	70	Gaston	70	Pasquotank	100
Alleghany	70	Gates	90	Pender	100
Anson	70	Graham	80	Perquimans	100
Ashe	70	Granville	70	Person	70
Avery	70	Greene	80	Pitt	90
Beaufort	100	Guilford	70	Polk	80
Bertie	90	Halifax	80	Randolph	70
Bladen	90	Harnett	70	Richmond	70
Brunswick	100	Haywood	80	Robeson	80
Buncombe	80	Henderson	80	Rockingham	70
Burke	70	Hertford	90	Rowan	70
Cabarrus	70	Hoke	70	Rutherford	70
Caldwell	70	Hyde	110	Sampson	90
Camden	100	Iredell	70	Scotland	70
Carteret	110	Jackson	80	Stanley	70
Caswell	70	Johnston	80	Stokes	70
Catawba	70	Jones	100	Surry	70
Cherokee	80	Lee	70	Swain	80
Chatham	70	Lenoir	90	Transylvania	80
Chowan	90	Lincoln	70	Tyrell	100
Clay	80	Macon	80	Union	70
Cleveland	70	Madison	80	Vance	70
Columbus	90	Martin	90	Wake	70
Craven	100	McDowell	70	Warren	70
Cumberland	80	Mecklenburg	70	Washington	100
Currituck	100	Mitchell	70	Watauga	70
Dare	110	Montgomery	70	Wayne	80
Davidson	70	Moore	70	Wilkes	70
Davie	70	Nash	80	Wilson	80
Duplin	90	New Hanover	100	Yadkin	70
Durham	70	Northampton	80	Yancey	70
Edgecombe	80	Onslow	100		
Forsyth	70	Orange	70		

B. Review and Approval

The Engineer is responsible for the review and approval of temporary works' drawings.

Submit the working drawings sufficiently in advance of proposed use to allow for their review, revision (if needed), and approval without delay to the work.

The time period for review of the working drawings does not begin until complete drawings and design calculations, when required, are received by the Engineer.

Do not start construction of any temporary work for which working drawings are required until the drawings have been approved. Such approval does not relieve the Contractor of the responsibility for the accuracy and adequacy of the working drawings.

4.0 CONSTRUCTION REQUIREMENTS

All requirements of Section 420 of the Standard Specifications apply.

Construct temporary works in conformance with the approved working drawings. Ensure that the quality of materials and workmanship employed is consistent with that assumed in the design of the temporary works. Do not weld falsework members to any portion of the permanent structure unless approved. Show any welding to the permanent structure on the approved construction drawings.

Provide tell-tales attached to the forms and extending to the ground, or other means, for accurate measurement of falsework settlement. Make sure that the anticipated compressive settlement and/or deflection of falsework does not exceed 1 inch. For cast-in-place concrete structures, make sure that the calculated deflection of falsework flexural members does not exceed 1/240 of their span regardless of whether or not the deflection is compensated by camber strips.

A. Maintenance and Inspection

Inspect and maintain the temporary work in an acceptable condition throughout the period of its use. Certify that the manufactured devices have been maintained in a condition to allow them to safely carry their rated loads. Clearly mark each piece so that its capacity can be readily determined at the job site.

Perform an in-depth inspection of an applicable portion(s) of the temporary works, in the presence of the Engineer, not more than 24 hours prior to the beginning of each concrete placement. Inspect other temporary works at least once a month to ensure that they are functioning properly. Have a North Carolina Registered Professional Engineer inspect the cofferdams, shoring, sheathing, support of excavation structures, and support systems for load tests prior to loading.

B. Foundations

Determine the safe bearing capacity of the foundation material on which the supports for temporary works rest. If required by the Engineer, conduct load tests to verify proposed bearing capacity values that are marginal or in other high-risk situations.

The use of the foundation support values shown on the contract plans of the permanent structure is permitted if the foundations are on the same level and on the same soil as those of the permanent structure.

Allow for adequate site drainage or soil protection to prevent soil saturation and washout of the soil supporting the temporary works supports.

If piles are used, the estimation of capacities and later confirmation during construction using standard procedures based on the driving characteristics of the pile is permitted. If preferred, use load tests to confirm the estimated capacities; or, if required by the Engineer conduct load tests to verify bearing capacity values that are marginal or in other high risk situations.

The Engineer reviews and approves the proposed pile and soil bearing capacities.

5.0 REMOVAL

Unless otherwise permitted, remove and keep all temporary works upon completion of the work. Do not disturb or otherwise damage the finished work.

Remove temporary works in conformance with the contract documents. Remove them in such a manner as to permit the structure to uniformly and gradually take the stresses due to its own weight.

6.0 METHOD OF MEASUREMENT

Unless otherwise specified, temporary works will not be directly measured.

7.0 BASIS OF PAYMENT

Payment at the contract unit prices for the various pay items requiring temporary works will be full compensation for the above falsework and formwork.

CRANE SAFETY (8-15-05)

Comply with the manufacturer specifications and limitations applicable to the operation of any and all cranes and derricks. Prime contractors, sub-contractors, and fully operated rental companies shall comply with the current Occupational Safety and Health Administration regulations (OSHA).

Submit all items listed below to the Engineer prior to beginning crane operations involving critical lifts. A critical lift is defined as any lift that exceeds 75 percent of the manufacturer's crane chart capacity for the radius at which the load will be lifted or requires the use of more than one crane. Changes in personnel or equipment must be reported to the Engineer and all applicable items listed below must be updated and submitted prior to continuing with crane operations.

CRANE SAFETY SUBMITTAL LIST

A. **Competent Person:** Provide the name and qualifications of the "Competent Person" responsible for crane safety and lifting operations. The named competent person will have the responsibility and authority to stop any work activity due to safety concerns.

B. **Riggers:** Provide the qualifications and experience of the persons responsible for rigging operations. Qualifications and experience should include, but not be limited to, weight calculations, center of gravity determinations, selection and inspection of sling and rigging equipment, and safe rigging practices.

C. **Crane Inspections:** Inspection records for all cranes shall be current and readily accessible for review upon request.

D. **Certifications:** **By July 1, 2006**, crane operators performing critical lifts shall be certified by NC CCO (National Commission for the Certification of Crane Operators), or satisfactorily complete the Carolinas AGC's Professional Crane Operator's Proficiency Program. Other approved nationally accredited programs will be considered upon request. All crane operators shall also have a current CDL medical card. Submit a list of anticipated critical lifts and corresponding crane operator(s). Include current certification for the type of crane operated (small hydraulic, large hydraulic, small lattice, large lattice) and medical evaluations for each operator.

GROUT FOR STRUCTURES (9-30-11)

1.0 DESCRIPTION

This special provision addresses grout for use in pile blockouts, grout pockets, shear keys, dowel holes and recesses for structures. This provision does not apply to grout placed in post-tensioning ducts for bridge beams, girders, or decks. Mix and place grout in accordance with the manufacturer's recommendations, the applicable sections of the Standard Specifications and this provision.

2.0 MATERIAL REQUIREMENTS

Use a Department approved pre-packaged, non-shrink, non-metallic grout. Contact the Materials and Tests Unit for a list of approved pre-packaged grouts and consult the manufacturer to determine if the pre-packaged grout selected is suitable for the required application.

When using an approved pre-packaged grout, a grout mix design submittal is not required.

The grout shall be free of soluble chlorides and contain less than one percent soluble sulfate. Supply water in compliance with Article 1024-4 of the Standard Specifications.

Aggregate may be added to the mix only where recommended or permitted by the manufacturer and Engineer. The quantity and gradation of the aggregate shall be in accordance with the manufacturer's recommendations.

Admixtures, if approved by the Department, shall be used in accordance with the manufacturer's recommendations. The manufacture date shall be clearly stamped on each container. Admixtures with an expired shelf life shall not be used.

The Engineer reserves the right to reject material based on unsatisfactory performance.

Initial setting time shall not be less than 10 minutes when tested in accordance with ASTM C266.

Test the expansion and shrinkage of the grout in accordance with ASTM C1090. The grout shall expand no more than 0.2% and shall exhibit no shrinkage. Furnish a Type 4 material certification showing results of tests conducted to determine the properties listed in the Standard Specifications and to assure the material is non-shrink.

Unless required elsewhere in the contract the compressive strength at 3 days shall be at least 5000 psi. Compressive strength in the laboratory shall be determined in accordance with ASTM C109 except the test mix shall contain only water and the dry manufactured material. Compressive strength in the field will be determined by molding and testing 4" x 8" cylinders in accordance with AASHTO T22. Construction loading and traffic loading shall not be allowed until the 3 day compressive strength is achieved.

When tested in accordance with ASTM C666, Procedure A, the durability factor of the grout shall not be less than 80.

3.0 SAMPLING AND PLACEMENT

Place and maintain components in final position until grout placement is complete and accepted. Concrete surfaces to receive grout shall be free of defective concrete, laitance, oil, grease and other foreign matter. Saturate concrete surfaces with clean water and remove excess water prior to placing grout.

Do not place grout if the grout temperature is less than 50°F or more than 90°F or if the air temperature measured at the location of the grouting operation in the shade away from artificial heat is below 45°F.

Provide grout at a rate that permits proper handling, placing and finishing in accordance with the manufacturer's recommendations unless directed otherwise by the Engineer. Use grout free of any lumps and undispersed cement. Agitate grout continuously before placement.

Control grout delivery so the interval between placing batches in the same component does not exceed 20 minutes.

The Engineer will determine the locations to sample grout and the number and type of samples collected for field and laboratory testing. The compressive strength of the grout will be considered the average compressive strength test results of 3 cube or 2 cylinder specimens at 28 days.

4.0 BASIS OF PAYMENT

No separate payment will be made for "Grout for Structures". The cost of the material, equipment, labor, placement, and any incidentals necessary to complete the work shall be considered incidental to the structure item requiring grout.

SUBMITTAL OF WORKING DRAWINGS (6-19-15)

1.0 GENERAL

Submit working drawings in accordance with Article 105-2 of the *Standard Specifications* and this provision. For this provision, "submittals" refers to only those listed in this provision. The list of submittals contained herein does not represent a list of required submittals for the project. Submittals are only necessary for those items as required by the contract. Make submittals that are not specifically noted in this provision directly to the Engineer. Either the Structures Management Unit or the Geotechnical Engineering Unit or both units will jointly review submittals.

If a submittal contains variations from plan details or specifications or significantly affects project cost, field construction or operations, discuss the submittal with and submit all copies to the Engineer. State the reason for the proposed variation in the submittal. To minimize review time, make sure all submittals are complete when initially submitted. Provide a contact name and information with each submittal. Direct any questions regarding submittal requirements to the Engineer, Structures Management Unit contacts or the Geotechnical Engineering Unit contacts noted below.

In order to facilitate in-plant inspection by NCDOT and approval of working drawings, provide the name, address and telephone number of the facility where fabrication will actually be done if different than shown on the title block of the submitted working drawings. This includes, but is not limited to, precast concrete items, prestressed concrete items and fabricated steel or aluminum items.

2.0 ADDRESSES AND CONTACTS

For submittals to the Structures Management Unit, use the following addresses:

Via US mail: Via other delivery service:

Mr. T. K. Koch, P. E.
State Structures Engineer
North Carolina Department
of Transportation
Structures Management Unit
1581 Mail Service Center
Raleigh, NC 27699-1581

Attention: Mr. P. D. Lambert, P. E.

Mr. T. K. Koch, P. E.
State Structures Engineer
North Carolina Department
of Transportation
Structures Management Unit
1000 Birch Ridge Drive
Raleigh, NC 27610

Attention: Mr. P. D. Lambert, P. E.

Submittals may also be made via email.

Send submittals to:

plambert@ncdot.gov (Paul Lambert)

Send an additional e-copy of the submittal to the following address:

jgaither@ncdot.gov (James Gaither)

mrorie@ncdot.gov (Madonna Rorie)

For submittals to the Geotechnical Engineering Unit, use the following addresses:

For projects in Divisions 1-7, use the following Eastern Regional Office address:

Via US mail:

Mr. K. J. Kim, Ph. D., P. E.
Eastern Regional Geotechnical
Manager
North Carolina Department
of Transportation
Geotechnical Engineering Unit
Eastern Regional Office
1570 Mail Service Center
Raleigh, NC 27699-1570

Via other delivery service:

Mr. K. J. Kim, Ph. D., P. E.
Eastern Regional Geotechnical
Manager
North Carolina Department
of Transportation
Geotechnical Engineering Unit
Eastern Regional Office
3301 Jones Sausage Road, Suite 100
Garner, NC 27529

For projects in Divisions 8-14, use the following Western Regional Office address:

Via US mail:

Mr. Eric Williams, P. E.
Western Regional Geotechnical
Manager
North Carolina Department
of Transportation
Geotechnical Engineering Unit
Western Regional Office
5253 Z Max Boulevard
Harrisburg, NC 28075

Via other delivery service:

Mr. Eric Williams, P. E.
Western Region Geotechnical
Manager
North Carolina Department
of Transportation
Geotechnical Engineering Unit
Western Regional Office
5253 Z Max Boulevard
Harrisburg, NC 28075

The status of the review of structure-related submittals sent to the Structures Management Unit can be viewed from the Unit's web site, via the "Drawing Submittal Status" link.

Direct any questions concerning submittal review status, review comments or drawing markups to the following contacts:

Primary Structures Contact: Paul Lambert (919) 707 – 6407
(919) 250 – 4082 facsimile
plambert@ncdot.gov

Secondary Structures Contacts: James Gaither (919) 707 – 6409
Madonna Rorie (919) 707 – 6508

Eastern Regional Geotechnical Contact (Divisions 1-7):
K. J. Kim (919) 662 – 4710
(919) 662 – 3095 facsimile
kkim@ncdot.gov

Western Regional Geotechnical Contact (Divisions 8-14):
Eric Williams (704) 455 – 8902
(704) 455 – 8912 facsimile
ewilliams3@ncdot.gov

3.0 SUBMITTAL COPIES

Furnish one complete copy of each submittal, including all attachments, to the Engineer. At the same time, submit the number of hard copies shown below of the same complete submittal directly to the Structures Management Unit and/or the Geotechnical Engineering Unit.

The first table below covers "Structure Submittals". The Engineer will receive review comments and drawing markups for these submittals from the Structures Management Unit. The second table in this section covers "Geotechnical Submittals". The Engineer will receive review comments and drawing markups for these submittals from the Geotechnical Engineering Unit.

Unless otherwise required, submit one set of supporting calculations to either the Structures Management Unit or the Geotechnical Engineering Unit unless both units require submittal copies in which case submit a set of supporting calculations to each unit. Provide additional copies of any submittal as directed.

STRUCTURE SUBMITTALS

Submittal	Copies Required by	Copies Required by	Contract Reference Requiring Submittal [1]

	Structures Management Unit	Geotechnical Engineering Unit	
Arch Culvert Falsework	5	0	Plan Note, SN Sheet & "Falsework and Formwork"
Box Culvert Falsework [7]	5	0	Plan Note, SN Sheet & "Falsework and Formwork"
Cofferdams	6	2	Article 410-4
Foam Joint Seals [6]	9	0	"Foam Joint Seals"
Expansion Joint Seals (hold down plate type with base angle)	9	0	"Expansion Joint Seals"
Expansion Joint Seals (modular)	2, then 9	0	"Modular Expansion Joint Seals"
Expansion Joint Seals (strip seals)	9	0	"Strip Seals"
Falsework & Forms [2] (substructure)	8	0	Article 420-3 & "Falsework and Formwork"
Falsework & Forms (superstructure)	8	0	Article 420-3 & "Falsework and Formwork"
Girder Erection over Railroad	5	0	Railroad Provisions
Maintenance and Protection of Traffic Beneath Proposed Structure	8	0	"Maintenance and Protection of Traffic Beneath Proposed Structure at Station ___"
Metal Bridge Railing	8	0	Plan Note
Metal Stay-in-Place Forms	8	0	Article 420-3
Metalwork for Elastomeric Bearings [4,5]	7	0	Article 1072-8
Miscellaneous Metalwork [4,5]	7	0	Article 1072-8
Disc Bearings [4]	8	0	"Disc Bearings"
Overhead and Digital Message Signs (DMS) (metalwork and foundations)	13	0	Applicable Provisions

Placement of Equipment on Structures (cranes, etc.)	7	0	Article 420-20
Precast Concrete Box Culverts	2, then 1 reproducible	0	"Optional Precast Reinforced Concrete Box Culvert at Station ___"
Prestressed Concrete Cored Slab (detensioning sequences) [3]	6	0	Article 1078-11
Prestressed Concrete Deck Panels	6 and 1 reproducible	0	Article 420-3
Prestressed Concrete Girder (strand elongation and detensioning sequences)	6	0	Articles 1078-8 and 1078-11
Removal of Existing Structure over Railroad	5	0	Railroad Provisions
Revised Bridge Deck Plans (adaptation to prestressed deck panels)	2, then 1 reproducible	0	Article 420-3
Revised Bridge Deck Plans (adaptation to modular expansion joint seals)	2, then 1 reproducible	0	"Modular Expansion Joint Seals"
Sound Barrier Wall (precast items)	10	0	Article 1077-2 & "Sound Barrier Wall"
Sound Barrier Wall Steel Fabrication Plans [5]	7	0	Article 1072-8 & "Sound Barrier Wall"
Structural Steel [4]	2, then 7	0	Article 1072-8
Temporary Detour Structures	10	2	Article 400-3 & "Construction, Maintenance and Removal of Temporary Structure at Station ____"
TFE Expansion Bearings [4]	8	0	Article 1072-8

FOOTNOTES

1. References are provided to help locate the part of the contract where the submittals are required. References in quotes refer to the provision by that name. Articles refer to the *Standard Specifications*.

2. Submittals for these items are necessary only when required by a note on plans.
3. Submittals for these items may not be required. A list of pre-approved sequences is available from the producer or the Materials & Tests Unit.
4. The fabricator may submit these items directly to the Structures Management Unit.
5. The two sets of preliminary submittals required by Article 1072-8 of the *Standard Specifications* are not required for these items.
6. Submittals for Fabrication Drawings are not required. Submittals for Catalogue Cuts of Proposed Material are required. See Section 5.A of the referenced provision.
7. Submittals are necessary only when the top slab thickness is 18" or greater.

GEOTECHNICAL SUBMITTALS

Submittal	Copies Required by Geotechnical Engineering Unit	Copies Required by Structures Management Unit	Contract Reference Requiring Submittal [1]
Drilled Pier Construction Plans [2]	1	0	Subarticle 411-3(A)
Crosshole Sonic Logging (CSL) Reports [2]	1	0	Subarticle 411-5(A)(2)
Pile Driving Equipment Data Forms [2,3]	1	0	Subarticle 450-3(D)(2)
Pile Driving Analyzer (PDA) Reports [2]	1	0	Subarticle 450-3(F)(3)
Retaining Walls [4]	8 drawings, 2 calculations	2 drawings	Applicable Provisions
Temporary Shoring [4]	5 drawings, 2 calculations	2 drawings	"Temporary Shoring" & "Temporary Soil Nail Walls"

FOOTNOTES

1. References are provided to help locate the part of the contract where the submittals are required. References in quotes refer to the provision by that name. Subarticles refer to the *Standard Specifications*.

2. Submit one hard copy of submittal to the Engineer. Submit a second copy of submittal electronically (PDF via email) or by facsimile, US mail or other delivery service to the appropriate Geotechnical Engineering Unit regional office. Electronic submission is preferred.

3. The Pile Driving Equipment Data Form is available from:
https://connect.ncdot.gov/resources/Geological/Pages/Geotech_Forms_Details.aspx
See second page of form for submittal instructions.

4. Electronic copy of submittal is required. See referenced provision.

Project Special Provisions
Control House Renovations

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DocuSigned by:
Scott Reynolds
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11/10/2016

RAISED 'T' SEAMED PANEL WITH CAP **(SPECIAL)**

1.0 DESCRIPTION

This section covers the materials, techniques and labor requirements for installation of a raised "T" seamed roof panel with cap on the bridge's control house.

2.0 MATERIALS

A. SUBMITTALS

1. Submit detailed drawings showing plan layout of panels at the same scale as Construction Documents. Detail drawings of anchoring details, fasteners, joint details, trim, flashing and accessories shall be submitted prior to any execution of work. Show details of weatherproofing, terminations, and penetrations of metal work.
2. If contractor recommends substitution of proposed system as shown on the contract drawings, then the new roof system design calculations and drawings shall be stamped and sealed by a licensed Professional Civil Engineer in the State of North Carolina. The design and shop drawings shall be submitted to the engineer for approval prior to beginning of work. The new roof system shall fully comply with specified requirements in appearance, assembly, and performance
3. Indicate location, gauge, and finish of all related components.
4. Include fastener types and spacing.
5. Provide submittals showing the new downspout material data, downspout locations, downspout route and connections details
6. Provide written certification that the submitted roofing system and related details comply with local building code and as specified herein.
7. Finish Warranty – Manufacturer's 20-year warranty covering checking, crazing, peeling, chalking, fading, and adhesion.
8. Water-tightness Warranty – Applicator shall furnish a 2-year non-prorated Water-tightness warranty covering all roofing system materials and workmanship. Manufacturer shall furnish a 20-year non-prorated Water-tightness warranty covering all roof panels, flashing, penetrations and edge details. Warranty period shall begin at the time substantial completion.

B. PRODUCT DATA FOR ROOF SYSTEM

1. Metal Roof Manufacturers: 24-gauge Fabral – "Stand 'N Seam" roofing system or approved equal in Dark Grey or Green color
2. Purlins and Purlin braces: All purlins and purlin braces are cold-formed steel members conforming to AISI Cold Formed Steel 2007 Design Specifications with Supplement No.2 of 2010. All purlins and purlin braces shall conform to material specifications of ASTM A653 Galvanized steel with a minimum yield strength F_y = 50ksi and 12gauge (97 mils) thickness.
3. Panel Width: 16"
4. Finished seam height will be a minimum of 2"
5. Texture: Stiffener Ribs

6. Site-rolled continuous roofing panels from eave to ridge using factory roll-forming equipment and operated by personnel
7. Panel design shall be symmetrical
8. Cap shall have 2 rows of continuous factory applied hot melt sealant. Sealant shall not make contact with the clip.
9. Panel must offer individual replaceability, without altering adjacent panels, after final installation is completed.
10. Manufacturer's data sheet including all accessories
11. Roof panel clips shall be continuous for maximum wind uplift capacity. Clips must allow for thermal movement.
12. All trims, clips, screws and flashing will be supplied by the metal roof system manufacturer
13. All anchors shall be as specified in the contract drawings
14. Sealants and Sealant Tapes will be specified and supplied by the metal roof system manufacturer.

C. PROVIDE SAMPLES

1. 12" long section of specified panel width and finish
2. 12" length of each type of Panel Clip

D. DESIGN AND PERFORMANCE CRITERIA

1. Installed roof system shall withstand positive and negative loading pressures complying with the controlling load combination of (0.6 x Dead load $\pm$ 0.6 x Wind Load) as shown on sheet A-1 of contract drawings.
2. All panel and trim attachments will be designed to specifically satisfy the requirements of the roof design.
3. Thermal Movement - Metal Roofing system, including flashing, shall accommodate thermal movement without buckling or excess stress on the structure.

E. DESIGN TEST REPORTS – MUST MEET OR EXCEED DESIGN AND PERFORMANCE CRITERIA

1. Wind Load Criteria: Meet 129mph wind load.
2. ASTM E1592 – Static air pressure difference test
3. ASTM E2140 – Static water pressure head test

3.0 CONSTRUCTION METHODS

A. INSTALLER QUALIFICATIONS

1. A minimum of 5 years of experience specializing in the installation of structural standing seam metal roof systems
2. Must be trained to install the specified system
3. A minimum of 5 years of experience in installation of specialized anchorage and screw connections

B. DELIVERY, STORAGE AND HANDLING

1. Upon receipt of panels and other materials, installer shall examine the shipment for damage and completeness.

2. Panels should be stored in a clean, dry place. One end should be elevated to allow moisture to run off. Do not store material in contact with other materials that might cause staining, denting or other surface damage.
3. Protective film should be removed prior to extended exposure to sunlight, heat, and other weather elements.
4. Stack all materials to prevent damage and to allow for adequate ventilation.
5. Protect components using best practices to prevent abrasion damage, mechanical abuse, staining discoloration, or corrosion during manufacturing, shipment and storage.
6. Secure panels where they are protected from wind and moisture, while allowing proper drainage and air circulation
7. Any unsatisfactory components will be rejected and/or reproduced to meet quality criteria.

C. REMOVAL OF EXISTING ROOF ATTACHMENTS

The existing roof has existing bracket with security camera and mounting, wind measurement devices and guy wires attached to the devices. The contractor shall remove these without damage to these components and the existing roof. These components will be handed to the bridge owner for safe storage until reinstallation.

D. CLEANING OF EXISTING ROOF

The existing roof has a gravel finish on top. Contractor shall remove the gravel finish, clean the roof and the roof ledge of all dirt. Contractor shall seal the existing cracks in the roof with DAP liquid cement crack filler or approved equal. Contractor shall remove the existing roof drains and plug the holes.

E. SUBSTRATE INSPECTION

Determine, with the presence of the installer, that structural conditions are satisfactory. Conflicts resulting from inspection should be resolved prior to roofing system installation.

F. PRE-ROOFING MEETING

Prior to beginning of metal roof system assembly, a pre-roofing meeting shall be held to review work to be completed. Required attendees will include the Contractor, Engineer, Department's Engineer, metal roofing subcontractor, and metal roof system manufacturer's warranty inspector.

G. PANEL INSTALLATION

1. Protective film should be removed prior to extended exposure to sunlight, heat, and other weather elements
2. Panels should be handled at seams to prevent buckling
3. Limit foot traffic on installed panel to prevent unnecessary damage to the finish
4. Install panels without excessive waves, warps, or buckles

H. ROOFING AND FLASHING INSTALLATION

1. All trim shall be installed using the fastener type and spacing as displayed on the shop drawings of the roof system manufacturer.

2. Fabricate and install sheet metal flashing in accordance with SMACNA manual
3. In the process of sheet metal installation, allow no sealant to migrate onto exposed surfaces
4. Any damaged product should be removed and replaced immediately.
5. Touch up paint should be used minimally for minor scratches. Major scratches or paint failures shall be recognized as damaged and require replacement
6. Remove all metal dust and shavings caused by installation of roof system and associated materials to prevent oxidation and corrosion of panel finish.
7. Clean exposed surfaces upon completion of installation to prevent finish damage

I. REATTACHMENT OF EXISTING ROOF ATTACHMENTS

After the new roof is installed, all the existing roof attachments which were removed shall be reattached as per electrical drawing E3.

4.0 MEASUREMENT AND PAYMENT

Standing Raised 'T' Seamed Panel With Cap will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Control House Renovations*.

Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

REPLACEMENT OF DOORS (SPECIAL)

1.0 DESCRIPTION

A. THIS WORK INCLUDES:

1. Remove existing metal doors and frames, and provide new hurricane resistant doors and frames with all required accessories for a complete installation as shown in the drawings and as specified herein. This work shall be coordinated with all other work including replacement of windows, painting of control house walls and floor tiles installation.

B. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Names and addresses of all manufacturers and suppliers to be utilized in this Section.
2. Product certificates, signed by manufacturers of equipment, certifying that their products comply with specified requirements.
3. Delivery, Storage and Handling. Deliver all materials and fixtures in manufacturer's protective packing, crating, and covering and stored in a dry location.

2.0 MATERIALS

A. GENERAL

1. Field measure and verify the existing dimensions and details of doors with all frames, details, finish hardware requirements, existing door openings, and other related items affecting metal doors, before creating shop drawings.
2. Before ordering materials, carefully examine all scale, full size, and shop drawings of work requiring hardware so that the material ordered will properly fit the work to which it is to be secured and will function as designed.
3. Inserts, bolts and fasteners shall be the manufacturers standard or as recommended by the manufacturer.
4. Door and door frame color shall be Shell White or shall closely match the new control house wall color.

B. HARDWARE

1. Following manufacturers of hurricane doors and frames are preferred. The Engineers decision as to conformity of operation, design, finish, quality, and size shall be final.
   a. CecoDoor
   b. DeanSteel
   c. Republic Doors and Frames
   d. Steelcraft, A Allegion Brand
   e. or approved equal
2. Provide all hardware by the same manufacturer as the doors and frames, entirely free of imperfections in manufacture and finish, and guaranteed by the manufacturer to satisfactorily perform the various functions required.

C. PAINT AND PRIMER

New doors and frames shall be painted with a multi-coat system that matches the Shell White color of the control house walls. Paint and primer shall be chosen to match compatibility with each other and preferably made by same manufacturer. The finish coat shall be touched up after installation. If the doors and frames are only shop primed when they are installed, the finish coat shall be field applied after installation.

3.0 CONSTRUCTION METHODS

A. INSTALLATION OF METAL DOORS AND FRAMES.

1. Remove existing doors, frames and ensure that no damage to the existing walls has occurred. If there is damage to the walls, then all remedial action shall be contractor’s responsibility at no additional cost to the Owner.
2. Install new frame to fit existing wall opening. Set frames accurately in position, plumb, align and brace securely until permanent anchors are set.
3. Installation of Metal doors and frames shall be as per manufacturers specifications and recommendations.

4. Check and readjust operating finish hardware items prior to final inspection. Remove and replace defective work, including doors or frames which are warped, bowed or otherwise damaged.
5. Install all hardware in compliance with manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a secure place during the finish application.
6. Door locks and keys shall be handed to the bridge owner as per their preferences.

4.0 MEASUREMENT AND PAYMENT

Replacement of Doors will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Control House Renovations*.

Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

REPLACEMENT OF WINDOWS (SPECIAL)

1.0 DESCRIPTION

A. THIS WORK INCLUDES:

1. Remove existing windows and frames, and providing new hurricane resistant windows, screens and frames with all required accessories for a complete installation as shown in the drawings and as specified herein. This work shall be coordinated with all other work including replacement of doors, painting of operator house walls and floor tiles installation.

B. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Names and addresses of all manufacturers and suppliers to be utilized in this Section.
2. Product certificates, signed by manufacturers of equipment, certifying that their products comply with specified requirements.
3. Delivery, Storage and Handling. Deliver all materials and fixtures in manufacturer's protective packing, crating, and covering and stored in a dry location.

2.0 MATERIALS

A. GENERAL

1. Coordinate the dimensions and details of windows with all frames, details, finish hardware requirements, existing window openings, and other related items.

2. Before ordering materials, carefully examine shop drawings of work requiring hardware so that the material ordered will properly fit the work to which it is to be secured and will function as designed.
3. Inserts, bolts and fasteners shall be the manufacturers standard or as recommended by the manufacturer.
4. Window and window frame color shall be Shell White or shall closely match the new control house wall color.

B. HARDWARE

1. Following manufacturers of Hurricane Windows and Frames are preferred. The Engineers decision as to conformity of operation, design, finish, quality, and size shall be final.
   a. Kawneer, A Alcoa company
   b. Viwinco
   c. or approved equal
2. Provide all hardware by the same manufacturer as the windows and frames, entirely free of imperfections in manufacture and finish, and guaranteed by the manufacturer to satisfactorily perform the various functions required.

C. PAINT AND PRIMER

New windows and frames shall be painted with a multi-coat system that matches the Shell White color of the control house walls. Paint and primer shall be chosen to match compatibility with each other and preferably made by same manufacturer. The finish coat shall be touched up after installation. If the windows and frames are only shop primed when they are installed, the finish coat shall be field applied after installation.

3.0 CONSTRUCTION METHODS

A. INSTALLATION OF WINDOWS AND FRAMES.

1. Remove existing windows, frames and ensure that no damage to the existing walls has occurred. If there is damage to the walls, then all remedial action shall be contractor’s responsibility at no additional cost to the Owner.
2. Install new frame to fit existing wall opening. Set frames accurately in position, plumb, align and brace securely until permanent anchors are set.
3. Installation of windows and frames shall be as per manufacturers specifications and recommendations.
4. Check and readjust operating finish hardware items prior to final inspection. Remove and replace defective work, including windows or frames which are warped, bowed or otherwise damaged.
5. Install all hardware in compliance with manufacturer’s instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a secure place during the finish application.
6. Window locks shall be handed to the bridge owner as per their preferences.

4.0 MEASUREMENT AND PAYMENT

Replacement of Windows will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Control House Renovations*.

Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

REPLACEMENT OF HANDRAILS (SPECIAL)

1.0 DESCRIPTION

Under this Section, the Contractor shall perform all work necessary to complete the replacement of the Control House handrails on the second floor.

A. THIS WORK INCLUDES:

1. Removal of existing handrails and posts of the Control House
2. Cleaning of all existing post base plate and connection bolts
3. Installation of new galvanized handrails and posts on top of the existing post base plate
4. Installation of primer and paint for the new handrails, new posts, existing base plate and connection bolts.
5. This work shall be coordinated with all other work including door replacement, window replacement and floor tiles installation.

B. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Names and addresses of all manufacturers and suppliers to be utilized in this Section.
2. Product certificates, signed by manufacturers of equipment, certifying that their products comply with specified requirements.

C. DELIVERY, STORAGE AND HANDLING.

Deliver all materials and fixtures in manufacturer's protective packing, crating, and covering and stored in a dry location.

2.0 MATERIALS

A. HANDRAIL SYSTEM

The new handrails and posts shall be galvanized steel and shall match the existing 2-rail system and existing height. The post locations shall correspond to existing base plate locations. The handrails and posts shall be at least 2 in. diameter sections.

B. PAINT AND PRIMER

Paint and primer shall be chosen to be compatible with each other and preferably made by same manufacturer. Finish coats shall be Enamel Paint in Shell White Color.

3.0 CONSTRUCTION METHODS

A. REMOVAL OF EXISTING HANDRAIL SYSTEM

All existing handrails and posts shall be removed from the second floor of the control house. The base plate and connections bolts of the posts shall be left in place.

B. RUST REMOVAL

Use wire brush and steel wool for removal of existing rust and existing residual paint system of the base plate and connection bolts, thus exposing the base metal surface. Power tools could be used to remove the rust, but care should be taken to not abrade the base metal surface. If the existing paint contains lead, then the Contractor shall contain and remove the waste and dispose of properly.

C. INSTALL NEW HANDRAIL SYSTEM

Install the new galvanized steel handrails and posts as specified above. The post locations shall match the existing base plate locations. Connection of the new posts to the existing base plates can be made using field welds or threading. Severely damaged areas of the base plate should be brought to the attention of the Engineer.

D. PAINTING.

Paint all handrails, posts, base plates and connection bolts surfaces with a minimum of 1 primer coat and 2 finish coats.

4.0 MEASUREMENT AND PAYMENT

Replacement of Handrails will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Control House Renovations.*

Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

REPLACEMENT OF FLAGPOLE (SPECIAL)

1.0 DESCRIPTION

Under this Section, the Contractor shall perform all work necessary to complete the replacement of existing flag pole of the Control House.

A. THIS WORK INCLUDES:

1. Removal and disposal of existing flagpole and connections to the Control House wall
2. Installation of new flagpole and connections to the Control House wall at location as shown in drawings.
3. This work shall be coordinated with all other work including painting of control house walls.

B. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Names and addresses of all manufacturers and suppliers to be utilized in this Section.
2. Product certificates, signed by manufacturers of equipment, certifying that their products comply with specified requirements.

C. DELIVERY, STORAGE AND HANDLING.

Deliver all materials and fixtures in manufacturer's protective packing, crating, and covering and stored in a dry location.

2.0 MATERIALS

A. ALUMINUM POLE AND ACCESSORIES

The new flagpole shall be of same height as the existing, wall mounted, heavy duty aluminum pole with the following accessories.

1. Gold anodized aluminum ball ornament
2. Cast aluminum revolving truck
3. Solid braided polypropylene halyard
4. Two (2) swivel flag snaps
5. Cast aluminum cleats with mounting screws
6. Cast aluminum mounting brackets with connections.

B. PREFERRED VENDOR AND MODEL

The preferred vendor for the new flagpole is WWW.FLAGS.COM. The preferred model is LVWA27. Other flagpoles will be considered if the above wall mounted pole and accessories requirements are met.

3.0 CONSTRUCTION METHODS

A. REMOVAL OF EXISTING FLAGPOLE

Existing flagpole, accessories and connections shall be removed with no damage to existing control house walls. If the existing flagpole has flags attached to it, then the flags shall be removed carefully and stored for future attachment to the new flagpole. Any damage to existing control house walls shall be repaired at no additional cost to the Owner.

B. INSTALLATION OF NEW FLAGPOLE

The location of the new flagpole will be determined by the engineer prior to installation. The new flagpole shall be installed and supported as per manufacturers guidelines and recommendations.

4.0 MEASUREMENT AND PAYMENT

Replacement of Flagpole will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Control House Renovations*.

Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

PAINTING OF CONTROL HOUSE (SPECIAL)

1.0 DESCRIPTION

Under this Section, the Contractor shall perform all work necessary to complete the painting of the Control House.

A. THIS WORK INCLUDES:

1. Cleaning, preparing and painting the interior and exterior walls of the control house
2. This work shall be coordinated with all other work including door replacement, window replacement, and electrical rehabilitation of the control house. For general material and installation requirements for electrical items the Contractor is directed to the requirements as listed under the Electrical specifications.

B. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Names and addresses of all manufacturers and suppliers to be utilized in this Section.
2. Product certificates, signed by manufacturers of equipment, certifying that their products comply with specified requirements.

C. DELIVERY, STORAGE AND HANDLING.

Deliver all materials and fixtures in manufacturer's protective packing, crating, and covering and stored in a dry location.

2.0 MATERIALS

A. PAINT, PRIMER AND SEALER.

Paint, primer and sealer shall be chosen to match compatibility with existing paint system in Control House. Primer, sealer and top coats shall be compatible with each

other and preferably made by same manufacturer. Finish coats shall be Latex Paint in Shell White Color.

3.0 CONSTRUCTION METHODS

A. PAINTING.

Paint all walls (Interior and Exterior), door frames and window frames with a minimum of 1 primer coat and 2 finish coats.

4.0 MEASUREMENT AND PAYMENT

Painting of Control House will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Control House Renovations*.

Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

FLOOR TILES (SPECIAL)

1.0 DESCRIPTION

Under this Section, the Contractor shall perform all work necessary to complete the installation of new floor tiles in the operator room of the Control House

A. THIS WORK INCLUDES:

1. Removal of existing floor tiles containing asbestos and proper disposal as per federal, state and local code regulations
2. Installing new vinyl composite floor tiles in operator room (second floor)
3. Installing the wall base tiles in operator room (second floor)

This work shall be coordinated with all other work including replacement of doors, replacement of windows, painting of control house walls and electrical rehabilitation of the control house.

B. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Names and addresses of all manufacturers and suppliers to be utilized in this Section.
2. Product certificates, signed by manufacturers of equipment, certifying that their products comply with specified requirements.
3. Delivery, Storage and Handling. Deliver all materials and fixtures in manufacturer's protective packing, crating, and covering and stored in a dry location.

2.0 MATERIALS

A. VINYL COMPOSITE FLOOR TILE.

1. Hardness-Manufacturer's standard hardness measured using Shore, Type A durometer per D2240
2. Wearing Surface - Molded pattern consisting of raised discs
3. Thickness – 0.125 inch
4. Size - 12 inch x 12 inch
5. Colors and Patterns - As selected by Engineer from manufacturer's full range

B. VINYL COMPOSITE BASE TILE.

1. ASTM Standard F1861
2. Type - TS (rubber, vulcanized thermoset) or TP (rubber, thermoplastic).
3. Group - I (solid)
4. Minimum Thickness - 0.125 inch
5. Height - 4 inch
6. Lengths - Coils in manufacturer's standard lengths
7. Surface - Smooth
8. Colors and Patterns - As selected by Engineer from manufacturer's full range

3.0 CONSTRUCTION METHODS

A. REMOVALS:

1. The Bridge Owner has tested the existing floor tiles and has found asbestos (5% Chrysotile) in them. Hence the existing floor tiles and other flooring elements have to be properly abated by a licensed asbestos abatement contractor and the proper permits must be obtained prior to installation of the new floor tiles. The asbestos abatement shall be as per local, state and federal regulations regarding removal and disposal of asbestos.

B. EXISTING CONDITIONS:

1. Contractor shall examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance. Contractor shall verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products. Contractor shall proceed with installation only after unsatisfactory conditions have been corrected.

C. PREPARATION OF SUBSTRATES

1. For installation of new floor tiles, the Contractor shall prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products. Contractor shall verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Substrate Coatings: Contractor shall remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone,

using mechanical methods recommended by manufacturer. Use of solvents will not be permitted.

3. Filling: Contractor shall use leveling and patching compound to fill cracks, holes, and depressions in substrates.
4. Cleaning: Contractor shall sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

D. TILE INSTALLATION

1. Resilient products and installation materials shall be moved into spaces where they will be installed at least 48 hours in advance of installation. Resilient products shall not be installed until they are same temperatures as space where they are to be installed.
2. Contractor shall lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter. Tiles shall be laid square with room axis.
3. Contractor shall match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Broken, cracked, chipped, or deformed tiles shall be discarded. Lay tiles with grain/pattern running in one direction.
4. Contractor shall scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings. Extend tiles into toe spaces, door reveals, closets, and similar openings. Contractor shall maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
5. Contractor shall adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
6. After walls have been painted install the wall base tile along the perimeter of the operator room walls. After installation of the base tile, touch-up wall paint shall be applied to the walls along the top of the base tiles.

E. CLEANING AND PROTECTION.

1. Contractor shall clean and protect the tiles immediately after completing resilient product installation. Remove adhesive and other blemishes from exposed surfaces. Sweep and vacuum surfaces thoroughly. Damp-mop surfaces to remove marks and soil. Surfaces shall not be washed until after time period recommended by manufacturer.
2. Contractor shall protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

4.0 MEASUREMENT AND PAYMENT

Floor Tiles will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Control House Renovations*. Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

SEPTIC TANK PLATFORM (SPECIAL)

1.0 DESCRIPTION

Under this Section, the Contractor shall perform all work necessary to complete the replacement of existing septic tank platform with a new platform beneath the existing control house.

A. THIS WORK INCLUDES:

1. Disconnecting the piping connections of the septic tank, removing the septic tank and temporarily storing it as per Owners recommendations.
2. Removal of existing septic tank platform and all connections to the deck, removal of compression rings at existing piles, and removal of existing access ladder.
3. Installation of new platform, new compression rings, connections and new access ladder as per contract drawings
4. Reinstall the septic tank and existing piping connections
5. This work shall be coordinated with all other work including electrical rehabilitation of the control house and swing span.

B. SUBMITTALS SHALL INCLUDE THE FOLLOWING:

1. Names and addresses of all manufacturers and suppliers to be utilized in this Section.
2. Product certificates, signed by manufacturers of equipment, certifying that their products comply with specified requirements.

C. DELIVERY, STORAGE AND HANDLING.

Deliver all materials and fixtures in manufacturer's protective packing, crating, and cover and store in a dry location.

2.0 MATERIALS

A. GENERAL

1. Before ordering materials, carefully measure existing field measurements as described below in Construction Methods section, so that material ordered will properly fit the work to which it is to be secured and will function as designed.

B. STRUCTURAL STEEL

1. All structural steel for platform supports shall be of ASTM A572 grade steel with minimum yield strength of F_y = 50ksi. All steel works are galvanized.
2. The new platform grating shall be galvanized steel regular duty press-locked by AMICO or approved equal, with 1-1/2in. x 3/16in. bearing bars spaced at 1-3/16in. The cross bars shall be spaced at 2in. Bolts and fasteners for grating installation to the grating support shall be the manufacturers standard or as recommended by the manufacturer.
3. The existing compression ring and connections shall be replaced in-kind.

3.0 CONSTRUCTION METHODS

A. EXISTING CONDITIONS:

1. The Contractor shall record the location of existing septic tank on the platform and piping connections to the control house.
2. The Contractor shall measure the existing septic tank platform dimensions and location of access ladder.
3. Verify all other dimensions shown on the contract drawings.
4. If the field measurements differ from the contract drawings, then the Engineer shall be notified so that minor modifications to the new platform layout may be made, prior to creating shop drawings for fabrication of the new platform.

B. REMOVALS:

1. Contractor shall coordinate with the bridge owner regarding the emptying of the existing septic tank prior to removal.
2. Remove the existing septic tank and piping connections and temporarily store them as per Owners recommendations. Care shall be taken to avoid damage to the tank during the removal.
3. Remove the existing platform, decking, framing, compression rings and all connections to the existing deck and piles. Care shall be taken to avoid damage to the deck, superstructure and piles during the removal.
4. Contractor shall patch the holes in the deck and piles using steelstik epoxy putty or approved equal.

C. INSTALLATION OF NEW PLATFORM:

1. Install new platform supports, new platform grating, new compression rings, connections and access ladder as per the contract drawings.
2. Install septic tank and piping connections at previously determined location.
3. The new submarine cables for electrical rehabilitation of the swing span will pass through the septic tank platform grating near the north end. Contractor shall coordinate the installation of new platform with installation of submarine cables.

4.0 MEASUREMENT AND PAYMENT

Septic Tank Platform will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be

incidental to the Lump Sum price bid for the *Control House Renovations*. Payment will be made under:

Pay Item	**Pay Unit**
Control House Renovations	Lump Sum

Project Special Provisions
Electrical Equipment

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DocuSigned by:
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ELECTRICAL SUMMARY OF WORK (SPECIAL)

1.0 DESCRIPTION

A. FIELD MEASURING AND VERIFICATION

1. The Contractor shall perform field measurements to determine necessary existing dimensions of the control house, the pivot pier, and the bridge structure and approach roadway to locate new equipment and install the new equipment.

2. The Contractor shall perform field measuring to verify the existing wiring to verify the wire tags, as-built documentation, and contract plans.

B. UTILITY SERVICE, AERIAL CABLES, AND MEDIUM VOLTAGE TRANSFORMER

1. The existing service is a 2400V, 30kVA, medium voltage delta and shall be upgraded as shown on the plans. Furnish and install a pole mounted disconnection switch to facilitate maintenance of the service feeders. The Contractor shall furnish and install new aerial cables and supports. The new aerial cables shall be routed under the roadway to the Control House. In the control house, furnish and install a new service disconnect and a new step down 2400V Delta/480-277V Wye connected transformer. Furnish and install new copper clad ground rod and connection at service and bond the structural steel to the ground system. The electrical service ground shall meet the requirement of 10 ohms to ground at the service and the Contractor shall provide additional ground rods as required to meet this requirement.

C. STANDBY GENERATOR AND ATS

1. The Contractor shall furnish and install a new diesel generator rated at 480VAC and an automatic transfer switch (ATS) to transfer power from the normal utility source to the standby generator power source. The rating shall be as shown on the plans. The generator shall be located on the upper platform where the existing generator is located and shall be fully outdoor rated with a fuel tank located in the generator enclosure.

D. MOTOR CONTROL CENTER AND MOTOR DRIVES

1. Furnish and install a new Motor Control Center (MCC) to distribute power to all equipment and motors. The MCC shall be located in the control house as shown on the plans. The MCC shall be of modular construction and rated NEMA-12. The MCC shall house the motor drives for the span motor. All drives, contactors, and motor starters shall be provided with Ethernet communication capabilities and shall part of the PLC supervisory control and data acquisition. Each MCC shall be equipped with a human machine interface (HMI) to allow the equipment to be controlled if the PLC is out of service.

E. STEP DOWN TRANSFORMER AND SERVICE LIGHTING PANEL

1. Furnish and install one (1) NEMA-3R step down 480V/208-120 VAC connected transformer to power the bridge service equipment. Furnish and install one (1) new NEMA-12 bridge lighting panel to distribute power to the service equipment.

F. SPAN MOTOR

1. Furnish and install one (1) new 25HP, 480VAC, inverter duty, TENV motor to replace the existing span motor. The motor shall be equipped with an internal heater and an encoder to provide motor speed feedback through the PLC I/O to their associate drive. Furnish and install one (1) in-sight, NEMA-4X stainless steel disconnect switches for the motor.

G. WEDGE MOTOR

1. Furnish and install one (1) new 7.5HP, 480VAC, TENV motor to replace the existing wedge motor. Furnish and install one (1) in-sight, NEMA-4X stainless steel disconnect switch for the wedge motor.

H. MOTOR AND MACHINERY BRAKES

1. Furnish and install one (1) new 480VAC motor brake and two (2) new 480VAC machinery brakes. Each brake shall be equipped with a hand release mechanism and limit switches to indicate set, released, and hand released position. Furnish and install three (3) in-sight, NEMA-4X stainless steel disconnect switches, one for each brake.

I. PLC CONTROL SYSTEM

1. Furnish and install a new programmable logic controller (PLC) based control system. This will include a main PLC panel located in the control house, a remote I/O rack in the control desk, and a new remote I/O panel in the center pivot pier. The equipment located in the control house shall be rated NEMA-12 and the panel in the pivot pier shall be rated NEMA-4X stainless steel. The panels shall use Rockwell Automation: Allen-Bradley (AB) ControlLogix PLC equipment with an Ethernet communication network to communicate between the control desk, the main PLC panel, the MCC, and the remote I/O rack in the pivot pier. No exceptions for the PLC processors, I/O cards, and Ethernet switches shall be permitted. All required programming shall be provided.
2. Provide a new control desk with all operators and indicators as shown on the Contract Plans.

J. LIMIT SWITCHES AND CONTROL DEVICES

1. Integrate the existing span position rotary cam limit switch and span position transmitter into the new control system. Furnish and install a new wedge rotary cam limit switch at the location of the existing rotary cam limit switch. Integrate the new wedge rotary cam limit switch into the new control system. Integrate the new brake limit switches (item 9 above) into the new control system. Furnish and install new magnetic proximity limit switches on the near rest pier to provide span full closed and span overtravel position information. Furnish and install new magnetic proximity limit switches on the pivot pier to provide span full open and span

overtravel position information. Furnish and install new float switch in the waste water holding tank.

K. REFURBISH WARNING GATES

1. Reconnect all gate motors to operate at 480VAC. Clean and lubricate the gate equipment. Integrate the gates into the new control system. When the gates are rewired to 480VAC the service equipment, 120VAC heater and receptacle, shall require low voltage service wired to the warning gate enclosures. Replace the existing door and hand crank limit switches with new or provide new B&B equipment, and wire into the control system as shown on the plans.

L. REFURBISH BARRIER GATES

1. Demolish the existing barrier gate motors, far gate controller, and near gate drive. Furnish and install new drives and motors to operate at 480VAC. Clean and lubricate the gate equipment. Integrate the gates into the new control system. Furnish and install new low voltage service to the barrier gate enclosures. Replace the existing door and hand crank limit switches with new or provide new B&B equipment, and wire into the control system as shown on the plans. Replace the drive roller chains, drive sprocket, drive wheel sprocket, and drive wheels on each barrier gate with new B&B approved equipment.

M. REFURBISH TRAFFIC EQUIPMENT

1. Incorporate the existing traffic control equipment (traffic signals, flashing lights, etc.) into the new control system.

N. SUBMARINE CABLES TO PIVOT PIER

1. Furnish and install a new submarine cable between the control house to the pivot pier. This shall provide power and control to all equipment in the pivot pier for span operation. The existing submarine cable to the far side roadway equipment shall remain in service and be protected during construction. The panel shall be cleaned and sealed for continued operation.

O. CONDUIT AND WIRE

1. Furnish and install all conduit, boxes, and wire as required to fully wire all new and existing equipment.
2. All new conduit shall be rigid galvanized steel conduit, except for final connections to limit switches and motors which shall be liquid tight flexible conduits. No conduit smaller than ¾ inch shall be used on the project.
3. All new wiring shall be XHHW and installed in conduit. The minimum wire size for control wires shall be #14AWG inside panels and the minimum size for any wires outside of panels shall be #12AWG for all new wiring in accordance with AASHTO.
4. The existing wiring and conduit between the near roadway equipment and the control house shall be demolished. Furnish and install new conduit and wire, integrated into the power distribution system and the control system. The existing submarine cables between the control house and the far rest pier, across both channels, shall be reused and integrated into the power distribution system and the

control system. Furnish and install new conduit and wire, integrated into the power distribution system and the control system, between the far side submarine cabinet and the far roadway equipment

5. The Contractor shall furnish and install a Main Terminal Panel in the control house to provide the transition point between the new power distribution system and the new control system and the existing wiring and equipment to remain. The Contractor shall field verify all conductors, trace the wiring, and provide wire tags on all existing wiring that is to remain. This information shall be included on the as-built drawings for ease of future maintenance.

P. SIREN

1. Furnish and install a new siren on the control house. The new siren shall be an air horn with dual trumpets. The air horn shall use an air compressor to generate the sound. The siren shall be operated from a push button on the control desk.

Q. HVAC, SERVICE LIGHTING AND RECEPTACLES

1. Provide power and integrate the new control house HVAC into the power system. Furnish and install new lighting and receptacles in the control house and the pivot pier.

R. DEMOLITION

1. Demolish and remove from site the control desk, drives, motor controller panels, generator, ATS, aerial service cables, brakes, wedge motor, span motor, lights, receptacles, and associated conduit and wire. All equipment to remain in service shall be protected at all times.

S. AUXILIARY OPERATING SYSTEM

1. The Contractor shall keep the span operational at all time, in accordance with the Coast Guard approvals. The Contractor shall provide a temporary power and control system to operate the span, wedges, and associated equipment safely during construction in accordance with Section Auxiliary Operating System. Any requirements to take the span out of service shall be approved by the US Coast Guard and the Department's Engineer.

T. OPERATION AND MAINTENANCE MANUALS, TRAINING, AND AS-BUILT DOCUMENTATION

1. The Contractor shall furnish complete maintenance manuals with accurate as-built documentation for all work. These manuals shall be completed prior to commissioning the span and used as part of the commissioning process to verify the manual accuracy. The manuals shall be used as part of the training of the bridge operators and technicians on the safe operation and maintenance of the bridge.

U. COMMISSIONING

1. The Contractor shall completely commission the bridge control system in a factory test and then an onsite commissioning to show the equipment is installed accurately and safely in accordance with the plans and specifications. All equipment shall be

operated to the satisfaction of the Engineer and a testing procedure to record the testing of all equipment.

V. REGULATORY REQUIREMENTS

1. The Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

   a. National Fire Protection Association 70 National Electric Code (NEC)
   b. National Fire Protection Association 101 Life Safety Code (NFPA-101)
   c. Underwriter's Laboratory (UL)
   d. American National Standards Institute (ANSI)
   e. National Electrical Manufacturer's Association (NEMA)
   f. Institute of Electrical and Electronics Engineers (IEEE)
   g. International Cable Engineers Association (ICEA)
   h. The Occupational Safety and Health Act (OSHA)
   i. International Electrical Testing Association (NETA)
   j. Standard Specifications for Movable Highway Bridges, Published by the American Association of State Highway and Transportation Officials, Inc.
   k. Insulated Power Cable Engineers Association (IPCEA)
   l. American Society for Testing and Material (ASTM)

2. Nothing in these Plans and Special Provisions shall be construed to permit work that does not conform to governing codes or regulations. If conflict occurs between the aforementioned codes and the Plans and Special Provisions, the conflict shall be referred to the Engineer for resolution.

W. RELATED WORK

1. Field Measuring
2. Start Up and Commissioning
3. Operation & Maintenance Manuals, Training and As-Built Documentation
4. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
5. Electrical Demolition
6. Electrical Refurbishing
7. Raceway
8. Wire and Cable
9. Submarine Cable
10. Junction and Pull Boxes
11. Switches and Receptacles
12. Heating Ventilation and Air Conditioning (HVAC) Unit
13. Disconnect Switches
14. Grounding
15. Dry Type Transformer
16. Motors
17. Panelboard
18. Motor Control Center
19. Lighting
20. Siren

21. Bridge Control System

X. RESPONSIBILITY

1. The Contractor's responsibilities include:
   a. Operation and maintenance of the bridge, including providing qualified bridge operators during the operation of the temporary operating system up to acceptance of the final operating system.
   b. Complete installation of all equipment in accordance with these Contract Documents.
   c. Coordinating the details of installation for all Special Provisions sections that affect the work covered under this Specification.

Y. BRIDGE CONSTRUCTION OPERATION

1. This section covers the work necessary to provide operational control of the movable span of the Alligator River Bridge during the period the bridge controls are configured for interim temporary operation during construction.
2. The Contractor shall assume operation of the moveable span when any work is started within the moveable span limits or when any work outside of the moveable span limits may affect the operation of the moveable span. The work will be completed when permanent power and control systems are connected, tested, accepted and operation resumes from the refurbished control house. The Contractor shall submit a temporary operating system for review and approval. Once the temporary operating system equipment is installed, the Contractor shall perform testing of the system in the presence of the Engineer. The testing shall be performed and accepted prior to commencing operation for vessel traffic. Only Contracting Agency personnel shall operate the draw span prior to draw span operation by the interim temporary control system and after operation by the new control system.
3. The contractor shall comply with all United States Coast Guard requirements.
4. The contractor shall provide all materials and equipment as required to accomplish the work specified herein and as required to complete the project.
5. The contractor shall operate the swing span and associated equipment only in the presence of the Engineer unless permission to do otherwise is obtained from the Engineer. Sufficient personnel shall be employed during swing span operations to insure the safety of the operating equipment, the contractor's and the Agency's personnel, and the public. The swing span shall be operated by an approved interim temporary control system.
6. The swing span shall open as required for the passage of marine vessels. Non-marine traffic openings of the swing span shall only occur during times of low vehicular traffic as submitted to and approved by the Engineer.

Z. PROJECT CONDITIONS

1. The Contractor shall:
   a. Protect materials and equipment from the effects of weather. Prior to installation, store all items in indoor, dry locations.
   b. Cap conduit runs during construction with manufactured seals. Keep openings in boxes and equipment watertight during construction.
2. Special Conditions - Temporary Lighting and Warnings

a. Throughout construction periods the Contractor shall maintain power to these existing systems or provide temporary battery operated systems until the permanent units are installed and operational:
   i. Span Navigation lights (red/green)
   ii. Solar Powered Battery Fender Navigation marker lights (red)
   iii. Sign Lights

3. Scheduling. The Contractor shall submit both Progress Schedule(s) and a proposed construction schedule no later than fifteen days after the date the Contract is executed. This construction schedule shall comprehensively present all planned activities for all trades and identify any critical path work items including vehicular and/or marine traffic closure periods. The activities enumerated below are anticipated at a minimum during construction and as such shall be accounted for in the schedule.

   a. Identify date contract was executed and notice to proceed to Contractor was given.
   b. Mobilize for the project.
   c. Witness operation of the bridge at the first regularly-scheduled maintenance operation administered and conducted by the Contracting Agency subsequent to notice to proceed to verify operating condition of the bridge systems. Also, field-measure dimensions as specified and required for accurate and complete shop working drawing preparation. Field-verify existing equipment to be interfaced with the new construction.
   d. Prepare and submit working drawings. Identify all applicable measurements and confirmations as field-measured and field-verified, respectively, on the working drawings. Refer to the Submittal section herein for the working drawing requirements. Prepare and submit all other submittals. Refer to the Submittal section herein for the submittal requirements.
   e. Assume 30 days are required for shop working drawing review by Contracting Agency.
   f. After approval of working drawings, fabricate and procure equipment.
   g. Schedule inspection and functional testing/witnessing.
   h. Deliver equipment to the site and/or an approved storage facility in accordance with approved vehicular/marine traffic interruptions. Include necessary vehicular and/or marine traffic closures in the construction schedule for delivering equipment.
   i. Prepare a lock-out/tag-out procedure to ensure the bridge equipment cannot be operated while vehicular traffic is on the bridge. Submit the lock-out/tag-out procedure to the Engineer for approval.
   j. Perform preliminary work that does not require bridge closures in order to prepare for the closure period.
   k. Remove existing equipment designated to be disconnected and removed. Include necessary vehicular and/or marine traffic closures in schedule.
   l. Install approved equipment that has been shop inspected by the Contracting Agency. Identify critical path work items. Identify items that involve multiple disciplines/subcontractors and schedule such activities so that no interference between trades occurs.

m. Deliver spare parts to location designated by Contracting Agency.
n. Initial start-up of systems and equipment. Include necessary vehicular and/or marine traffic closures in schedule.
o. Adjust and tune components to achieve performance specified.
p. Submit field functional testing checklist.
q. Submit Operation and Maintenance Manuals for review.
r. Submit detailed training syllabus and schedule for review.
s. During the Final Phase of the Proposed Construction Schedule, perform Start Up and Commissioning procedures. Provide advance notice of test date in accordance with the Contracting Agency requirements. Perform tuning procedures for bridge systems, Stage 1 - Contractor's Field Testing and Stage 2 - Conditional Acceptance Functional Checkout (see Section Start Up and Comissioning). Identify necessary vehicular and/or marine traffic closures in schedule. Adjust equipment as required to achieve specified operation.
t. During the Final Phase of the Proposed Construction Schedule, after completion of Stage 1 and Stage 2, perform Stage 3 - Endurance Test (see Section Start Up and Commissioning). Provide advance notice of test date in accordance with Contracting Agency requirements.
u. Perform Contracting Agency personnel training.
v. Submit final As-Built drawings, as-built documentation and final Operation and Maintenance Manuals.

4. Temporary Platforms/Access
   a. Contractor shall obtain prior approval from the Engineer before installing any temporary platform, access, etc. Contractor shall submit proposed temporary platforms/access as a working drawing submittal. Contractor shall remove all temporary installations and restore any damaged areas to original condition.
5. Contract Documents
   a. Plans are partially diagrammatic. Exact conduit locations are not shown unless so indicated or specifically dimensioned. Installation of conduit stub-ups shall be in accordance with field conditions and actual manufacturer's shop plans. The Contractor shall be responsible for measuring all dimensions before proceeding with the work.
   b. The electrical wiring diagrams may not completely reflect all connections required for equipment proposed by the Contractor. The Contractor is responsible for installing all wiring required to provide a complete and operable system. All revised wiring shall be documented on the as-built drawings.
   c. Wiring diagrams are not intended to indicate the exact course of raceways or exact location of outlets. Raceway and outlet locations are approximate and are subject to revision as may be necessary or desirable at the time of installation. One-line and riser diagrams are schematic and do not show physical arrangement of equipment.
   d. Mechanical Plans show a correct and workable design based on commercially available machinery and hardware. The Contractor shall be responsible for final makeup and fit to complete the assembly as required for the equipment actually furnished. All deviations shall be shown on full-size as-built drawings.
6. Departures from Contract Documents

a. Submit to the Engineer, in writing, details of all proposed departures from these Contract Documents and the reasons therefore. Make no such departures without written approval of the Engineer.

7. Warranty
   a. Provide a written warranty that the work is free from all defects. The Contractor shall replace or repair, to the satisfaction of the Engineer, any Contractor furnished part that may fail within a period of twelve (12) months after the certificate of final acceptance, provided that such failure is due to defects in material or workmanship, or failure to follow these Special Provisions or Plans.
8. Working Drawings
   a. The Contractor shall submit complete sets of shop, assembly, erection and working drawings and catalog cuts as called for in the Special Provisions. During preparation of working drawings, the Contractor shall detail, coordinate and verify the relationship of all parts for a complete working system. Methods of fabrication, machining, rigging, special shimming, assembly, lubrication, interfacing with existing components, testing and painting necessary to fabricate, install and operate the various systems shall be considered part of the work and documented on the working drawings.
   b. The Contractor shall coordinate the submission of working drawings such that drawings for manufactured components are submitted and approved prior to, or in conjunction with, the related structural support drawings, mechanical assembly drawings and electrical interconnection diagrams. Working drawing preparation will require close coordination between the Contractor and all mechanical and electrical equipment suppliers to detail and verify the relationship and interconnection of all parts for a complete working system. Working drawings will not be reviewed and will be returned to the Contractor if, in the judgment of the Engineer, working drawing submittals are not coordinated by the Contractor.
   c. Upon completion of the work, the Contractor shall correct all working drawings to show the work as constructed and provide one set of 22 inch by 34 inch mylar reproducibles. One set of electronic copies shall be submitted on compact disc and the drawing files shall be in ‘.pdf’ and '.dxf' format or Microstation format.
9. Substitutions
   a. Each proposed substitution shall be accompanied with a cover letter stating that the substitution meets or exceeds all of the project Plans and Special Provisions, and that all engineering necessary to incorporate the substitution into the project has been completed and is included in the submittal of the substitution.
   b. An equivalent item made by another manufacturer may be substituted for the specified item (unless otherwise prohibited), subject to the written approval of the Engineer.
   c. All necessary changes to the project required by the substitution related to mechanical, structural and/or electrical work and all the required engineering design to completely verify the adequacy of the substitution and subsequent

related changes shall be made by the Contractor at no additional cost to the Contracting Agency.

d. The Contractor shall submit sufficient data for the proposed substitution to demonstrate its equivalency to the specified item, including engineering calculations.

e. The Engineer's decision on whether a proposed substitution is "equivalent" to the item specified shall be final. The approval of a proposed substitution by the Engineer shall not relieve the Contractor of any contractual responsibility in regard to defective material or workmanship and the necessity for replacing the same.

10. Submittals

a. All submittals shall be identified with the name of the bridge, the contract number, the contractor's name and the identification of the system or unit the submittal is in reference to. Three copies of each submittal shall be submitted. Working drawing submittals and other pertinent submittals shall include (but are not limited to the following):

i. Field Measurement and Survey Plan.

ii. Project schedules.

iii. Complete manufacturer's drawings for all motor and machinery brakes (including brake drum and limit switch mounting details).

iv. All limit switch mounting details for new proximity switches.

b. Electrical: Control System Vendor Submittals

i. Control system vendor's certification of compliance qualification (see Section Bridge Control System) and field start-up package (see Section Start Up and Commissioning).

ii. Working drawings, catalog cut sheets and mounting details shall be submitted for the following equipment:

A. Motors
B. Disconnect Switches
C. Rotary, Proximity, and Lever Arm Limit Switches
D. Motor Control Centers
E. Wedge Motor
F. Span Motor and Drive System
G. Panels
H. PLC Panels, Cards and Associated Equipment
I. Control Desk
J. All Control Enclosures
K. Indicating Lights
L. Transformers
M. Navigation Siren
N. New Barrier Gate Equipment and Wiring
O. Wiring Devices
P. Grounding Equipment
Q. Panel Wire and Cable
R. Lugs
S. Wire and Conduit Tags

T. Power Supplies

All pertinent electrical data, ratings, calculations and mounting details are to be included on the prints.

iii. Working drawings showing the complete schematic wiring diagram, including all power and control connections for all equipment and point of interface with existing equipment. Each electrical device and each wire between devices shall be identified by an individual designation of letters, numbers, or a combination of both; and such designations shall be used wherever the devices or wires appear on other drawings.

iv. Working drawings and internal connection diagrams of the control desk console, all control panels, PLC cabinet and external equipment.

v. Working drawings showing the schedule of electrical apparatus for each panel which shall list each electrical device by its designation as shown on the schematic wiring diagram and shall state for each device its rating, number of poles or contacts, function, catalog number, and location. A complete set of catalog cuts for materials furnished shall be included for each piece of apparatus.

vi. Working drawings showing the complete interconnection diagram(s) for all electrical apparatus and equipment used in the operation of the bridge and its auxiliaries. The diagram(s) shall be of the elementary type and shall show the external connections of all devices and equipment. Computer-generated inter-connection lists will not be acceptable in lieu of a true interconnection diagram.

vii. PLC and alarm panel programs and software, including text documentation and complete cross-referencing information. Submit the programs on compact disk and a paper hard copy.

viii. Shop testing procedures and schedule of testing of all equipment furnished by the vendor. Submit final PLC and Drive Systems parameters and settings.

ix. Submit all final settings on the control equipment supplied under this contract.

x. Working drawings showing the required interim control wiring, sequence of operation, and procedure for interim bridge operation shall be submitted.

c. Electrical: Installation Submittals

i. Working drawings showing the complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.

ii. Working drawings showing the complete set of layout and installation drawings for the electrical work showing the location and installation, including support and mounting details, of all electrical apparatus and equipment. These drawings shall be made to scale and shall show the

exact location of all conduits, cables, boxes, motors, switches, and other electrical equipment and the method of supporting them on the structure. These drawings shall be submitted prior to pertinent mechanical shop drawings so that the raceway installation details may be incorporated by the mechanical fabricators and erectors.

iii. Working drawings of all multi-conductor cables, including the sizes of conductors, type and thickness of insulation, jackets and other components, and giving the outer diameter of each finished cable.

iv. Working drawings showing outline drawings, catalog cut sheets and mounting details shall be submitted for the following equipment:

A. Wiring Devices
B. Grounding Equipment
C. Conduit
D. Boxes
E. Wire and Cable
F. Submarine Cable, supports, boxes, and cabinets
G. Lugs
H. Wire and Conduit Tags
I. Electrical Components provided by other trades.
J. Medium Voltage Equipment
K. Utility Service Equipment
L. Automatic Transfer Switch
M. Generator
N. HVAC System
O. Ground Rods and Bonding Conductor

Any other drawings, which may, in the opinion of the Engineer, be necessary to show the electrical work.

v. Wire compression terminal tools shall have been calibrated within the last six months by a calibration facility approved by the manufacturer of the test instruments. Written certification of calibration shall be submitted to and approved by the Engineer prior to connecting terminal lugs to any wires.

vi. Detailed written step-by-step testing procedures for Start Up and Commissioning Stages 1, 2 and 3 for the integrated bridge control and machinery systems.

vii. Final reports summarizing all results of Start Up and Commissioning Stages 1, 2 and 3.

viii. Documentation of all electrical conductor insulation resistance testing.

ix. Spare parts list.

x. As built drawings for all items.

xi. Operation and Maintenance Manuals.

xii. Training syllabus and materials.

2.0 MATERIALS

A. GENERAL

1. Furnish materials and equipment approved by UL listing wherever standards have been established by that agency.
2. Where two or more units of the same class of material or equipment are required, furnish products of a single manufacturer.
3. Furnish materials and equipment with manufacturer's standard finish system, except where otherwise specified. Furnish manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with ANSI Number 61, light gray color. Equipment that is exposed to the outside shall be painted to match Federal Standard 595a Number 34097 (Evergreen).

B. COMPLETE SYSTEM

1. All the systems mentioned shall be complete and operational in every detail except where specifically noted otherwise. Nothing in these Special Provisions shall be construed as releasing the Contractor from furnishing such additional materials and performing all labor required to provide complete and correctly operating systems.

C. NAMEPLATES

1. Furnish and install nameplates as required. Nameplates shall be constructed of plastic laminated material engraved through white surface material to black sub layer, giving black letters on white surfaces.
2. Nameplates shall be secured with stainless steel machine screws. Tapes, adhesives and rivets are not acceptable.

D. VOLTAGE AND ARC FLASH WARNING LABELS

1. Furnish and install warning labels to identify the equipment or panel operating voltage and arc flash warnings. The arc flash warning shall be in accordance with NEC 110.16.

E. LOCKS/LOCK SETS

1. Any Item specified as lockable shall be supplied with a lock set compatible with a Contracting Agencies Standard lock and key standards. If the Contracting Agency does not have specific lock requirements the locks shall have a stainless steel padlock hasp sized to accept a padlock with a minimum of three eighths diameter shackle.
2. Specified Items shall include but not be limited to the following: Entry doors, Traffic warning gates, Electrical cabinets, Control consoles, Junction boxes accessible to the public, Sidewalk hatches, etc.
3. Substitute lock sets for items that are too small for practical application of this specification, shall be approved by the engineer prior to installation.

F. SPARE PARTS

1. Spare parts shall be furnished by the Contractor as required in the Special Provisions. Spare parts shall be packaged in corrugated cardboard boxes of

sufficient thickness for shipping and handling the part contained within. A laminated label identifying the part manufacturer, model or catalog number, description and quantity shall be affixed to each box. The Contractor shall provide a typewritten directory of all spare parts furnished under this Contract. Spare parts shall be delivered to location identified by the Contracting Agency, prior to scheduling final acceptance testing. The Contractor shall stack the material where directed by the Engineer. The Contractor shall contact the Engineer at least five working days prior to scheduled delivery to confirm delivery arrangements.

2. The intent of furnishing spare parts to the Contracting Agency is to provide a spare part component inventory after the construction is accepted. If the Contractor elects to utilize a specified spare part during construction to replace a failed component, said spare part(s) shall be replaced by the Contractor prior to final acceptance at no additional cost to the Contracting Agency.

3.0 CONSTRUCTION METHODS

A. General

1. In the event of conflicts between components shown in the Plans and existing openings, structural members and/or components of other existing systems and equipment having fixed locations, the Contractor shall consult the Engineer. The Engineer's decision shall govern.
2. Special attention is called to the fact that this structure moves and that allowances for clearance, snagging of cables and amount of displacement shall be considered. All interference with new and existing structural elements caused by the Contractor's operations shall be corrected by the Contractor at no additional expense to the Contracting Agency.
3. Any temporary or permanent modifications to the bridge which the Contractor deems necessary in order to perform the work shown on the Plans or in the Special Provisions, or as a result of any substitutions or departures from the Contract Documents shall be submitted to the Engineer for approval.

B. Cleaning and Painting

1. All equipment, whether exposed to the weather or stored indoors shall be covered to protect it from water, dust and dirt.
2. After installing, all metal finishes shall be cleaned and polished, cleaned of all dirt, rust, cement, plaster, grease and paint.
3. Scratched surfaces shall be refinished with paint matching the original finish.

C. Equipment Identification

1. Furnish and install identifying engraved nameplates on all equipment, including pull boxes, to clearly indicate the use, area served, circuit identification, voltage, and equipment ratings.
2. Each auxiliary system shall be clearly labeled to indicate its function.

D. HANGERS AND SUPPORTS

1. Furnish and install hangers, brackets, suspension rods and supplementary steel to support equipment. Hangers and supports shall be 316 stainless steel or hot-dipped galvanized after fabrication and/or drilling.

E. CUTTING AND PATCHING

1. Submit a plan and procedure for work and obtain approval from the Engineer prior to cutting. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. Cut concrete with diamond core drills except where space limitations prevent the use of such drills.

2. All construction materials damaged or cut into during the installation of this work must be repaired or replaced with materials of like kind and quality as original materials by skilled labor experienced in that particular building trade.

F. SHOP INSPECTION AND TESTING

1. The Contractor shall furnish facilities for shop inspection of all mechanical and electrical components.
2. All mechanical and electrical equipment shall be assembled, wired, adjusted and operated in the shop to demonstrate proper operation and to permit adjustment of components. The bridge controls shall be shop tested as a complete system (see Section Bridge Control System for additional information). All motor and machinery brakes shall be shop tested together with the bridge control testing.
3. The Contractor shall schedule shop testing dates on the construction schedule and provide two weeks advance notice to the Engineer.

G. INSTALLATION & CONSTRUCTION SEQUENCING

1. The rehabilitation of the bridge machinery and replacement of the electrical systems will result in periods when the bridge is inoperable. The Contractor shall minimize any outages by use of the temporary operating system. The Contractor shall schedule the work and provide the necessary equipment and personnel to minimize the disruptions to the roadway and waterway users. The Contractor shall be responsible for insuring that all necessary materials and equipment are properly fabricated, tested and on site prior to beginning any roadway lane closure, marine closure or bridge detour period.

4.0 MEASUREMENT AND PAYMENT

Electrical Summary of Work will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work required herein shall be bid as part of the individual contract items.

FIELD MEASURING **(SPECIAL)**

1.0 DESCRIPTION

A. WORK INCLUDES

1. The Contractor shall field survey and measure the existing machinery components and structural components as required to ensure that the replacement components and other system modifications as designed and detailed in the plans will fit into the existing systems as intended. All such survey and measurement shall be done before preparation of the shop plans or working drawings and before performing work at the bridge. A survey shall consists of identifying equipment, equipment locations, elevations, coordinates, dimensions, and measuring to provide confirmation the work.
2. The Contractor shall field survey and measure the electrical equipment to verify field wiring shown on the drawing and all equipment shall fit in the proposed locations.
3. The Contractor shall be responsible to ensure the field measuring accuracy is sufficient to properly fabricate and machine the components.
4. The existing dimensions/information to be field measured shall include, but need not be limited to, the following:
   a. General
      i. Any dimensions, sizes and/or features necessary to achieve the proper fit-up of new and/or existing components.
      ii. Any existing dimensions or features which in the opinion of the Contractor and/or the Engineer deviate from the contract documents or as-built drawings and which may impact the installation or alignment of machinery or electrical components.
   b. Control House:
      i. Survey and measure locations for lights, switches and receptacles.
      ii. Survey and measure locations for main terminal panel, supports, and boxes.
      iii. Survey and measure entry pathways for installing equipment in the control house rooms.
      iv. Survey and measure locations for conduit runs and boxes.
      v. Survey and measure locations for disconnect switches, MCC, control desk, HVAC unit, panels, and other enclosures.
      vi. Survey and measure locations for generator, automatic transfer switch, and medium voltage equipment on the roof area.
      vii. Survey and measure submarine cable routing, terminal cabinets, and support locations.
   c. Pivot Pier:
      i. Survey and measure locations for lights, switches and receptacles.
      ii. Survey and measure locations for drag cables, support and boxes.
      iii. Survey and measure locations for span position proximity limit switches.
      iv. Survey and measure locations for conduit runs and boxes.

v. Survey and measure locations for wedge motor, span motor, limit switches, brakes, disconnect switches, panel, and other enclosures.
vi. Survey and measure fender locations for conduit, navigation lights, marker and siren.
vii. Survey and measure submarine cable routing, terminal cabinets, and support locations.

d. Channel
i. Survey and measure locations for submarine cable routing to not interfere with existing cables.
ii. Survey and measure locations for cables, support and boxes.

e. Approaches:
i. Survey and measure locations for roadway equipment and operation.
ii. Survey and measure locations medium voltage incoming service pole, medium voltage pole mounted disconnect, and locations for aerial cable installation supports.
iii. Survey and measure existing warning gates and barrier gates for proposed modifications.

5. Once the surveying and measuring has been completed, any discrepancies shall be marked on the corresponding contract documents and submitted to the Engineer for approval. If any discrepancies are determined to affect the design, Contract, or both, the change will be addressed. If any discrepancies are determined to not affect the design, Contract, or both, the Contractor shall construct the item of work to the field measurement.
6. Related Work
a. Electrical Summary of Work
b. Start Up and Commissioning
c. Operation & Maintenance Manuals, Training and As-Built Documentation
d. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
e. Electrical Demolition
f. Electrical Refurbishing
g. Raceway
h. Wire and Cable
i. Submarine Cable
j. Junction and Pull Boxes
k. Switches and Receptacles
l. Heating Ventilation and Air Conditioning (HVAC) Unit
m. Disconnect Switches
n. Grounding
o. Dry Type Transformer
p. Motors
q. Panelboard
r. Motor Control Center
s. Lighting
t. Siren
u. Bridge Control System

2.0 CONSTRUCTION METHODS

Errors in measurements of any of the components of the bridge machinery could result in errors in the shop plans and working drawings, delays in the approval process, impacts to the project schedule, and problems with the assembly and operation of the systems. The work required to obtain measurements of some of the existing components may require temporary disassembly of those components or systems. The Contractor shall submit a Measure and Survey Plan that shall include but not be limited to the following:

1. The overall sequence and schedule of the systems and components to be measured.
2. A description and plan of how the Contractor will access all areas where measurements will be taken. Propose temporary platforms/access in accordance with Section Field Measuring.
3. A description of the methods, procedures and equipment that will be used where it may be necessary to disassemble and reassemble components or systems in order to perform the measurements.
4. A description of the methods and equipment used to perform the measurements. Identify control points, datum's and plumb lines.
5. A narrative of the potential impacts to the systems and operation of the bridge. The Contractor shall comply with the Coast Guard requirements that may limit the durations that the bridge can be taken out of service.
6. Identify the individuals doing the field measuring and provide resumes that show that they are competent and experienced.
7. A complete list of personnel who will be performing surveys or taking measurements to be used in the preparation of shop/working drawings or for coordinating and verifying the relationship of machined parts.

All measurements affecting elements to be included in the shop plans and working drawings shall be performed by or under the direct supervision of the Contractor who is responsible for preparing the shop plans or working drawings.

The Contractor shall not begin field measuring until the Measurement and Survey Plan for that work item is approved.

3.0 MEASUREMENT AND PAYMENT

Field Measuring will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Field Measuring*.

Payment will be made under:

Pay Item	**Pay Unit**
Field Measuring	Lump Sum

START UP AND COMMISSIONING **(SPECIAL)**

1.0 DESCRIPTION

A. WORK INCLUDED

1. The work under this item is to demonstrate that all the bridge electrical and mechanical systems have been correctly installed and function properly.
2. The Contractor shall provide all test equipment, safety equipment, personnel and monitoring devices necessary to show each piece of equipment has been installed, operates properly, is in proper operating condition, and integrated into the bridge control system. This work shall be coordinated with control system vendor and the installing Contractor.

B. REQUIRED COMMISSIONING STAGING DURING THE FINAL PHASE OF THE PROPOSED CONSTRUCTION SCHEDULE:

1. Stage 1 - Contractor's Field Testing
   a. The Contractor shall adjust, calibrate and test all equipment, place the integrated system in service, and test the integrated system. The Contractor shall provide verification that all inputs and outputs and all signals have been properly installed and tested.
   b. The Contractor shall demonstrate that the completed system functions properly by performing at least 10 consecutive complete bridge operations under PLC control, each without failure or any adjustments. (A complete bridge operation shall be defined as starting from turning control power on, operating all equipment up to completely opening the span, operating all equipment up to completely closing the span, and ending by turning control power off.) The Contractor shall demonstrate the operation of all bypass functions, including operating the span in the clockwise direction. The Contractor shall demonstrate the operation of the ATS and generator, and provide at least 3 complete operations under generator power. The Contractor shall deliver a report describing results of the contractor’s field tests, diagnostics, and calibrations including written certification to the Contracting Agency that the installed complete system has been calibrated, tested, and is ready to begin Stage 2 – Conditional Acceptance Functional Checkout. The report shall also include a copy of the approved Stage 1 – Contractor’s Field Testing procedure.
2. Stage 2 - Conditional Acceptance Functional Checkout
   a. Upon successful completion of Stage 1 Contractor’s Field Testing and its acceptance by the Engineer, the Contractor shall demonstrate that the completed bridge machinery and control systems comply with the contract requirements. Using approved test procedures; all physical and functional requirements of the project shall be demonstrated. The conditional acceptance functional checkout test, as specified, shall not commence until receipt by the Contractor of written permission from the Contracting Agency, based on the Contractor's Stage 1 written report. This shall include certification of successful completion of Stage 1- Contractor’s Field Testing, as specified above. The Contracting Agency may terminate this portion of the testing at any time when the system fails to perform as specified.

b. Upon a failure resulting in termination of testing by the Contracting Agency or by the Contractor, the Contractor shall commence an assessment period. The Contractor shall identify all failures, determine the cause of all failures, repair all failures, and deliver a written report to the Contracting Agency. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which the testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Contracting Agency. As part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing the appropriate portions of the conditional acceptance functional checkout test. Based on the Contractor's report and test review meeting, the Contracting Agency will determine the retest date.

c. Upon successful completion of the conditional functional checkout testing, the Contractor shall deliver test reports and other documentation specified to the Contracting Agency for approval prior to commencing the endurance test.

3. Stage 3 - Endurance Test

a. The endurance test shall not be started until the Contracting Agency notifies the Contractor, in writing, that the Stage 2- Conditional Functional Checkout Testing has been completed and correction of all outstanding deficiencies have been satisfactorily completed.

b. The Contractor shall provide one qualified person to direct the Contracting Agency's operator how to operate the system as required during Phase I and Phase III of the Endurance Testing. The Contracting Agency may terminate testing at any time the system fails to perform as specified. Upon termination of testing by the Contracting Agency or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the Endurance Test, the Contractor shall deliver test reports and other documentation specified to the Contracting Agency prior to acceptance of the system.

c. Phase I (Testing): The test shall be conducted 24 hours per day for 10 consecutive calendar days, including holidays, and the system shall operate as specified without fault or failure. A minimum of 30 complete bridge operations shall be performed during this period. The Contractor shall make no repairs during this phase of testing unless authorized by the Contracting Agency in writing. If the system experiences no failures during Phase I testing, the Contractor may proceed directly to Phase III testing, after receipt of written permission from the Contracting Agency.

d. Phase II (Failure Assessment): If Phase I is unsuccessful, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Contracting Agency. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Contracting Agency. As a part of this test review meeting, the Contractor shall

demonstrate that all failures have been corrected by performing appropriate portions of the conditional acceptance functional checkout test. Based on the Contractor's report and the test review meeting, the Contracting Agency will determine the restart date, or may require that Phase I be repeated. If the retest is completed without any failures, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Contracting Agency.

e. Phase III (Completion): If Phase I is successful, the Contractor shall prepare and submit a written report to the Contracting Agency. The report shall explain in detail the number of operations performed, results of each operation, and the results of all tests performed. Based on the Contractor’s report, the Contracting Agency will determine whether the bridge control/machinery system is to be accepted by the Contracting Agency.

4. Other Testing and Inspection Requirements
   a. Perform insulation resistance testing on all new electrical conductors installed under this contract.
   b. Perform inspection of motors and motor starters installed under this contract.
   c. Perform ground measurement testing on all new electrical panels installed under this contract.
5. Related Work
   a. Electrical Summary of Work
   b. Field Measuring
   c. Operation & Maintenance Manuals, Training and As-Built Documentation
   d. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
   e. Electrical Demolition
   f. Electrical Refurbishing
   g. Raceway
   h. Wire and Cable
   i. Submarine Cable
   j. Junction and Pull Boxes
   k. Switches and Receptacles
   l. Heating Ventilation and Air Conditioning (HVAC) Unit
   m. Disconnect Switches
   n. Grounding
   o. Dry Type Transformer
   p. Motors
   q. Panelboard
   r. Motor Control Center
   s. Lighting
   t. Siren
   u. Bridge Control System

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

1. In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:
   a. Institute of Electrical and Electronic Engineers
   b. International Cable Engineers Association (ICEA)
   c. Life Safety Code (NFPA 101)
   d. National Electric Safety Code
   e. National Electrical Manufacturers Association (NEMA)
   f. National Fire Protection Agency 70 National Electric Code (NEC)
   g. American Association of State Highway and Transportation Officials (AASHTO)

B. TEST EQUIPMENT

1. Furnish test equipment of types approved by the Engineer, properly calibrated to conduct testing. Prepare reports recording test results as required.

3.0 CONSTRUCTION METHODS

A. GENERAL

1. Conduct all tests in the presence of the Contracting Agency, except when the Contracting Agency allows the test to be performed otherwise. The Contractor shall submit the dates for any testing for approval. Testing shall not commence until the date is approved by the Contracting Agency.
2. Maintain a written record of all tests showing date, personnel making test, equipment or material tested, tests performed, manufacturer and serial number of testing equipment and results. All test reports and data shall be submitted to the Engineer for approval.
3. In order to prevent accidents, Stage 1 and Stage 2 the Conditional Acceptance Functional Checkout will be performed during periods when there is a traffic closure on the bridge, unless approved in advance by the Engineer.

B. SUBMITTALS

1. The Contractor shall provide a written procedure for Stages 1 and 2 testing to the Contracting Agency at least forty (40) working days prior to commencing any testing. These procedures shall be reviewed and approved before any testing may be performed. All written test procedures shall be step by step, with pass or fail check marks as required. At a minimum the test shall include, but is not limited to:
   a. Demonstrate complete bridge operations using the span drive motor/drive by the PLC control system.
   b. Demonstrate complete bridge operations under emergency generator power.
   c. Demonstrate that all alarms function properly.
   d. Demonstrate that all control system safety interlocks function properly by attempting out of sequence operations.
   e. Demonstrate that all control system bypass functions operate properly.

f. Demonstrate MCC human-machine-interface (HMI) manual operation of the wedge lock machinery.
g. Demonstrate MCC human-machine-interface (HMI) lowering/raising of all traffic gates.
h. Demonstrate MCC human-machine-interface (HMI) manual release of all motor and machinery brakes.
i. Demonstrate MCC human-machine-interface (HMI) manual operation of all motor and drive systems.
j. Demonstrate manual operation of the traffic warning signals.

2. Submit calibration and certification documents for all testing equipment.
3. Submit control system vendor field start-up service crew qualifications and test equipment certifications.
4. Submit all wire testing, motor starters and motors, and ground measurements test results.
5. Submit all final test reports. All reports shall be organized, bound and signed by the Contractor

C. QUALITY ASSURANCE

1. Furnish and use safety devices such as rubber gloves and blankets, protective screens, barriers and danger signs to adequately protect and warn all personnel in the vicinity of the tests.
2. Test equipment shall be calibrated and certified. Certification data shall be dated within six months of the testing.
3. All testing shall be performed after the equipment has been fully installed at its final location.
4. The Contractor shall be responsible for all damage to equipment or material as a result of any test procedures, improper testing, or test apparatus handling. The Contractor shall replace or restore to original condition any damaged equipment or material.

D. TEMPORARY TRIAL USAGE

1. The Contracting Agency reserves the privilege of putting to temporary and/or trial usage before acceptance of any apparatus, device, or materials for such reasonable length of time that the Engineer deems necessary for making a complete and thorough test of equipment operation.
2. The temporary trial usage by the Contracting Agency of any equipment or materials supplied under this contract before their final completion and written acceptance by the Engineer shall not be construed as an evidence of the acceptance of same by the Engineer.
3. No claim for damage shall be made by the Contractor for the injury to or breaking of any part of equipment during temporary or trial usage, which may be caused by defective equipment and materials or poor workmanship on the part of the Contractor.

E. OTHER TESTING AND INSPECTION REQUIREMENTS

1. The Contractor shall test and visually inspect all equipment, installation and mounting. The Contractor shall visually inspect and verify all nameplates.

2. All repairs and replacements will be made to the satisfaction of the Engineer at no additional cost. All repairs and replacements shall be made and tested before proceeding to the next stage.

F. INSULATION RESISTANCE FIELD TESTING OF WIRE AND CABLE

1. The Contractor shall administer an insulation resistance test for all new conductors after said conductors have been installed but prior to being connected to a device at either end of the conductor as specified in Section Wire and Cable.

G. MOTOR STARTER AND MOTORS

1. Visually inspect all motors and motor starters for any physical damage. Verify all motor circuit breaker settings and overload settings.
2. Prepare a list for all motor nameplate information (including horsepower, full load and locked rotor amperes, RPM, voltage, service factor, and temperature rise), motor overload heater code, fuse size and type.
3. Check motor for proper lubrication.
4. Check motors for proper rotation after insulation tests and lubrication checks but before coupling the motor.

H. CONDITIONAL ACCEPTANCE FUNCTIONAL CHECKOUT

1. The Contractor shall perform a step-by-step demonstration of the bridge operating systems as specified. The demonstration shall not be performed until all construction is completed and the prior stage (and all repairs or replacements) has been completed, and the as-built plans, O&M manuals and other documents are submitted to and approved by the Engineer.
2. The Contractor shall prepare a test procedure that lists in numbered steps each device to be demonstrated , the action required by the operator and the expected results. The bridge operation shall be demonstrated in manual operation, automatic operation with normal utility service and generator service. Operation of all interlocks and bypasses shall be demonstrated. Each step shall be provided with a pass/fail blank.
3. See Section Bridge Control System for additional Control System Vendor testing requirements and actions.
4. All repairs and replacements will be made to the satisfaction of the Engineer at no additional cost. All repairs and replacements shall be made and tested before proceeding to the next stage.

I. CONTROL SYSTEM VENDOR FIELD START-UP SERVICE

1. In addition to furnishing the major items of electrical equipment, the control system vendor shall furnish all necessary field supervisory start-up material and labor to facilitate proper adjustment of the electrical equipment so as to achieve satisfactory functioning of the bridge. It is specifically brought to the control system vendor’s attention that field start-up will include tuning the drive systems and PLC program modifications.
2. The control system vendor's field service engineering personnel shall be experienced in the adjustment and functioning of the particular control equipment furnished under this item. The personnel shall be capable of locating and correcting

faults or defects and of obtaining from the manufacturer, without delay, parts or replacements for apparatus that, in the opinion of the Engineer, does not perform satisfactorily.

3. The Contractor's detailed start-up plan and procedure shall be submitted to the Engineer for approval 40 days before the start-up is scheduled to begin. The Contractor shall submit to the Engineer the qualifications of the field start-up service crew, as a submittal for approval 40 days before start-up is scheduled to be begin. This submission shall provide the qualifications of the staff, including a brief work experience history of each individual, and the Contractor's plan and procedure for start-up.

J. MANUAL CONTROL FUNCTIONAL TESTING

1. Upon completion of the electrical work for the bridge, the Contractor shall arrange for and provide all necessary field tests listed herein, and as directed by the Engineer, to demonstrate that proper operation of the entire electrical system for the bridge is achieved and is in accordance with the Contract Documents under MCC human-machine-interface (HMI) manual control.

K. PLC PROGRAM FUNCTIONAL TESTING

1. Upon completion of the electrical work for the bridge, the Contractor shall arrange for and provide all the necessary field tests listed herein, per the Contractors testing procedure, and as directed by the Engineer, to demonstrate that proper operation of the entire electrical system for the bridge is achieved and in accordance with the Contract Documents. The Contractor shall complete an I/O check for all PLC I/O.
2. It shall be demonstrated that there are no problems with the 'Hot Back Up' redundancy module transfer from PLC A processor to PLC B processor and then back to PLC A processor. It shall also be demonstrated that there are no problems transferring from PLC operation to manual operation, then transferred back to automatic operation from the control desk PLC operation.
3. Final acceptance testing shall include verification of proper operation of each piece of equipment, proper operation of the complete bridge, and proper operating logic for all of the bridge. Each interlocking feature in the PLC Program shall be tested by causing the interlock condition to physically occur. If physical testing of a particular interlock poses a hazard to personnel or equipment, the interlock shall be simulated by manually operating the appropriate limit switch or device.

L. ENDURANCE TEST PERIOD

1. Upon completion of Stage 2 – Conditional Acceptance Functional Checkout, the Stage 3 - Endurance Test period shall begin. The bridge must operate error free during this period, or the Endurance Testing shall be terminated and the Contractor shall return to Stage 2.
2. During this period the Contractor shall perform any required maintenance and shall repair or replace, as directed by the Engineer, any component that fails.
3. It is during this stage that the training will be completed.

4.0 MEASUREMENT AND PAYMENT

Start Up and Commissioning will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Start Up and Commissioning*.

Payment will be made under:

Pay Item	**Pay Unit**
Start Up and Commissioning	Lump Sum

OPERATION AND MAINTENANCE MANUALS, TRAINING AND AS-BUILT DOCUMENTATION (SPECIAL)

1.0 DESCRIPTION

Furnish a complete Operations and Maintenance manual for all electrical and mechanical equipment as specified herein.

Perform NCDOT personnel training subsequent to the Engineer's final approval of the Operation and Maintenance Manuals.

Furnish complete as built drawings of all mechanical and electrical equipment, schematic diagrams and other documentation for all equipment installed or modified under this contract.

A. RELATED WORK

1. Electrical Summary of Work
2. Field Measuring
3. Start Up and Commissioning
4. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
5. Electrical Demolition
6. Raceway
7. Wire and Cable
8. Submarine Cable
9. Junction and Pull Boxes
10. Switches and Receptacles
11. Heating Ventilation and Air Conditioning (HVAC) Unit
12. Disconnect Switches
13. Grounding
14. Dry Type Transformer
15. Motors
16. Panelboard
17. Motor Control Center
18. Lighting
19. Siren
20. Bridge Control System

21. Auxiliary Operating System
22. Center Wedge Machinery
23. Centering Device Machinery
24. End Lift Machinery
25. Stabilizing Machinery
26. Turning Machinery
27. General Specification for Bridge Machinery

2.0 CONSTRUCTION METHODS

A. OPERATION AND MAINTENANCE MANUALS

1. The Contractor shall compile and develop an operation and maintenance manual for all newly installed equipment with the following information in the title page:

   Operation and Maintenance Manual

   Alligator River Swing Span Bridge

   Tyrrell County Bridge No. 7

   Contract No. ___

   Date of Preparation: MM/DD/YYYY

2. All drawings shall be as follows:
   a. All as built drawings shall be originals. No photocopies shall be permitted.
   b. All as built catalog cuts shall be identified with part identifiers, contract number, complete manufacture's part number, pertinent information highlighted and non-pertinent information crossed out.
   c. All as built drawings showing equipment assemblies shall be documented with part identifiers.
3. Operation and maintenance manuals shall contain the following minimum information:
   a. CHAPTER I - Mechanical Equipment Maintenance

      Manufacturer's Information:

      i. Schedule of newly installed mechanical apparatus and modified existing apparatus.
      ii. Descriptive leaflets, bulletins, maintenance instructions, and drawings covering all items of equipment furnished and installed under this Contract.
      iii. Names, addresses, websites and telephone numbers of vendors and suppliers.
      iv. Maintenance instructions for all newly installed mechanical equipment and modified existing mechanical equipment, including warnings and precautions to be observed during maintenance actions, provided under this Contract.

      Spare Parts Directory

      i. Mechanical Assembly and Installation Shop/Working Drawings
      ii. Complete mechanical shop/working drawings prepared by the Contractor.

iii. Lubrication charts for all newly installed machinery provided under this Contract.

b. CHAPTER II - Electrical Equipment Maintenance

Manufacturer's Information

i. Schedule of newly installed electrical apparatus.
ii. Descriptive leaflets, bulletins, maintenance instructions, and drawings covering all approved items of equipment furnished and installed under this Contract.
iii. Names, addresses and telephone numbers of vendors and suppliers.
iv. Maintenance instructions for all newly installed electrical equipment and modified existing electrical equipment, including warnings and precautions to be observed during maintenance actions, provided under this Contract.

Spare Parts Directory

Electrical System Wiring Diagrams and Panel Drawings

i. Complete electrical shop/working drawings prepared by the control system vendor.
ii. Control desk, control panels, equipment panels, motor control center, motor drives and PLC control panel layouts and wiring diagrams for the work covered in this Contract.

Electrical Installation Shop/Working Drawings

i. Conduit layout drawings.
ii. Mounting and construction detail drawings for electrical components.
iii. All complete shop/working drawings related to the electrical installation.
iv. Final version of the installed Flux Vector Drive parameters in hard copy format (8.5" x 11").
v. Electronic copy of final version of the installed Flux Vector Drive parameters on an EEPROM flash drive.

Programmable Logic Controller (PLC) Program

i. Final version of the installed PLC Program in hard copy format (8.5" x 11").
ii. Electronic copy of final version of the installed PLC program and alarm panel program on a flash drive.

Data Logging Alarm Panel (Panelview) Program

i. Final version of the installed Data Logging Alarm Panel Program in hard copy format (8.5" x 11").
ii. Electronic copy of final version of the installed Data Logging Alarm Panel Program on a flash drive.

The material for the operation and maintenance manual shall be assembled to form a book with heavy plastic covers. Each book shall be approximately 9 inches by 12 inches, three-ring binder with 3-inch "D" rings, and vinyl cover to allow title sheet inserts. Each book shall be neatly entitled with a descriptive title, the name of the bridge, the Contracting Agency, the contract number, date of installation, and Contractor. Copies of drawings shall be in black on a white background and shall be easily legible. Sepia and/or blue line drawings shall not be used. Each

section/subsection shall be separated with laminated tabbed divider sheets. Each tab shall be suitably titled. All literature, descriptive materials for inclusion in the manuals shall have all sheets numbered and listed by section in the Table of Contents. The arrangements of the booklets, the method of binding, material to be included, and the text shall all be as approved by the Engineer.

The Contractor shall submit a 90% preliminary copy of the maintenance manual to the Engineer for review, prior to the 100% review copy. The manuals shall be submitted to the Engineer for review and shall be approved prior to commencement of the training session specified. The manuals shall also be made available at the bridge site for use during the start up and commissioning period. Three copies of the final operation and maintenance manuals shall be submitted to the Engineer for review to verify all comments have been incorporated. Upon this final approval, 6 bound copies of the final approved operation and maintenance manuals shall be delivered to the Engineer 14 days before the schedule date for the first day of the instruction period begins.

Final approval of each volume of the Operation and Maintenance Manual shall be obtained by the Contractor prior to final acceptance testing of the bridge.

B. TRAINING

The Contractor shall provide training services for the Contracting Agency's bridge operators and maintenance personnel. The Contractor shall submit at least two weeks (14 days) prior to the schedule date for the first day of the instruction training session, a complete training syllabus outlining topics to be covered, timeframes and training location for said topics and materials to be furnished as part of the training sessions. The training sessions shall be organized and be administered to a multi-disciplined group. Training sessions shall be devoted to theory of operation, maintenance and trouble shooting of the retrofitted bridge machinery systems and the new bridge electrical control and power distribution systems.

Each session shall be capable of training no more than 25 people. The Contractor shall furnish off-site classroom facilities located in a location suitable to Contracting Agency, all necessary instruction sheets, student training aids, paper, and booklets to supplement training.

1. Bridge Operator Training –
   a. The Contractor shall provide bridge operator trainers to train 15 of the Contracting Agency's bridge operation personnel at the bridge for a period of two consecutive working days (8 hours per day) after the construction has been completed, functionally tested but prior to turning over the bridge to the Contracting Agency for resuming normal operation. The trainers shall be skilled persons competent to operate the bridge and be completely familiar with the operating equipment of the bridge and its auxiliaries that have been installed, changed, or altered as part of this contract.
2. Maintenance Personnel Training –
   a. The Contractor shall provide on-site and off-site training of the Contracting Agency's electricians, maintenance workers, and other personnel as indicated by

the agency on subjects such as maintenance, adjustment, troubleshooting, and repair of all equipment furnished, modified and/or installed by the Contractor under this Contract. Five sessions of eight hours shall be devoted to electrical and mechanical equipment and maintenance-related topics. The Contractor shall submit to the Engineer for approval, a detailed outline of topics to be covered and training material for review, The outline of topics shall consist of a schedule of training based upon a detailed list of topics, including start and finish times for each topic each day.

b. It shall also be the Contractor's responsibility to coordinate with the Contracting Agency. Supplying of visual aid equipment and other miscellaneous items required for training shall be the responsibility of the Contractor.
c. Contractor shall provide copies of step-by-step operating instructions for each trainee.
d. Training shall not commence until bridge is operational and system has been conditionally accepted by the Engineer. See Section Start Up and Commissioning.

3. Personnel Training on Drives
   a. This additional Flux Vector Drive training is to occur before the shop testing and the dates are to be approved by the Contracting Agency.
   b. In-depth, hands-on training by the Flux Vector Drive manufacturer shall be provided for six (6) of the Contracting Agency's personnel and shall last 3 eight hour days of classroom training. The Flux Vector Drive training shall be specific to the Flux Vector Drive that is used on the bridge and shall include configuring, startup, and maintaining and troubleshooting. Training shall occur on identical types of equipment to be installed on the bridge under this Contract.
4. Personnel Training on PLC Equipment
   a. Additional PLC training is to occur before the shop testing and the dates are to be approved by the Contracting Agency.
   b. In-depth, hands-on training by the PLC manufacturer shall be provided for six (6) of the Contracting Agencies personnel and shall last 4 eight hour days of class room training and 4 eight hour days of field training for practical application and troubleshooting. The PLC training shall be specific to the PLC that is used on the bridge and shall include programming, fundamentals, and maintaining and troubleshooting. Training shall occur on identical types of equipment to be installed on the bridge under this Contract. The training shall be provided by Rockwell Automation or approved equal. The training shall include the Ethernet communications equipment, Ethernet communications to the drives, and operation of the Ethernet enabled overload relays in the Motor Control Center.

C. AS-BUILT DOCUMENTATION

1. After completion of all work, Contractor shall mark the prints to show all departures from the contract Plans. Indicate exact circuiting and wire numbers. Contractor shall make the markings with red indelible pen and shall deliver these prints to the Engineer.
2. As-builts shall be in accordance with the AASHTO LRFD Movable Highway Bridge Design Specifications First Edition 2000 Article 1.7 and as follows:

a. In addition to furnishing the data required under Article 1.7, the Contractor shall make complete working drawings for the electrical equipment. The tracings, or translucent copies thereof on cloth, mylar or equivalent, shall become the property of the Contracting Agency after they have been corrected to show the work as constructed. These drawings shall include:

   i. Complete wiring interconnection diagrams, giving complete termination identification of wires and cables, and sizes and numbers of all wires and cables, and the make and capacity of all apparatus., including the rating of all impedance. Schematic diagrams shall include three-line power diagrams showing the scheme of connections including detailed apparatus and complete control schematic diagrams which shall include the control panels and the control desk. The number of each wire and an individual device designation for each electrical device or piece of apparatus shall be shown on the control schematic diagram. This device designation shall be used to identify each piece of apparatus on all assembly and installation drawings. Assembly drawings shall include locations to scale of all external and internal identified components including terminal blocks contained on or in the control panels, motor control centers, drive systems, terminal boxes and control desk.

   ii. Complete conduit drawings, which show the physical routing and the size of each conduit and the wire number and size of each wire therein. These drawings shall show the exact location and method of support of all conduits, ducts, boxes and expansion fittings, and each conduit shall be given an individual conduit designation.

   iii. Complete submarine cable and installation drawings, which show dimensioned prints of all the electrical equipment and physical routing. Dimensioned prints shall be provided for all submarine cables, cabinets, ducts, concrete boxes, splices, terminal strips, supports, and associated electrical equipment. The physical routing drawings shall be plan and elevation drawings showing all final soundings of the installed submarine cable path, elevations of the riverbed, concrete boxes, buried submarine cables, submarine cable terminal cabinets, supports and all other electrical equipment installed.

   iv. The requirements of Article 1.7 may be partially fulfilled by use of a suitably coordinated conduit and cable schedule.

   v. Installation drawings giving locations of all cables, conduits, motor control centers, drive systems, navigation lighting, roadway signals, service equipment, control panels, control desk, limit switches, resolvers, switches, lamps and all other apparatus.

   vi. Final drawings of all installed bridge machinery components including layout and installation drawings.

   vii. Drawings showing the general construction and dimensions of all control panels, motor control centers, drive systems, and the arrangement of all apparatus thereon.

   viii. Drawings showing the general construction and dimensions of the control desks and the arrangement of all apparatus thereon.

ix. Certified dimension prints of all electrical apparatus.
x. Detailed construction drawings of all boxes, troughs, ducts, and raceways other than conduit.
xi. Special apparatus shall be designated by the manufacturer's name and catalog reference.

3. The marked up prints shall be submitted to the Engineer for approval. Once the marked up prints are approved by the Engineer, the Contractor shall incorporate any comments and marked up prints into a final computer aided design and drafted (Microstation) set. Submit complete set of printed drawings and an electronic copy of all drawings on a flash drive for all as-built drawings.

3.0 MEASUREMENT AND PAYMENT

Operation and Maintenance Manuals, Training and As-Built Documentation will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Operation and Maintenance Manuals,* Training and As-Built Documentation.

Payment will be made under:

Pay Item	**Pay Unit**
Operation and Maintenance Manuals, Training and As-Built Documentation	Lump Sum

UTILITY SERVICE, MEDIUM VOLTAGE EQUIPMENT, AUTOMATIC TRANSFER SWITCH AND GENERATOR (SPECIAL)

1.0 DESCRIPTION

Furnish and install a complete medium voltage (2400V) utility service, medium voltage (2400V) pole mounted disconnect switch, medium voltage (2400V) aerial cables, and a medium voltage (2400V) step down transformer rated 2400-480/277VAC. All equipment, junction terminal boxes, splices, and wiring shall be weather proof and watertight, rated for outdoor use.

Furnish and install a 60KW Diesel Generator and 100A automatic transfer switch.

The contractor shall be fully responsible for coordinating and securing all work from the Utility.

A. RELATED WORK

1. Summary of Work
2. Field Measuring
3. Start Up and Commissioning
4. Operation & Maintenance Manuals, Training and As-Built Documentation
5. Electrical Demolition
6. Raceway
7. Wire and Cable

8. Junction and Pull Boxes
9. Grounding
10. Bridge Control System

B. SUBMITTALS

1. Submit all materials in accordance with Section Electrical Summary of Work.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

1. The Contractor shall perform all work and install all materials and equipment in accordance with Section Electrical Summary of Work.

B. NAMEPLATES

1. Each piece of electrical equipment and apparatus shall have a corrosion - resisting metal nameplate on which is stamped the name of the manufacturer and the rating or capacity of the equipment or apparatus. This nameplate shall clearly identify the equipment and the electrical qualities for ease of inspection, repair and replacement at a later date. The nameplate shall also clearly identify the piece of equipment in relation to the Plans by providing the alphanumeric designation of the equipment as shown in the Plans or the approved shop drawings.

C. GENERAL REQUIREMENTS

1. All metal parts of the electrical installation, except structural steel, shall be of corrosion-resisting material, such as bronze or stainless steel. Cast-iron, malleable iron, or steel with a hot-dip galvanized finish shall be used where specified in the Plans and these Special Provisions. Structural steel shall conform to the requirements given elsewhere in the Plans and these Special Provisions.

D. UTILITY SERVICE

1. The existing electric service is 2400-volts nominal, 30kVA, three phase, three wire, 60-Hertz and will be replaced by a 50kVA, three phase, three wire, 60-Hertz system. All existing feeders will be replaced and routed to a new meter cabinet. From the meter cabinet, new medium voltage aerial cables shall be furnished and installed to a new step down transformer.
2. The Contractor shall furnish and install all aerial cables, conduits, wiring, boxes and other equipment required to properly route the new 2400-volt feeders to the new CT Cabinet, service disconnect, and medium voltage transformer located at the bridge control house.
3. The Contractor shall be fully responsible for coordinating and contracting the Utility to upgrade the existing service. The contractor shall provide a meter base and Current Transformer (CT) cabinet. The cabinet shall be as specified and approved by the Utility. The Contractor shall coordinate all requirements, inspections, approvals with the Utility directly. The Contractor shall be responsible for all costs to secure the new service and metering from the Utility.

E. MEDIUM VOLTAGE POLE MOUNTED DISCONNECT SWITCH

1. Furnish and install a pole mounted disconnect switch after the utility service. This disconnect shall serve as the safety disconnect for the aerial cables and medium voltage transformer. The Contractor shall furnish and install a new pole, disconnect switch, terminations, and all associated equipment. The work shall meet the requirements and standards of the Utility and the NCDOT. All equipment shall be listed for the service voltage and be rated weatherproof.

F. MEDIUM VOLTAGE AERIAL CABLES

1. Furnish and install a complete aerial cable system which shall include the messenger cable, aerial cable, aerial cable supports and messenger cable supports to route utility power from the approach to the control house medium voltage transformer.
2. The messenger cable shall be 0.5 inch diameter stainless steel 302 steel messenger cable. Any splices in the messenger cable shall be stainless steel, minimum 302, and rated for the full strength of the messenger cable for 33,700 pound breaking strength.
3. The messenger cables shall be connected and supported to eyebolts with stainless steel 316 shackles. Each shackle shall be a minimum of five-eighths (5/8) inch interior diameter, but sized by the Contractor to support the messenger cable. The shackle shall be bolt and screw type with a lock nut to secure the shackle.
4. The eyebolts shall be resin bonded to the concrete approach under deck. The anchor eyebolts sized with a minimum eyebolt diameter of five-eighths (5/8) inch, but sized by the Contractor to support the shackle. The eyebolts shall provide a minimum of 1000 pound ultimate capacity. The eyebolt spacing shall be 10 feet wherever practically achievable. Where not achievable, 25 feet maximum spacing shall apply.
5. The aerial cables shall be supported with a saddle type support as shown in the plans in accordance with the cable and support manufacturer's recommendations. Supports shall be stainless steel 316 cable rings equipped with stainless steel 316 cable saddles. Each cable shall be provided a separate cable ring.
6. Any required splices for the aerial cable system shall be made in NEMA-4X, 316 stainless steel boxes mounted to the bridge. The cables shall be provided strain relief fittings on both sides of the boxes to protect the equipment. All box entries shall be provided hubs and shall be watertight. The cables shall be looped in the panel to provide at least 10 feet additional cable to allow future splices. All splices shall be watertight and weather proof. The boxes shall be sized to meet all NEC requirements and provide room for the loops of cables.
7. The aerial cables shall be 5kV rated, shielded cables with ethylene propylene rubber (EPR) insulation and a sunlight resistant poly vinyl chloride (PVC) outer jacket. The cables shall be class B stranded, annealed copper with a 5 mil copper conductor shield. The cables shall be UL Listed MV-105 and meet the ICEA requirements. The Contractor shall work with the manufacturer to provide the longest length cables possible to reduce splices and splice boxes on the bridge. Each cable shall be:
   a. 1 Conductor #1/0 Ground Cable

b. 3 Conductor #4 AWG with one #6 AWG Ground multi-conductor cable

G. MEDIUM VOLTAGE TRANSFORMER

1. Provide a custom transformer designed according to the latest revision of NEMA ST-20. The transformer shall be equipped with a stainless steel, NEMA-3R enclosure with drip shield, vibration isolator pads, equipped with a space heater, suitable for outdoor, wet, environment.
2. Ratings for the transformers shall be as:
   a. Primary Voltage: 2400VAC Delta Connection
   b. Secondary Voltage: 480VAC Wye Connection
   c. KVA Rating: 75 kVA minimum
   d. Phase: 3 Phase
   e. Frequency: 60 Hertz
   f. Taps: 2 - 2.5% up and 2 - 2.5% down
3. Provide a transformer designed for:
   a. Continuous operation at rated KVA, 24 hours a day, 365 days a year.
   b. Required performance must be obtained without exceeding an 80° C temperature rise.
   c. 150° C average temperature rise by resistance or 180° C hot spot temperature rise in a 40° C maximum ambient and 30° C average ambient.
   d. Maximum coil hot spot temperature shall not exceed 220° C.
4. Transformer shall be equipped with high grade iron laminated core and solid copper cores and windings. Separate the ground connection to the enclosure in order to insure the laminations are insulated from the enclosure except through a single point ground.
5. Provide a mounting support for the transformer to raise the transformer above grade. The support shall be made from stainless steel plates and angles. Coordinate the size of the transformer with the size of the roof available space. Coordinate the supports with the roof existing design and layout.
6. The transformer shall be Hammond Power Solution Catalog Number MG3A0075RKSCHC0 or approved equal.
7. The contractor shall provide a dedicated ground rod system to ground the utility ground wire. The ground wire shall be connected in accordance with Section Grounding.

H. CIRCUIT BREAKER DISCONNECT SWITCH

1. The new service circuit breaker disconnect shall be listed for a service disconnect switch. Trip rating shall be as indicated on the plans. The circuit breaker shall meet all local code, utility, and NEC requirements for a service disconnect. The circuit breaker shall be rated for 42 KAIC short circuit interrupting capability. The service disconnect shall be installed in a NEMA-4X, stainless steel 316 enclosure equipped with a space heater. The interior mechanism, back pan and springs shall be stainless steel. The disconnect enclosure handle shall be lockable in the 'off' position. The disconnect shall be located where shown on the plans. An approved nameplate shall be installed on the enclosure indicating the devices function.

I. AUTOMATIC TRANSFER SWITCH

1. Furnish and install an automatic transfer switch in a NEMA-4X rated enclosure. The automatic transfer switch shall conform to the requirements of the following codes and standards:
   a. UL 1008 - Standard for Transfer Switch Equipment
   b. IEC 947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching EquipmentEN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
   c. NFPA 70 - National Electrical Code
   d. NFPA 99 - Essential Electrical Systems for Health Care Facilities
   e. NFPA 110 - Emergency and Standby Power Systems
   f. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
   g. NEMA Standard ICS 10-2005, Electromechanical AC Transfer Switch Equipment.
   h. EN61000-4-4 Fast Transient Immunity Severity Level 4
   i. EN61000-4-5 Surge Immunity Class 4 (voltage sensing and programmable inputs only)
   j. IEEE 472 (ANSI C37.90A) Ring Wave Test
   k. IEC Specifications for EMI/EMC Immunity (CISPR 11, IEC 1000-4-2, IEC 1000-4-3, IEC 1000-4-4, IEC 1000-4-5, IEC 1000-4-6, IEC 1000-4-8, IEC 1000-4-11)
   l. CSA C22.2 No. 178 certification
2. The switch shall be suitable for a transfer of all connected loads and shall be rated for all classes of loads. It shall be mechanically held, electrically operated type and rated for continuous duty. The switch shall be double-throw, operated by a single operator mechanism momentarily energized, and interlocked mechanically and electrically. The failure of any coil or disarrangement of any part shall not permit a sustained neutral position. The switch shall be positively locked mechanically on one source or the other without the use of hooks, latches, semi-permanent magnets or springs. Operating current for transfer shall be obtained from the source to which the load is being transferred. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. The switch shall be provided with front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
3. A control module shall be supplied with a protective cover and be mounted on the front of the ATS. Sensing and control logic shall be solid-state and mounted on plug-in printed circuit boards. Printed circuit board shall be keyed to prevent incorrect installation. Interfacing relays shall be industrial-control-grade, plug-in type with dust covers and locking clips. The control module shall provide all necessary sensing, timing and control functions necessary to achieve the defined

automatic transfer of sources. The microprocessor-based control module shall include a panel mounted keypad and a four-line LCD display. The control module shall be provided complete with communications capability and appropriate communications protocol to allow it to communicate with the PLC and the standby generator control panel for both status and control as indicated herein and on the Contract Drawings and as approved by the Engineer. The control module shall be of ASCO Series 300 power technologies manufacture or Engineer approved equal.

4. The switch shall be configured to automatically transfer the load circuit from the utility power source to the standby generator source when any phase of the utility power source drops below 85% and shall automatically retransfer the load circuit to the utility power source when all phases are restored to 90% or more of rated voltage for a defined period of time. Transfer to standby generator shall not occur until standby generator voltage is 90% and frequency is 57Hz or higher. The automatic transfer switch shall be rated to withstand the rms symmetrical short circuit current available at the automatic transfer switch terminals (65kA).
5. The switch, unless otherwise specified herein or as approved by the Engineer, shall be furnished with factory wired components according to the manufacturer's standards the switch shall include the following basic control function:
6. Full phase sensing of utility voltage with adjustable setting. Factory set to drop out at 85% and picking up at 90%.
7. Adjustable time delay of 1/2 to 6 seconds on engine start to override momentary voltage dips.
8. Engine starting contacts to close after the ½ to 6 second delay specified above.
9. Switch shall include a time delay to ignore momentary outages. It shall delay closing of the engine start contacts for a fixed time of 3 second.
10. Adjustable time delay on transfer to standby generator, 6-60 seconds.
11. Voltage-frequency sensitive relay to lock-out transfer from utility to standby generator source until the generator output is up to 90% of voltage and 57Hz adjustable.
12. Gold plated contacts rated 10 amps, 32 volts DC which close when the utility source fails shall be provided to initiate engine starting.
13. Adjustable time relay of 1 to 30 minutes on retransfer of load from standby generator to utility source after restoration of utility power with adjustable unloaded generator running time of 0-5 minutes. The time delay shall be automatically bypassed if the standby generator
14. source fails and the utility source is available.
15. Test switch function shall be provided to simulate utility power failure, momentary type.
16. Auxiliary contacts on main shaft or operator 1-NO and 1-NC.
17. Automatic exerciser with load/NO load selector.
18. Switch position indicator lights, utility and standby generator.
19. The ATS shall be rated to close on and withstand the available 65,000 amp RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection indicated on the contract drawings.
20. The ATS shall be UL listed in accordance with UL 1008 and be labelled in accordance with that standard's 1-1/2 and 3 cycle, long-time rating.

21. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
22. The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number of the switch. No exceptions to the specifications, other than those stipulated at the time of submittal, shall be included in the certification.
23. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, and installation and servicing in accordance with ISO 9001.
24. The automatic transfer switch shall be rated 600 volt, 3-phase, and Ampacity as shown on the Contract Drawings, and be of ASCO power technologies their 300 series power transfer switch or Engineer approved equal.

J. GENERATOR

1. The generator shall be rated for continuous standby service at 60 KW, rating as shown on the Contract Drawings, at 0.8 Power factor, 480 volts, three phase, four wire, 60 hertz, and 1800 rpm and shall be furnished complete with equipment that meets the following requirements:
   a. The generator shall be a three-phase, single bearing synchronous type built to NEMA Standards. Class F insulation shall be used on the stator and rotor, and no materials which will support fungus growth shall be used.
   b. The generator shall be limited to a maximum temperature rise of 105 Degrees C at 40 Degrees C ambient at full rated kW output and be capable of one-step loading of 50 kW as required by NFPA-110.
   c. A standby generator mounted digital control panel shall be furnished to control the generator. The digital generator control unit shall be microprocessor based and provide generator set monitoring, metering and control. The control shall provide an operator interface with the standby generator, digital voltage regulation, digital speed governing and generator protective relaying functions in one single digital standby generator control system. The digital standby generator control system shall be furnished complete with the following functionality:
   d. Engine Speed Control Governor: Isochronous frequency control. The governor shall be arranged to directly control the engine fuel control valve. The isochronous governor shall control the engine speed within plus or minus 0.25% for any steady state load from no load to full load. Frequency drift shall not exceed plus or minus 0.5% for a 33 Degree C change in ambient temperature over an 8 hour period.
   e. Temperature Dynamic Control (TDC): Shall have the ability to modify the engine fuel system (governing) control parameters as a function of engine temperature. TDC shall be implemented to make the engine more responsive when warm and more stable when operating at lower temperature levels.

f. Smart Idle Mode: Engine governing shall have the capability of regulating at an idle speed for a programmed period following an automatic or manual stop of the engine. In an automatic mode, the control shall bypass the idle operating period if the generator was operating at low load prior to shut down for sufficient duration for engine cool down. During smart idle the engine protective functions shall be adjusted for lower engine speed and alternator protective functions disabled. In addition to automatic functioning, idle speed shall be capable of being operated by the bridge operator when the standby generator set is operating in the manual mode such as during load testing with the herein specified load bank.

g. Digital Voltage Regulation: Digital voltage regulation shall consist of an integrated 3-phase line to neutral voltage sensing and regulation that can be used with either shunt or PMG type excitation. The voltage regulator shall be full wave rectified with PWM output to assure good motor starting capability and stability when powering non-linear loads.

h. The voltage regulation system shall be capable of regulating the generator output voltage to within 0.5% for any load between no load and full load. Voltage drift shall not exceed plus or minus 0.5% for a 33Degree C change in ambient temperature over an 8 hour period. On engine start or sudden load application, voltage shall be controlled to a maximum of 5% overshoot over normal level.

i. The regulator shall be capable of regulating the output current of any phase to a maximum of three times rated current under fault conditions for both single phase and three phase faults for motor starting and short circuit coordination purposes.

j. Standby Generator Set Alarm, Monitoring, Control and Protection: The standby generator control system shall provide the following functionality:
   - Alternator overcurrent protection
   - Analog and digital metering
   - Battery status monitoring and alarm
   - Digital alarm and status message displays
   - Monitoring and display status of all critical engine and generator functions
   - Advanced serviceability indication using PC based software service tool

k. Inputs/Outputs: The standby generator control system shall be provided with hardwired inputs and outputs as shown on the plans.

l. Suitability and Certifications: The standby generator control system shall be suitable for use with the specified standby generator that shall have been designed, manufactured, tested and certified to relevant UL, ISO, IEC and CSA standards and be of Cummins Power Generation manufacture or Engineers approved equal.

m. Generator shall be equipped with an extension terminal box for connection of output power leads and sized to accept the feeder cables.

2. Standby Generator Acoustic Enclosure: The standby generator shall be housed in an acoustic enclosure to minimize noise to the surrounding area. The housing shall be of sheet steel construction that shall be pre-treated and polyester coated. The internal of the housing shall be furnished complete with the following features:

a. The interior walls of the enclosure shall be covered with fire-retardant polyurethane foam to minimize the noise from the engine.
b. Enclosure door operated lighting shall be provided in each compartment for maintenance and inspection of the engine, generator and electrical power and control equipment. The lighting shall be of the fluorescent type and provide average illumination level of 200 lx.
c. Anti-condensation heaters and thermostats shall be provided in the enclosure to prevent condensation.
d. Two (2) duplex receptacles shall be located inside the enclosure for maintenance purposes and be located as approved by the Engineer.
e. The enclosure shall be provided with control panel and generator cut outs.
f. Emergency stop pushbutton shall be located on the outside of the enclosure.
g. The exhaust tailpipe when transitioning the wall of the enclosure shall be provided with an air gap between the exhaust pipe and the enclosure wall.
h. The enclosure construction shall be provided with lifting points to lift the enclosure complete with the exhaust muffler or other installed components attached to the enclosure.

3. Cooling System: The standby generator cooling system shall consist of a skid mounted radiator and associated fan.
   a. The expansion tank of the radiator shall be fitted with a low water level switch and be wired into the safety shutdown system for the standby generator.
   b. The engine cooling system shall be pre-treated by the engine supplier with an approved antifreeze, with rust inhibitor added, in accordance with the manufacture's requirements.
4. Standby Generator Day Tank Fuel System: The standby generator shall be equipped with an in-base double walled fuel day tank. The manufacturer of the tank shall have a minimum of ten year's experience in the design and construction of UL-142 listed in-base tank systems. The tank shall be constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; the Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and Standby Power Systems, NFPA 110. The day fuel system shall be furnished complete with equipment and meet the following requirements:
   a. The in-base tank shall be rectangular and include a reinforced steel box channel for generator support and have length and width dimensions compatible with the specified and proposed generator.
   b. Normal venting shall be provided in accordance with the requirements of the American Petroleum Institute Standard No.2000 for venting atmospheric and low pressure storage tanks. The tank shall be provided with atmospheric (normal) vent cap with screen.
   c. Emergency venting shall be provided and sized to accommodate the total capacity of both normal and emergency vents and be not less than that derived from NFPA 30, Table 2-8, based on wetted surface area of the tank (calculated based on 100% of the inner tank). A zinc plated emergency pressure relief vent cap shall be installed on the tank. The vent shall be spring pressure operated. The vent cap shall start opening at a pressure of 3.45 kPa and a full opening pressure of 17.25 kPa.

d. The fuel tank shall be fitted with a low and high fuel level alarm with contacts for annunciation with the generator control panel.
e. In addition to the standard fuel filters provided by the engine manufacturer, a primary fuel filter/water separator shall also be installed in the fuel inlet line to the engine. The filter shall be as required for proper fuel flow. Capped fuel supply and return piping connection shall be provided outside generator enclosure.

5. Standby Generator Fuel Supply Tank and System: A fuel supply tank shall be furnished and installed at in the standby generator compound to serve the standby generator. The supply tank shall be double walled fuel tank. The manufacturer of the tank shall have a minimum of ten year's experience in the design and construction of UL-2085 listed supply diesel fuel tank systems. The tank shall be constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; the Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and Standby Power Systems, NFPA 110. The tank and all associated equipment, fittings and piping shall be in accordance with the requirements of UL-2085 Listed Fireguard Main Tank. The tank shall be UL listed fire rated protected design featuring lightweight thermal insulation and be constructed of heavy gauge stainless steel with a welded stainless steel containment basin. The supply fuel system shall be furnished complete with equipment and meet the following requirements:
   a. The supply tank shall be coated with an Engineer approved rust inhibitor inside, primed and finish painted outside.
   b. The tank shall be provided complete with all required, necessary and Code compliant tank fittings, fuel and vent lines, sight gauge for the proper performance and operation of the fuel supply tank.
   c. The fuel containment basin shall be welded steel and sized at a minimum of 150% of the tank capacity to prevent the escape of fuel into the environment in the event of a tank rupture.
   d. An Engineer approved fuel containment basin leak detection switch shall be provided and wired into the generator control system to alarm a tank rupture.
   e. Normal venting shall be provided in accordance with the requirements of the American Petroleum Institute Standard No.2000 for venting atmospheric and low pressure storage tanks. The tank shall be provided with atmospheric (normal) vent cap with screen.
   f. Emergency venting shall be provided and sized to accommodate the total capacity of both normal and emergency vents and be not less than that derived from NFPA 30, Table 2-8, based on wetted surface area of the tank (calculated based on 100% of the inner tank). A zinc plated emergency pressure relief vent cap shall be installed on the tank. The vent shall be spring pressure operated. The vent cap shall start opening at a pressure of 3.45 kPa and a full opening pressure of 17.25 kPa.
   g. Fuel filter/water separator in the fuel outlet line shall be installed.
   h. The supply fuel system shall be provided complete with an oil fuel pump and associated controls to automatically pump and control the level of fuel in the standby generator in-base day fuel tank. The fuel pump control system shall

consist of a microprocessor based unit housed in a NEMA 4X enclosure and located in close proximity to the fuel tank as indicated on the Contract Drawings. The fuel pump control system shall be provided with the following equipment and functionality:

i. A fuel level transducer that provides an LED fuel level indication
j. A high level warning alarm
k. Low level warning alarm
l. Critical low level alarm and shut off.
m. Fuel in basin alarm
n. Pump controls (start pump at day tank 60% of capacity and stop at 100% of capacity)
o. Provide controls points to the PLC as shown on the contract plans.
p. The pump control system shall be provided with an Auto-Off-Manual switch and Start/Stop pushbuttons and shall conform in all respects to the requirements of UL-508 and be suitable for 120 volt, single phase, 60 Hz operation.
q. The fuel supply tank shall be provided with a fuel oil pump sized to pump fuel oil from the supply tank to the in-base standby generator day tank in the standby generator compound.

6. Exhaust Silencer: A critical type silencer and flexible stainless steel exhaust shall be furnished and installed according to the manufacturer's recommendation inside the standby generator acoustic housing to minimize overall noise from the operating standby generator. Mounting of the exhaust system shall be provided by the standby generator manufacturer and the exhaust silencer shall form an integral part of the overall packaged standby generator. The silencer shall be mounted so that its weight is not supported by the engine nor will forces due to exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer. So called "spiral" or truck silencers are disallowed and will not be considered.
7. The silencer shall be fitted with a tail pipe extension terminating in the horizontal plane as indicated on the Contract Drawings and at a 45 degree angle and flap cap to prevent the entrance of rainwater. It shall also be fitted with an expanded metal bird screen. The Contractor shall submit calculations of his proposed exhaust system that includes the effect of the required tail piping as described on the Contract Drawings.
8. Jacket Water Heater: A unit mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 32 Degrees Celsius. The heater shall be powered from 120 volts, single phase, 60 hertz supply.
9. Engine Block Heater: An engine block heater incorporating a thermostatic control shall be furnished to maintain engine at 32 Degrees Celsius. The heater shall be powered from 120 volts, single phase, 60 hertz supply.
10. Supply Fuel Tank Heater: A unit mounted supply fuel tank heater incorporating a thermostatic control shall be furnished to maintain fuel oil to 32 Degrees Celsius. The heater shall be powered from 120 volts, single phase, 60 hertz supply.

11. Batteries: Lead-acid storage batteries of the heavy duty diesel starting sealed "maintenance free" type shall be provided. Battery size shall be determined by the engine manufacturer, and shall be rated no less than that required for five consecutive starting cycles from cold under the most severe ambient temperature (-18 Degree C) without charging.
12. Battery Tray: The batteries shall be mounted in a battery tray. It shall be constructed of steel and so treated as to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over of battery electrolyte shall be contained within the tray to prevent a direct path to the ground.
13. Battery Charger: A current limiting, automatic DC charger shall be furnished to automatically recharge batteries. The battery charger shall include; overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase, 60Hz. The charger shall be sized to recharge the battery bank in no less than 8 hours from a fully discharged state while providing control power for the system. Charger shall be housed in a NEMA 1 enclosure and be U.L. Listed as an industrial control panel. The charger shall be as manufactured in compliance with the requirements of NFPA 110 and U.L. 508. The charger shall be mounted and wired within the enclosure of the generator set.
14. Generator Main Breaker: The generator main breaker shall be mounted within the standby generator enclosure or at the MCC. If the main breaker is located within the MCC, then a local disconnect or circuit breaker shall be provided for maintenance and isolation of equipment locally. The main breaker shall be a moulded case circuit breaker. The breaker shall have a frame size of 100 amps, 42kAIC, and be installed as a load circuit interrupting and protection device. It shall operate both manually and provide overload and short circuit protection. The trip unit of each pole shall be furnished with elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriters Laboratories, and National Electric Manufacturers Association. The circuit breaker shall be equipped with rear copper stabs and load cable lugs.

K. SUPPORTS AND CONCRETE PADS

1. The contractor shall furnish all supports as required to securely mount the generator to the roof portion of the control house in accordance with the manufacturers recommendations.

L. HEATERS

1. Provide a space heater in all boxes located outside of temperature controlled rooms. Space heaters shall be heavy duty, thermostat controlled, rated for 120VAC. All boxes shall be sized to accommodate the equipment. The heater shall be provided to prevent condensation.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. The Contractor shall submit in detail the proposed procedures and methods for the installation of the service equipment.
3. The Contractor shall prepare and submit the following working drawings and catalog cuts:
   a. Catalog cuts, certified dimensioned prints, and a complete material list for all equipment.
   b. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.
   c. Submit mounting details for all equipment, boxes, and raceway. Mounting details shall show all equipment required to support the equipment.
   d. Submit all test results.
   e. Submit all copies of all correspondence and authorizations from the Utility.
   f. Complete, detailed installation methods and procedures. The procedures shall include coordination of transfer of service form the old service to the new service, scheduling the Utility service, methods, and complete the installation.

B. UTILITY WORK

1. All work shall be done in accordance with the utility requirements and specifications.

C. SCHEDULING

1. The Contractor shall schedule all utility work with the sequence of construction. It is brought to the Contractor's attention that once the service is upgraded, the existing equipment can no longer operate.

D. MOUNTING SUPPORTS

1. Install the generator to the roof as shown on the plans. Care shall be taken to ensure all roofing material is protected and not damaged during construction. The work shall ensure the roof remains water tight and drains properly, with no water pooling.

4.0 MEASUREMENT AND PAYMENT

Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator*.

Payment will be made under:

Pay Item	**Pay Unit**
Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator	Lump Sum

ELECTRICAL DEMOLITION (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

This work consists of a complete demolition of the existing bridge electrical system in the control house and pivot pier, excepting the roadway equipment, pivot pier span navigation lights, and pivot pier span rotary cam limit switch, called out to be refurbished or reused. Demolition work includes the disconnection and/or removal and disposal of equipment. Equipment to be demolished shall include, but shall not be limited to, all control house and pivot pier electrical junction boxes, pull boxes, conduit and wire, control panels, control desk, lights, receptacles, motors, brakes, generator, navigation lights, submarine cables to pivot pier, service equipment, and supports for all existing electrical equipment removed. Conduit and wire to the nearside roadway equipment from the control house shall be demolished. Conduit and wire between the far side submarine terminal cabinet and the far side roadway equipment shall be demolished.

B. RELATED WORK

1. Summary of Work
2. Electrical Refurbishment

2.0 MATERIALS

The Contractor shall supply all tools and equipment required to remove the existing electrical equipment in a safe and secure manner.

3.0 CONSTRUCTION METHODS

A. FIELD VERIFICATION

1. The Contractor shall be fully responsible for performing field inspections and surveys to determine the complete extent of the existing equipment to be demolished.

B. SUBMITTALS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. The Contractor shall submit in detail the proposed procedures and methods for the demolition of the equipment.

3. The Contractor shall prepare and submit the following working drawings and catalog cuts:
   a. A complete schedule of the equipment demolition, including the scheduled demolition of medium voltage equipment, electrical service, power distribution and control equipment, scheduled demolition of navigation lights, and scheduled demolition of other electrical equipment.

C. DEMOLITION

1. The demolition work at the existing bridge under this subsection shall be done in conformance with all requirements governing the sequencing and scheduling of construction. Demolition of electrical equipment shall not commence until all new equipment and parts to be installed are delivered to the site or an approved storage facility unless otherwise approved by the Engineer. Special attention is called to coordination requirements.
2. The electrical equipment to be demolished and disposed of off State Right-of-Way at an approved disposal site shall include, but is not limited to:
   a. Control House: exposed panels, control desk, indicators, conduit, wire, lights, receptacles, and all other electrical equipment.
   b. Pivot Pier: motors, brakes, drag cable, conduit, wire, all electrical equipment except the rotary cam limit switches (for the span and the wedge operation) and span navigation lights.
   c. Roadway: The roadway equipment shall not be demolished, but refurbished and integrated into the new control system. All conduit and wiring shall be demolished between the control house and the equipment, and between the far side submarine cable terminal cabinet. The demolition of the existing controls and power shall be up to the Main Terminal Panel, but the equipment shall be existing after that point to the roadway equipment.
   d. Submarine Cable to Pivot Pier and Drag Cable: Cables, submarine cable terminal cabinets, drag cables, supports, conduit, wire and all other electrical equipment.
   e. River Channel: Fender navigation lights, conduit, wire and all other electrical equipment.
3. The following materials and equipment from the Alligator River Bridge will be salvaged and delivered to the Contracting Agency:
   a. Existing Generator
   b. Existing ATS
   c. The North Carolina Department of Transportation shall identify any additional equipment to be salvaged or any historically important relevant equipment to be salvaged.

   All salvaged equipment shall be delivered to the Creswell Bridge Yard. The address is 14183 NC Hwy 94 N, Creswell, NC 27928. The contact number is 252-797-4468. The Contractor shall contact the Creswell Bridge Yard and only deliver material at agreed upon times.
4. The contractor will notify the Contracting Agency at least 14 days prior to beginning any salvage work.

5. All remaining materials and equipment demolished under this item shall become the property of the Contractor, and shall be removed from the site and disposed of properly.
6. In general, all apparatus to be demolished shall be disconnected by removing existing bolts, nuts and screws. The work shall include demolition of all brackets, hangers, clamps, fittings and other hardware no longer needed.
7. Embedded conduits that are not to be reused shall be demolished level flush with the concrete. The conduits shall then be cleared of any debris and abandoned in place. Provide a cover on both ends of all abandoned conduits and embedded conduit shall be filled with grout.
8. It is brought to the Contractor's attention that there are requirements in Section Electrical Summary of Work for the requirements in maintaining navigation warning lights at all times. Coordinate demolition of this item with the installation of temporary navigation lights.
9. It is brought to the Contractor's attention that it is the Contractor's responsibility to maintain power to the bridge for operating purposes. The Contractor shall maintain the existing Utility service, or the service generation, or a portable generator until the new service equipment and distribution equipment is completed. Then the Contractor shall utilize the new service. The Contractor shall provide temporary power as required.
10. The equipment to remain in place on the bridge shall be protected at all times from damage or defacement caused by the Contractor's operations. Any such damage or defacement shall be promptly repaired or cleaned to the satisfaction of the Engineer at no extra cost. If, in the opinion of the Engineer, the Contractor's operations require the temporary removal of existing equipment for proper protection, such removal and remounting shall be done at no extra cost.
11. Fire protection is required in areas where welding or flame cutting will be performed. All areas shall be dust free before flame cutting will be permitted. Furnish protective blankets to protect combustible materials. Furnish and install dry chemical fire extinguishers and train personnel in their use.
12. Upon completion of the work, the Contractor shall repair all damaged or defaced areas exposed by the demolition of equipment, or caused by his operations, in a workmanlike manner satisfactory to the Engineer. The Contractor shall patch any concrete that was cut for removal of equipment. Small bolt holes in concrete surfaces shall be filled with epoxy mortar. Holes in the walls, ceilings or floors of the house shall be filled with grout and finished to match the existing surfaces. Any damage to windows, window framing, sash, sills, frames or any other architectural trim shall be repaired, and painted surfaces shall be repainted after being repaired. Any holes in the ground shall be filled with earth top soil and suitably landscaped to match the surrounding areas. Touch-up painting of structural steel shall be performed under another item.

D. SUBMARINE CABLE DEMOLITION

1. The existing submarine cable to the pivot pier shall be cut at the low tide waterline and the submarine cable below the water line The cable shall be abandoned in place at the near pier. The submarine cable shall be removed from the pivot pier core drilled access to install the new cable to the pivot pier. The sequence of demolition

shall be coordinated with appropriate utility companies to protect and maintain their facilities.

4.0 MEASUREMENT AND PAYMENT

Electrical Demolition will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Electrical Demolition*.

Payment will be made under:

Pay Item	**Pay Unit**
Electrical Demolition	Lump Sum

ELECTRICAL REFURBISHING (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

1. This work consists of the refurbishing necessary to maintain, protect, and rehabilitate the equipment to remain in service.
2. The equipment to be refurbished and integrated in the new power and control system is as follows:
   Roadway Equipment:
   a. Four (4) Traffic Warning Gates
   b. Two (2) Traffic Barrier Gates
   c. Two (2) Gongs
   d. One (1) Flashing Light 'Draw Bridge Ahead Sign'
   e. Two (2) Red-Yellow-Green Traffic Signal Poles with Mast Arms and Lights

   Span/Pivot Pier Equipment:
   a. Four (4) Span Navigation Red/Green Lights
   b. Ten (10) Fender Solar/Battery Powered Red Navigation Lights
   c. Rotary Cam Limit Switch for Span Position

   Far Side Equipment:
   a. Far Side Submarine Cabinet

B. RELATED WORK

1. Summary of Work
2. Electrical Demolition
3. Raceway
4. Wire and Cable

5. Grounding
6. Motor Control Center
7. Bridge Control System

C. SUBMITTALS

1. Submit all materials in accordance with Section Electrical Summary of Work.

D. CONTROL SYSTEM VENDOR

1. This item shall be coordinated with the equipment supplied by the control system vendor.

2.0 MATERIALS

Material used to refurbish the indicated equipment shall be compatible with the existing material and manufacturer and new as far as practicable.

The equipment to be refurbished and integrated in the new power and control system is as follows:

A. ROADWAY EQUIPMENT:

1. Four (4) Traffic Warning Gates
   a. Reconnect the motor to operate at 480VAC. Rewire the equipment in the gate to provide the PLC inputs/outputs shown on the contract plans. Adjust the cam settings to match the contract plans. Clean and furnish and install a new gasket to the gate. Rewire the 120VAC equipment to be powered from the new lighting panel as shown on the plans.
   b. Replace or provide new door switches and hand crank limit switches with new B&B Roadway approved equipment. Wire the equipment as shown on the plans.
2. Two (2) Traffic Barrier Gates
   a. The near barrier gate existing motor drive is a soft starter and the far side motor is controlled by a two speed contactor. Replace the existing motors with new 480VAC motors and the existing motor controllers with a new 480VAC VFD drive and all associated required equipment as shown on the plans. The new VFD drives and motors shall be in accordance with the gate manufacturer's recommendation for proper gate operation. Replace the existing back panel in accordance with the manufacturer's recommendation. Mount all new relays, contactors, flashers, drive, terminal blocks and all existing equipment on the new back panel.
   b. Adjust the cam settings to match the contract plans. Clean and furnish and install a new gasket to the gate. Rewire the equipment in the gate to provide the PLC inputs/outputs shown on the contract plans. Rewire the 120VAC equipment to be powered from the new lighting panel as shown on the plans. Seal and secure the gate enclosures to be watertight and sealed. Clean and lubricate the gate equipment as needed.
   c. Replace or provide new door switches and hand crank limit switches with new B&B Roadway approved equipment. Wire the equipment as shown on the plans.

d. The work shall be coordinated with the mechanical work to replace the barrier gate wheel and modify the concrete and roadway adjacent to the gate.

3. Two (2) Gongs
   a. Rewire the gongs to the new power and control wiring on the contract plans. Clean and seal the gong equipment as needed.
4. One (1) Flashing Light 'Draw Bridge Ahead Sign'
   a. Rewire the lights to the new power and control wiring on the contract plans. Clean and seal the lights as needed.
5. Two (2) Red-Yellow-Green Traffic Signal Poles with Mast Arms and Lights
   a. Rewire the lights to the new power and control wiring on the contract plans. Clean and seal the lights as needed.
6. Replace the drive roller chains, drive sprocket, drive wheel sprocket, and drive wheels on each barrier gate.

B. SPAN/PIVOT PIER EQUIPMENT

1. Four (4) Span Navigation Red/Green Lights
   a. Rewire the lights to the new power and control wiring on the contract plans. Clean and seal the lights as needed.
2. Ten (10) Fender Solar/Battery Powered Red Navigation Lights
   a. Clean and seal the lights as needed.
3. Rotary Cam Limit Switch for Span Position
   a. Rewire and adjust the cam settings to match new power and control wiring on the contract plans. Provide all work required to attach the new position transmitter to match new power and control wiring on the contract plans. Clean and furnish and install a new gasket to the enclosure. Furnish and install a new nameplate to the switch.

C. FAR SIDE SUBMARINE CABINET

1. Four (4) Span Navigation Red/Green Lights
   a. Clean and seal enclosure.Provide new fittings to provide watertight seals on all existing penetrations. Coordinate work with the new conduit and wire to the gates and roadway equipment.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. The Contractor shall submit in detail the proposed procedures and methods for the refurbishing of the equipment. Working drawings shall be included with the procedures and methods.
3. The Contractor shall prepare and submit the following working drawings and catalog cuts for all new components used:
   a. Catalog cuts, certified dimensioned prints, and a complete material list for all equipment, splice kits, gaskets, and electrical equipment.
   b. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction

boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.

c. Submit mounting details for all equipment, boxes, and raceway. Mounting details shall show all equipment required to support the equipment.

4. Mounting details for connections to the existing structural steel shall be detailed to show the bolt location on the existing structure. Existing rivets shall be removed and replaced with bolts in order to mount all new conduits. Each mounting location shall be detailed and submitted to the Engineer for approval. Submittals showing the locations for the rivets to be removed shall be prepared as part of the Submittals. Submittals showing the procedure for removing the existing rivets shall be submitted to the Engineer. No work shall commence in the field until all locations and procedures are approved by the Engineer.

B. REFURBISHMENT

1. The equipment to remain in place on the bridge shall be protected at all times from damage or defacement caused by the Contractor's operations. Any such damage or defacement shall be promptly repaired or cleaned to the satisfaction of the Engineer at no extra cost. If, in the opinion of the Engineer, the Contractor's operations require the temporary removal of existing equipment for proper protection, such removal and remounting shall be done at no extra cost.
2. Verify all equipment is electrically bonded to the ground wire, and furnish and install all wire and lugs to the equipment to ground the equipment if it is not grounded.

4.0 MEASUREMENT AND PAYMENT

Electrical Refurbishing will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Electrical Refurbishing*.

Payment will be made under:

Pay Item	**Pay Unit**
Electrical Refurbishing	Lump Sum

RACEWAY (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish all material and equipment necessary to install a complete raceway system in accordance with the Plans and these Special Provisions. Furnish and install terminal

blocks when required, according to these Special Provisions, whether specifically shown on the plans or not.

B. RELATED WORK

1. Summary of Work
2. Field Measuring
3. Start Up and Commissioning
4. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
5. Electrical Refurbishment
6. Wire and Cable
7. Submarine Cable
8. Junction and Pull Boxes
9. Switches and Receptacles
10. Disconnect Switches
11. Grounding
12. Panelboard
13. Motor Control Center
14. Lighting

C. QUALITY ASSURANCE

1. All raceway shall be the product of one supplier.
2. All raceway shall be UL listed and labeled.
3. All raceway shall be delivered and stored with protective end caps to prevent damage to the threads and the entrance of foreign materials prior to installation.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

1. In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:
   a. Institute of Electrical and Electronic Engineers
   b. International Cable Engineers Association (ICEA)
   c. Life Safety Code (NFPA 101)
   d. National Electric Safety Code
   e. National Electrical Manufacturers Association (NEMA)
   f. National Fire Protection Agency 70 National Electric Code (NEC)
   g. American Association of State Highway and Transportation Officials (AASHTO)
2. Conduit and Fittings
   a. Conduit shall be hot dipped galvanized rigid metal conduit type RMC or liquidtight flexible metallic type LFMC as shown on the Contract Plans. Conduit shall be the minimum size of ¾ inch. Conduit connections to equipment that requires a smaller size conduit connection shall be routed to a junction terminal box within 18 inches of the equipment and transitioned to ¾ inch conduit or larger at the box.

b. Rigid metal conduit bodies, where permitted, shall consist of malleable iron, hot-dip galvanized castings with gasketed covers of the same material, and fastened with brass or stainless steel cover screws.
c. Conduit drain fittings shall be located at all low points in the conduit runs and shall be field determined. Conduit drain fittings shall be of stainless steel and shall be capable of passing 25 cc of water per minute.
d. At any point where a conduit crosses an expansion joint longitudinally, or where movement between adjacent sections of conduit can be expected, conduit expansion fittings shall be installed. The fittings shall be bronze expansion fittings, and shall be provided with flexible bonding jumpers to maintain the electrical continuity across the joints. The fittings shall permit a total conduit movement of plus/minus 2-inches in either linear direction.
e. At any point where a conduit crosses a joint laterally, or where an offsetting type movement between adjacent sections of conduits can be expected, expansion and deflection fittings shall be installed. The fittings shall permit a movement of ½ inch from the normal in any direction.
f. Conduit hubs for making connections to boxes or enclosures shall be malleable iron, hot-dip galvanized hubs providing watertight connections. Conduit hubs to be used with any stainless steel enclosure shall be stainless steel.
g. Insulated bushings shall be provided for the ends of all conduits projecting into boxes and equipment enclosures. Insulated bushings shall be malleable iron or bronze insulated grounding bushings. The insulated portion shall be of molded phenolic compound, and each fitting shall have a screw type combination lug for bonding and grounding.
h. Conduit sealing bushings shall be used where required to provide a seal between SOW-A cords and conduits. The fittings shall be constructed as follows: Thick steel disks and a neoprene sealing ring shall be factory drilled to accommodate the cables, and the disks shall be PVC coated after fabrication. Stainless steel hardware shall compress the two disks against the neoprene sealing ring. The sealing assembly shall be affixed to the end of the conduit with a malleable iron hot dip galvanized threaded locking collar. The collar shall be provided with gaskets to ensure a complete seal.
i. When terminating from rigid metal conduit to any equipment whose position may have to be regularly adjusted shall use flexible conduit. Flexible conduit shall be PVC coated, flexible, metallic, liquid-tight conduit. Connectors for rigid to flexible conduit shall be malleable iron or steel, hot-dip galvanized.

3. Wiring Trough
   a. This section is provided to allow the Contractor the option of providing wiring trough in lieu of RGS conduit. The Contractor is not required to use trough, but if the Contractor determines that this option is more cost effective, the requirements are provided here-in.
   b. Ceiling-mounted, feed-through wiring trough shall be furnished and installed to provide for termination of conduits and cables and to distribute the wiring to the various motor control cabinets and control cabinets. Wiring trough will be fully bonded to the raceway system. The Contractor shall be responsible for any derating of conductor ampacity that require increasing the conductor sizes.

c. A drawing showing the assembly and complete construction details of the trough shall be prepared and submitted for approval before the trough is fabricated.
d. The wiring trough installed in temperature controlled areas shall be NEMA 12, constructed of No. 12 gauge sheet steel, suitably reinforced with structural steel angles, and welded continuously at all seams and joints. Wiring trough not installed in temperature controlled areas shall be NEMA-4X stainless steel. It shall have a removable cover on one side to provide access to the interior. Covers shall be secured by stainless steel screw clamps spaced no more than 8 inches apart.
e. The NEMA-12 wiring trough shall be painted inside and out with one coat of primer followed by one coat of gray or white enamel on the inside surfaces and two coats of gray enamel on the outside. The finish coat shall be ANSI 61 Light Gray.

4. Hardware and Supports
   a. Mounting bolts, nuts, washers and other detail parts used for fastening conduit clamps, conduit supports, brackets and other electrical equipment shall be of stainless steel conforming to the requirements of ASTM A593, Type 316. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers. Bolts smaller than ½ inch in diameter shall not be used except as may be necessary to fit the mounting holes in small limit switches, boxes and similar standard devices.
   b. Supports for raceway shall be fabricated from 316 stainless steel not less than ¼ inch in thickness. Channels, angles, bent plates, clip angles, other 316 stainless steel supporting members, hardware and gaskets for supporting electrical equipment shall be paid for under this item.
   c. Stainless steel brackets, boxes and other equipment mounted on concrete surfaces shall be provided with a full neoprene gasket not less than 1/8-inch thick, between the equipment and the surface of the concrete.
   d. Anchors for fastening equipment or brackets to concrete surfaces shall be epoxy resin bonded anchors.
   e. Preformed metal framing channels, such as Kindorf, Unistrut, Superstrut, etc., will not be acceptable for mounting or fastening structural supports, conduits, boxes, or other electrical equipment, except as approved by the Engineer.
   f. The use of J-bolts or beam clamps to fasten structural supports or to clamp conduits, boxes, or other electrical equipment will not be permitted.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. The Contractor shall submit in detail the proposed procedures and methods for the installation of the conduit.

3. The Contractor shall coordinate conduit installation and blocking requirements with other structural and civil work on this project in order to allow proper blocking in concrete pours.
4. The Contractor shall prepare and submit the following working drawings and catalog cuts:
   a. Catalog cuts, certified dimensioned prints, and a complete material list for all raceway equipment.
   b. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.
   c. Submit mounting details for all raceway. Mounting details shall show all equipment required to support the equipment.
   d. Mounting details for connections to the existing structural steel shall be detailed to show the bolt location on the existing structure. Existing rivets shall be removed and replaced with bolts in order to mount all new conduits. Each mounting location shall be detailed and submitted to the Engineer for approval. Submittals showing the locations for the rivets to be removed shall be prepared as part of the Submittals. Submittals showing the procedure for removing the existing rivets shall be submitted to the Engineer. No work shall commence in the field until all locations and procedures are approved by the Engineer.
   e. Submit details of all conduit penetrations through concrete. Indicate locations for the penetrations, size and quantity of conduits, and procedure for drilling through the concrete. Submit details of all blocking required for conduit penetrations through new concrete pours. No work shall commence in the field until all locations and procedures are approved by the Engineer.
   f. Submit details of all conduit penetrations through walls. Indicate locations for the penetrations, size and quantity of conduits, and procedure for drilling through the wall. Submit procedure and material to seal the penetration completely and watertight. No work shall commence in the field until all locations and procedures are approved by the Engineer.
   g. Submit locations to request approval for use of conduit bodies.
5. Layout and installation drawings for the raceway system, shall be submitted prior to pertinent structural and mechanical shop drawings so that the raceway installation details may be incorporated by the structural and mechanical fabricators and erectors.

B. CONDUIT AND FITTINGS

1. All conduit and fittings shall be carefully examined and cleaned before being installed. All conduit shall be free from blisters, cracks, deformations and defects.
2. Conduit shall be installed in accordance with the manufacturer's installation manual. The manufacturer's installation manual shall be kept on the job site and made available to the Engineer at all times.
3. Conduit lengths shall be connected to each other with approved threaded couplings assembled hand-tight and then, using strap wrenches, tightened two more turns.

Conduit runs shall be made with as few couplings as standard lengths will permit, and the total angle of all bends between any two boxes or cabinets shall not exceed two quarter bends, unless otherwise approved by the Engineer.

4. All conduit, enclosures, and fittings shall be mechanically joined and electrically bonded together to form a continuous electrical conductor to provide effective electrical continuity. An equipment ground conductor shall be provided in every conduit and enclosure throughout the raceway. Conduits shall be installed so as to be continuous and watertight between boxes and equipment. All conduits shall be pitched not less than one inch in ten feet (except by special permission) and drained to pull boxes. Conduits shall be protected at all times from the entrance of water or other foreign matter by being well-plugged overnight or when the work is temporarily suspended. Ends of abandoned conduits, spare conduits, and empty conduits and stubs shall be capped during and after construction, and care shall be taken to ensure that no moisture or other matter is in or enters the conduits.
5. Exposed conduits shall be installed parallel to, or at right angles to ceilings, walls and partitions. Where changes in direction of exposed conduit cannot be made with neat and orderly bends, pull boxes shall be used. Exposed conduits shall be securely clamped and supported at intervals not exceeding five feet in length. All boxes and fixtures shall be provided with structural supports independent of associated conduit. No boxes nor fixtures shall be cantilevered from nor supported by conduit. The conduit supports shall be as specified elsewhere under this item.
6. Watertight conduit hubs shall be provided at the ends of all conduits entering boxes and enclosures furnished with slip holes. Hubs shall be stainless steel when used in conjunction with stainless steel enclosures. Conduit entrances in sidewalk boxes shall be fastened with hubs so as to be concrete tight.
7. The ends of all conduits projecting into all boxes and enclosures shall be provided with bronze insulated grounding bushings, each bushing furnished with a screw type combination lug for bonding. All bushings in any box or enclosure shall be bonded together and to the equipment ground conductor with approved bare copper wire.
8. Pull boxes shall be used whenever necessary to facilitate the installation of the wire. Conduit bodies shall not be used for pulling conductors, for making turns in conduit runs, nor for branching conductors, unless specifically permitted by the Engineer. If the Contractor wishes to furnish and install conduit bodies, he shall request approval from the Engineer in writing as to the exact proposed locations of installation and reasons for use.
9. Expansion and deflection conduit fittings shall be installed at each expansion joint to accommodate the maximum designed structure movement. Flexible bonding jumpers shall be required to maintain bonding integrity whenever expansion fittings are required.
10. Flexible conduits for the connections between the rigid conduit system and all limit switches and other equipment subject to vibration shall be made with sections of approved flexible conduit. Approved liquid-tight connectors shall be provided for connections between rigid and flexible conduit. Each flexible, liquid-tight conduit section shall not exceed eighteen inches in length without prior approval of the Engineer.

11. All conduits shall be carefully cleaned after installation. Upon approval of the cleaning the conduit, the Contractor shall then draw in the conductors.
12. Both ends of each conduit run shall be provided with a brass tag having a number stamped thereon in accordance with the approved conduit diagrams. The tags shall be securely fastened to the conduit ends with No. 20 AWG brass wire. The numbers shall correspond to the Contractor's conduit and wire as-built drawings.

C. PENETRATIONS

1. Coordinate all locations for wall or floor penetrations with the structural development of the control house and concrete pads. All penetration locations shall be identified and submitted to the Engineer for approval. All methods and materials for core drilling through concrete and through steel shall be submitted to the Engineer for approval. No work shall commence in the field until all locations and procedures are approved by the Engineer.
2. Install conduit that stubs up through the floor or walls at such a depth that the exposed raceway is vertical and no curved section of the elbow is visible.
3. All penetrations, both wall and floor penetrations, shall be sealed and made watertight.
4. Where supports are required in existing slabs and walls use a drilled-in threaded insert, installed as recommended by the manufacturer and as approved by the Engineer. Sleeves shall be furnished and installed on all wall penetrations.

D. MOUNTING AND SUPPORTING CONDUITS

1. No conduit shall be mounted on walkways, gratings, etc. such that a tripping hazard is created. Also, conduit and boxes shall not be mounted in direct contact with structural steel or concrete. Steel stand-offs shall be furnished and installed by the Contractor for said equipment such that accumulation of debris between the structure and mounted component is minimized. A minimum of two-inches of air space shall be maintained between surface and the mounted device for outdoor installations and a minimum surrounding air space of 1/4 inch for all installations in controlled environments.
2. Bent plates, clip angles and other supporting members shall be fabricated from structural steel plates and shapes for supporting conduits and raceway.
3. No new holes shall be drilled into the structural steel. Rivets shall be replaced with bolts, as approved by the Engineer. Submittals showing the locations for the rivets to be removed shall be prepared as part of the Submittals. Bolts, accessories, and hole preparation shall be as specified in Section Electrical Summary of Work and as directed by the Engineer. Submittals showing the procedure for removing the existing rivets shall be submitted to the Engineer. No work shall commence in the field until all locations and procedures are approved by the Engineer.
4. Exposed conduits shall be securely clamped and supported at intervals not exceeding five feet in length. The conduit supports for conduit, in general, shall consist of stainless steel two-hole conduit straps, properly sized for conduit, attached to structural steel supports (bent plates or clip angles) bolted to the structural members. Each support shall be arranged so that the conduit rests upon the support and the stainless steel two-hole conduit straps secures the conduit to the steel support.

5. Exposed conduit supports on concrete surfaces shall be installed using approved anchors. Holes for the anchors shall be drilled to the size and depth recommended by the manufacturer using carbide tipped masonry drills providing six inch embedment minimum.
6. Each electrical device and enclosure shall be provided with a rigid structural steel support. No enclosure or device shall be permitted to be cantilevered from conduit unless specifically permitted by the Engineer.

E. CLEANING

1. All conduits furnished and installed by the Contractor shall be carefully cleaned after installation. The Contractor shall test for clear bore and clean each conduit by snaking each run with a steel band, to which shall be attached an approved tube cleaner equipped with a wire brush of the same diameter as the conduit and a mandrel of a diameter not less than 85% of the nominal inside diameter of the conduit.

4.0 MEASUREMENT AND PAYMENT

Raceway will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Raceway*.

Payment will be made under:

Pay Item	**Pay Unit**
Raceway	Lump Sum

WIRE AND CABLE (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish all wires, cables, terminations, and cable accessories in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Start Up and Commissioning
3. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
4. Electrical Refurbishment
5. Raceway
6. Submarine Cable and Installation
7. Junction and Pull Boxes
8. Switches and Receptacles
9. Heating Ventilation and Air Conditioning (HVAC) Unit

10. Disconnect Switches
11. Grounding
12. Dry Type Transformer
13. Motors
14. Panelboard
15. Motor Control Center
16. Lighting
17. Siren
18. Bridge Control System

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers (IEEE)
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. WIRE AND CABLE

Except where otherwise noted, wiring in conduits shall be as follows:

1. Single-conductor wire
2. Two conductor shielded cable (or twisted shielded pair)
3. Fiber Optic Cable
4. Drag Cable
5. Allen-Bradley 1786 EtherNet Cable

All wire and cable shall be of a nationally recognized brand, acceptable to the Engineer. All wire and cable shall be factory labeled or marked in the standard manner of that manufacturer, with the minimum information to identify the wire gauge and insulation type. Before wire and cable orders are placed with any manufacturer, the Contractor shall submit for approval, typical published test data for the type of insulation proposed, showing that it meets the requirements of NEMA Pub. No. WC70. Single conductor wiring, including the insulating material, shall have been factory-tested to demonstrate that it meets the specified requirements. The copies of the test reports shall indicate that the testing was performed as stipulated in NEMA Pub. No. WC70 and shall be submitted for approval.

C. SINGLE CONDUCTOR WIRE

1. All wire and cable shall conform to the requirements of NEMA Pub. No. WC70.
2. All conductors shall be soft annealed copper wire conforming to the requirements of NEMA Pub. No. WC70. All conductors shall have Class B stranding.

3. The insulation shall be a chemically cross-linked polyethylene compound conforming to the requirements of NEMA Pub. No. WC70. The conductor insulation shall be rated for 600VAC. The conductor type for all conductors except shop wiring installed within the confines of control panel enclosures shall be Type XHHW. The conductor type for all shop-wired conductors installed within the confines of the control panel enclosures shall be Type SIS.
4. Final connection to selected proximity limit switches shall be made with UL listed cable type SOOW rated –30° C to 90° C 600 volt. It shall be constructed of bunch stranded bare copper with color coded, free stripping oil resistant EPDM insulation, paper separators, non hydroscopic paper fillers and a CPE jacket. Where not factory epoxy terminated, the cables shall be supplied with a gland type strain relief connector. The connectors shall feature a neoprene grommet for moisture proof sealing and a nylon gripper. The assembled fitting shall be liquidtight/oiltight/raintight, suitable for NEMA 4X stainless steel enclosures and rated 90° C, and shall be mechanically galvanized or stainless steel.
5. High temperature connections, between drives and braking resistors, shall be made with high temperature wire, with TGGT insulation and rated for 250°C.

D. TWISTED SHIELDED CONDUCTORS

1. All twisted shielded wiring shall be multi-conductor shielded cable with an overall shield (twisted shielded pair). The shields shall be grounded in accordance with the manufacturers requirements for proper operations. The cables shall be equipped with 600VAC insulation suitable for installation in conduits with single conductor wires as specified herein. The cable shall be provided with an overall shield, PVC jacket and a #16 AWG drain wire.
2. The twisted shielded conductors for the motor encoders shall be selected to meet the manufacturer's recommendation for construction and voltage drop. They shall be routed in the corrugate pipe in the submarine cable.

E. GROUND CONDUCTORS

1. Equipment ground conductors shall be bare, stranded, coated copper conforming to the requirements of NEMA Pub. No. WC70. When required by the National Electrical Code, equipment ground conductors shall be provided with approved XHHW insulation.

F. FIBER OPTIC CABLES

1. The fiber optic cable shall be a 2 fiber heavy duty with strain relief. The fiber core clad shall be 62.5/125 Micron (Multimode). The cable construction shall be heavy duty, fibers encased in gel-filled loose buffer tubes stranded around a fiberglass epoxy (FGE) stabilization member. The stranded core shall be covered with a PVC inner jacket, surrounded by a kevlar braid. The outer jacket shall be black polyethylene. The cable shall have an attenuation of 5 dB/Km @ 850 NM and an environmental operating range of -40 °F to 176 °F. Each cable shall be equipped with two (2) fibers. The cables shall have a minimum bend radius of 8 inches during installation and 5 inches for long term.

G. DRAG CABLES

1. Drag cables shall be routed from the fixed portion of the pivot pier to the movable span.
2. Drag cables shall be multiconductor, flexible cables equipped with the number of conductors as shown on the plans.
3. All conductors shall be soft annealed copper wire conforming to the requirements of NEMA Pub. No. WC70. Flexible cable for specified connections shall be rubber insulated, multiple conductor portable cords conforming to the requirements of NEMA Pub. No. WC3, Part 7.7 or NEMA Pub. No. WC8, Part 7.4 for hard service. Each cable shall be provided with a heavy duty neoprene jacket conforming to the requirements NEMA Pub. No. WC3, Part 7.7.5.1 or NEMA Pub. No. WC8, Part 7.4.5.1. Flexible cables shall conform to the National Electrical Code, Article 400 for hard service. Flexible cables shall be provided with strain relief fittings and basket-weave cable grips at each end.

H. ALLEN-BRADLEY 1786 ETHERNET CABLE

1. EtherNet Cable shall be used for all connections between PLC communication cards.

I. WIRE TAGS

1. Wire tags for marking the conductors shall be as specified in the Standard Specifications. Each wire tag shall be permanently, mechanically printed with the wire number. No hand written tags shall be allowed.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. The Contractor shall prepare and submit the following working drawings and catalog cuts:
   a. Catalog cuts, certified dimensioned cross-sectional prints, and a complete material list for all wires, multi-cable conductors, supports, accessories, and other electrical equipment.
   b. Standard factory test results for the conductors.
   c. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.
   d. The terminal lugs catalog cuts. The crimping tool catalog cuts and calibration reports for all tools used onsite. All Allen Bradley approved tool catalog cuts and calibration reports.
   e. Written certification of calibration shall be submitted for the all test equipment. Results of all initial tests and final tests after any unacceptable results are

corrected shall be submitted to the engineer for approval. Testing requirements are specified in this Section.

B. BRIDGE WIRING

1. The size of conductors shall be as indicated in the Plans. If no size is indicated or conductor size and number as shown on the approved electrical schematics vary from that shown in the Plans, conductors of sufficient size and number shall be provided to accommodate the circuits to be installed. These conductors shall be sized in conformance with the National Electrical Code. The Contractor shall provide wiring and cables of sufficient ampacity and number as may be required for the installation in accordance with the wiring diagrams on his approved working drawings.
2. In each conduit and multi-conductor cable, at least one spare conductor shall be provided for every ten conductors (or fraction thereof) actually used.
3. Field wiring for alternating current circuits shall not be smaller than No. 12 AWG, except as specified. Field wiring requiring twisted shielded pairs shall not be smaller than No. 14 AWG. Internal shop wiring for control panels and the control stations shall not be smaller than No. 14 AWG.
4. Field wiring for direct current circuits shall not be smaller than No. 14 AWG, except as specified. Internal shop wiring for control panels and the control stations shall not be smaller than No. 14 AWG.
5. Wiring shall not be installed in any conduit before all joints are made up tightly, and the conduits rigidly secured in place. The drawing of conductors into conduits shall be done without injury to the wire, insulation or jacket. Engineer-approved lubricant may be used for the pulling of wires.
6. Sufficient slack shall be left in all cables to permit proper connections in boxes, cabinets and enclosures. Conductors inside terminal boxes, control panels, control stations and other enclosures shall be neatly formed into cables and laced with approved cable ties with the individual conductors leaving the bundled cable at their respective termination points. Each conductor shall be looped to allow not less than three inches of free conductor when disconnected from its respective terminal. The bundled cables shall be held securely away from the terminals and from contact with the enclosure by means of approved insulating supports and ties.
7. Equipment ground conductors shall be installed in all conduits and multi-conductor cables per the National Electrical Code and in all conduits.
8. Both ends of every single length of conductor shall be permanently and clearly tagged in accordance with the same numbers or designations appearing on the approved wiring diagrams.

C. TERMINATIONS

1. For all conductors No. 8 AWG and smaller:
   a. Use approved insulated pin tongue or ferrule terminal lugs shall be compressed on each end of said conductors.
   b. Terminal lugs shall be installed per lug manufacturer recommendations using a properly sized tool. The crimping tool shall provide a uniform crimping force throughout a controlled cycle with an automatic release when the desired

compression is achieved. All crimping tool shall be as approved by the manufacturer of the terminal lug.

c. The terminal lugs for all outgoing wires in terminal boxes, control panels, control stations and other enclosures shall be connected to terminal blocks specified in these Special Provisions.
d. Each terminal of all terminal blocks shall be permanently marked to show the same number or designation as appears on the wire connected thereto.
e. Splicing of wires will not be permitted. Wherever it becomes necessary to join or branch conductors, terminal blocks shall be used and wires shall be clearly tagged.

2. For all conductors No. 6 AWG and larger:
   a. Use power terminal blocks for wires No. 6 AWG and larger.
   b. The terminal blocks for all wires in terminal boxes, control panels, control stations and other enclosures shall be connected to terminal blocks specified in these Special Provisions.
   c. Each terminal of all terminal blocks shall be permanently marked to show the same number or designation as appears on the wire connected thereto.
   d. Splicing of wires will not be permitted. Wherever it becomes necessary to join or branch conductors, terminal blocks shall be used and wires shall be clearly tagged.
3. Motor terminations shall be made using engineer approved motor termination kits.
4. Wire nuts shall not be used for any circuit except building lighting and receptacle circuits.

D. FIBER OPTIC SPLICES

1. Fiber optic shall not be spliced and shall be routed directly between panels as shown on the Contract Plans. Fiber Optic Cables shall be pulled through the corrugated ducts in the submarine cables. See Section Submarine Cable for details.

E. CABLE SUPPORTS

1. Furnish and install conductor support devices as required by code in vertical cable runs.

F. COLOR CODING

1. Conductor identification of each phase shall be by color coded insulation. The color of the insulation of the ungrounded conductors of different voltage systems shall be as follows:
   a. 120/208-240V Black, Red, Blue, White (Neutral)
   b. 277/480V Brown, Orange, Yellow, Gray (Neutral)
   c. Equipment grounding conductors shall be bare or green insulation as required
2. Control Panel wiring shall be color coded as required by NFPA 79 Electrical Standard for industrial machinery.
   a. AC Controls – Red
   b. DC Controls – Blue
   c. Interlock and controls from an external source – Yellow
   d. Grounding conductors shall be bare or green insulation as required.

G. FIELD TESTING

The Contractor shall administer the following field tests after the conductors have been installed:

1. Insulation Resistance Test
   a. An insulation resistance test shall be performed for all conductors after said conductors have been installed but prior to being connected to a device at either end of the conductor. The insulation resistance of each conductor shall be tested to ground and to every other conductor in the raceway bonded together. The tests shall be completed in the presence of the Engineer. The conductor installation shall be rejected if the corrected (40°C) insulation resistance is lower than 100 megohms. Rejected conductors shall be removed and replaced. Then all conductors in the raceway with the replaced conductor shall then be tested as described above.
2. Continuity Tests
   a. The continuity of all wires shall be tested before energizing the circuit. Any conductor that is not continuous shall be investigated for poor connection to terminal blocks or other concern. If the discontinuity is not determined the conductor shall be replaced. The new conductor shall then be tested for proper continuity.
3. Fiber Optic Testing Requirements
   a. Test each fiber in the cable for attenuation (or decibel loss) in dB/kM. Return loss of light reflected back through the fiber from the far end. This value shall be less than -20dB. Measure and record the propagation delay. Measure and record the time domain reflectometry (TDR). Record any faults along the cable. If the fiber optic cables are found to have faults or signal loss that will interfere with the operation of the equipment the cable shall be replaced.
4. Coaxial Cable Testing Requirements
   a. Test each cable for attenuation (or decibel loss) in dB/kM. Return loss of signal reflected back through the cable from the far end. This value shall be less than 20dB. Measure and record the propagation delay. Measure and record the time domain reflectometry (TDR). Record any faults along the cable. If the cable is found to have faults or signal loss that will interfere with the operation of the equipment the cable shall be replaced.
5. Additional Testing Requirements
   a. If the insulation resistance test or the continuity tests fail, the Engineer may request additional tests on the conductors in the same raceway in order to guarantee the quality of the installation.
   b. Proposed test equipment shall be subject to approval of the Engineer. Test instruments shall have been calibrated within the last six months by a calibration facility approved by the manufacturer of the test instruments. Written certification of calibration shall be submitted to and approved by the Engineer prior to executing the tests.
   c. Test reports identifying each conductor by its wire number and its test results shall be tabulated and submitted to the Engineer for approval.

4.0 MEASUREMENT AND PAYMENT

Wire and Cable will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Wire and Cable*.

Payment will be made under:

Pay Item	**Pay Unit**
Wire and Cable	Lump Sum

SUBMARINE CABLE (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

1. The work consists of a completely locating, furnishing and installing a submarine cable system between the control house and pivot pier, in accordance with NCDOT direction. Furnish all wires, cables, panels, terminations, and cable accessories in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Field Measuring
3. Electrical Demolition
4. Raceway
5. Cable and Wire
6. Junction and Pull Boxes
7. Grounding
8. Bridge Control System

C. CONTROL SYSTEM VENDOR

1. The submarine terminal panels shall be coordinated with the Control System Vendor, as items to be installed in the panel shall be part of the equipment supplied by the control system vendor.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code

5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

The Contractor shall follow the requirements of all required permits and approvals of all Departments or Agencies having jurisdiction. The permits are obtained by the Contracting Agency. All work shall be in conformance with the requirements of the United States Coast Guard and all other applicable local jurisdiction authorities.

B. SUBMARINE CABLES

1. Before cable orders are placed with any manufacturer, the Contractor shall determine the true length of each cable between the submarine cable terminal cabinets and verify wire size will not be affected based upon voltage drop considerations. The Contractor shall be responsible for ascertaining and ordering the correct continuous length of submarine cables, including sufficient excess length to accommodate pulling equipment, adequate slack for cable terminations, cable clamping, and for test samples. Splicing or joining of conductors between submarine cable terminal cabinets will not be permitted. In addition, the Contractor shall verify the conductor count of each cable with the control System Vendor to ensure a minimum of 20% of the specified number of conductors are spare control conductors and 10% spare power conductors. In no case shall the conductor counts be less than as shown on the plans.
2. The submarine cable shall be furnished and installed as shown on the Plans. The cable shall be as shown on the contract plans.
3. The cables, terminal cabinets, cable supports, armor clamps, bell ends, cable terminators, brackets, and hardware shall be provided as needed for installation. Cable assemblies shall be metal clad, 2000 volt AC rated, armored cable.
4. Materials and construction of the submarine cables shall conform to the requirements of NEMA Publication No. WC70, latest revision. All conductors shall be soft annealed copper wire conforming to the requirements of NEMA Publication No. WC70. All conductors shall have Class B concentric stranding. The insulation of each conductor shall be a moisture resisting, cross linked, polyethylene compound conforming to the requirements of NEMA Publication No. WC70. The insulation shall incorporate mineral fillers (not carbon) to inhibit treeing.
5. In each cable, the insulated conductors shall be cabled to a full circular section using non-hygroscopic fillers, where necessary, to fill out the section. Each layer of the conductors shall be covered with a single serving of binder tape. Conductors in each layer shall be identified by coloring or marking the outer surface of the insulation. Over the cables conductors, there shall be applied one layer of binder tape followed by a homogeneous synthetic sheath conforming to the requirements of NEMA WC70, Polyethylene, Black. Over the sheath, there shall be applied cable armor consisting of a single layer of galvanized plow steel wire, each wire covered with a layer of polyethylene. A high density polyethylene jacket shall conform to NEMA WC70 and be sunlight and weather resistant. Any variations in cable construction or materials shall be submitted to the Engineer for review and approval.

6. Approved moisture resistant filler material suitable for submarine cable application shall be used in the interstices between and over the insulated conductors to give the complete cable a circular cross-section.
7. Binder tape of approved, suitable, flame resistant, and moisture resistant fabric material with a thickness of not less than 10 mils shall be applied over the multi conductor/filler assembly and overlapped not less than 10 percent of its width between turns.
8. Cable ends shall be factory sealed to prevent moisture from entering the conductor core area during shipment and storage.
9. Packaging of the cables shall be on suitable non-returnable reels capable of supporting the weight of the cables during transportation and normal handling. Cable shall be delivered on site and stored in its original factory packaging.
10. The Contractor shall coordinate the selection of the communication shielded cables and fiber optic cables with the equipment selected by the control system integrator to work properly with the control equipment.
11. For information purposes only, sources of submarine cables include, but are not limited to:

    The Okonite Company
    Washington D.C. District Office
    Ph. (703) 904-9494

    Kerite High Voltage & Cable Services
    Seymour, CT 06483
    Ph: (203) 881-5395

    Draka - Prysmiam Group
    North Dighton, MA 02764
    Ph: (508) 513-2321

C. TERMINAL CABINETS AND HARDWARE

1. Terminal cabinets shall be furnished and installed, as shown on the Plans, to provide termination for the submarine cables.
2. The terminal cabinets shall be NEMA-4X, fabricated from No. 10 gauge Type 316 stainless steel reinforced by steel angles. In the front cover there shall be installed a framed door installed on continuous stainless steel piano hinge and which shall provide access to the equipment inside. The door shall be constructed of No. 10 gauge sheet Type 316 stainless steel, suitably reinforced, and shall be provided with a three point, vault latch and padlock. The door shall be provided with a rubber gasket, which shall prevent water from entering the cabinet. Reinforcing plates shall be welded to the walls where conduits and cables enter the cabinets.
3. Terminal blocks, terminations, drain fittings, concrete pads, hardware and supports, and space heaters shall be as specified in the Special Provisions, Section Wire and Cable and Section Junction and Pull Boxes.

4. Clamp fittings for supporting each submarine cable at the top end of its conduit run shall be a threaded cable support clamp screwed onto the end of the threaded conduit. The clamp assembly shall be fabricated of hot dipped galvanized steel, and made specifically for this use. All hardware shall be stainless steel conforming to the requirements of ASTM Designation A276, Type 316. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.

The Contractor shall submit in detail the proposed procedures and methods for the installation of the submarine cables and installation.

1. The Contractor shall prepare and submit the following working drawings and catalog cuts:
   a. Submarine Cable Installation Experience
   b. Catalog cuts, certified dimensioned cross-sectional prints, and a complete material list for all submarine cables, supports, terminal blocks, splice kits, terminal cabinets, concrete boxes, clay, accessories, and other electrical equipment.
   c. Field survey sounding drawings for before installation and after installation.
   d. A complete layout drawing to scale showing the cable path and accessories. Obstructions, utilities, and other problems areas shall be identified on the drawings.
   e. A letter from the Control System Integrator approving the selection of the communication shielded cables and fiber optic cables to work properly with the control equipment.
   f. Complete, detailed installation methods and procedures.
   g. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all submarine cables. The size of each duct and submarine cable shall be shown on the diagrams. Each duct and submarine cable percent fill shall be shown.
   h. The terminal lugs catalog cuts. The crimping tool catalog cuts and calibration reports for all tools used onsite.
   i. Written certification of calibration shall be submitted for the all test equipment. Results of all initial tests and final tests after any unacceptable results are corrected shall be submitted to the engineer for approval.
   j. Factory test results, laboratory test results, and field test results of testing the conductors.

B. GENERAL REQUIREMENTS

1. All provisions for working in the waterway as specified in the Special Provisions and the applicable requirements of the U.S. Coast Guard shall apply. The Contractor must comply with the direction of the NCDOT.

2. Survey and accurately locate all existing utilities in the riverbed prior to any work in the waterway for the submarine cables. Soundings shall be taken to determine the existing elevations of the riverbed, the location in plan and elevation of the new submarine cables, and the elevations of the riverbed before and after installation. The soundings shall be performed in a 10-foot by 10-foot grid. The soundings shall extend a minimum of 30 feet beyond the location of the proposed submarine cable placement until a suitable routing location is determined. The soundings shall be performed by a licensed Land Surveyor registered in the State of North Carolina. This sounding information shall be submitted to the Engineer for his review and shall be shown on the as-built record drawings. The soundings shall also be submitted to the U.S. Coast Guard/Corps of Engineers through the Engineer upon completion of work.
3. Upon completion of the installation of the submarine cables, the Contractor shall prepare an As-Built record drawing and survey of the location of the submarine cables. The As-Built record drawing shall attest to the actual location and depth of the new submarine cables. A licensed Land Surveyor registered in North Carolina shall sign and seal the As-Built drawing.

C. SUBMARINE CABLES TESTING

1. Factory Testing of the Submarine Cables
   a. Factory testing of all the submarine cables shall be performed in accordance with the latest test methods of ICEA/NEMA Standards for the types of cables and insulating materials specified and shall meet or exceed the minimum requirements and criteria for acceptance as set forth herein.
   b. Prior to assembly and fabrication of the submarine cables, the individual insulated conductors to be incorporated in the cables shall be tested to demonstrate the quality of the production run. The conductors and insulating compounds shall meet the minimum physical and electrical requirements set forth in NEMA Publication No. WC70. The test reports shall be submitted for approval prior to shipping any cable.
   c. Prior to assembly and fabrication of the submarine cables the individual fiber optic cables to be incorporated in the cables shall be tested to demonstrate the quality of the production run. Test each fiber in the cable for attenuation (or decibel loss) in dB/kM. Return loss of light reflected back through the fiber from the far end. This value shall be less than -20dB. Measure and record the propagation delay. Measure and record the time domain reflectometry (TDR). Record any faults along the cable
   d. After each multi-conductor cable is completely assembled and armored, it shall be subjected to test for insulation resistance. The insulation resistance shall not be less than 80% of the original values for the individual wires. Each fiber optic cable shall be tested. The fiber optic cables shall not have test results off by more than 80% of the original value.
   e. The contractor shall submit to the Engineer seven (7) certified copies of all factory test data for approval before shipment of cable from the manufacturer. The test data shall include, in tabulated form, a description of the material-undergoing test, a description of each test performed, the measured or observed

results, and the value and limits required by the ICEA/NEMA Standard for acceptance.

f. In addition, the Contractor shall submit one (1) copy of a statement certifying that the cables delivered for use under this Contract has passed the required factory inspections and tests and complies with all the requirements, including materials and construction, of the Specifications in this Contract.

2. Testing on the Submarine Cables Samples
   a. The Contractor shall provide for sufficient additional length of cable on each reel so that a 15-foot sample shall be taken after installation of the cable from the leading portion of the cable that has been subjected to the pulling stresses and strains incurred in the raceway and conduit during installation.
   b. In the presence of the Engineer, the Contractor shall cut a 15-foot sample from each reel and cut it into a 14-foot section and a 1-foot section. Each section of the sample cable shall be individually tagged and marked with the date the sample was taken, manufacturer's reel number, size and type of cable, and Contractor number. The 1-foot section shall be given to the Engineer and become the property of the Contracting Agency. The Contractor, in the presence of the Engineer, shall test, cap, deliver, and submit each 14-foot section to Delta Line, PMI Industries, Consumer Testing Laboratories, Underwriters Laboratory or as approved by the Engineer.
   c. The Contractor shall provide the Engineer notice at least 72 hours in advance when cable samples are to be taken.
   d. The following inspections, measurements, and tests shall be performed, and the results recorded by the testing laboratory, on the section of cable sample taken from each reel, in accordance with test methods described in the applicable ICEA/NEMA Standards, for compliance with the Contract Specifications:

      i. Inspection of markings on cables for proper size, grade, type, and voltage rating.
      ii. Inspection of cable for physical condition of all materials with respect to defects and damage.
      iii. Quantity and measured size of each conductor, including quantity and size of its conductor strands, and the associated color code.
      iv. Direct current resistance and material of each conductor.
      v. Measured wall thickness of overall non-metallic jacket.
      vi. Measured wall thickness of insulation for each conductor, including minimum and average wall thickness per ICEA Standards.
      vii. Visual inspection of condition of filler materials and identification of type of materials used.
      viii. Measured diameter and quantity of individual wires used in wire armor and type and condition of protective finish.
      ix. Measured and observed test results and computations for accelerated water absorption test on insulation.
      x. Measured and observed original and aged properties of insulation.
      xi. Insulation resistance.
      xii. Test each fiber in the cable for attenuation (or decibel loss) in dB/kM. Return loss of light reflected back through the fiber from the far end. This

value shall be less than -20dB. Measure and record the propagation delay. Measure and record the time domain reflectometry (TDR). Record any faults along the cable.

e. The contractor shall submit to the Engineer seven (7) certified test data results on cable samples to the Engineer for approval. The Contractor shall pay the cost of testing the cable samples, including the costs of cable material, transportation of materials to the laboratory, and the submission of certified test data to the Engineer.

f. If, as a result of the laboratory tests, it is found that the cable does not comply with the approved certified factory test results or with the applicable ICEA/NEMA Standard, the Contractor will be ordered to remove all cable that came from the reel containing the defective cable with new cable, all without additional cost to the Department. The Contractor will be held responsible for any delays in the execution of work caused by the defective cable.

3. Field Testing of the Submarine Cables

a. After the submarine cables have been delivered to the site, prior to installation, the Contractor shall inspect and test the cables while on their reels in the presence of the Engineer. The Contractor shall:

i. Inspection of markings on cables for proper size, grade, type, and voltage rating.

ii. Inspection of cable for physical condition of all materials with respect to defects and damage.

iii. Quantity and measured size of each conductor, including quantity and size of its conductor strands, and the associated color code.

iv. Test the insulation resistance of each wire.

v. Test each fiber in the cable for attenuation (or decibel loss) in dB/kM. Return loss of light reflected back through the fiber from the far end. This value shall be less than -20dB. Measure and record the propagation delay. Measure and record the time domain reflectometry (TDR). Record any faults along the cable.

b. The field tests shall be compared to the shop test results to determine the condition of the cables. If test results indicate conductor failure, this will reveal significant deviation from the factory tests and the Contractor shall be required to replace the faulty cable.

c. After the submarine cables have been installed in the duct, clamped, secured, and terminal connectors attached, but prior to final connections, the Contractor, in the presence of the Engineer, shall then test all conductors as listed below:

d. The Insulation Resistance Field Testing Procedure, including test equipment, test methods, and test data shall be as follows:

i. The test methods for measuring insulation resistance of cables in the field shall be in accordance with the specified NEMA Publications.

ii. Polarity for connecting the mega-ohm meter to the cable under test and the duration of time for electrifying the cable before taking the resistance reading shall be in accordance with NEMA Publications.

iii. The insulation resistance of each conductor in the installed wire-armored, multi-conductor submarine cables shall be measured between the

conductor and all wires in the armor, all of which shall be bonded together and grounded.

iv. The measured values of insulation resistance shall for each conductor in the submarine cables shall be recorded for comparison with the test values determined at the factory and shall be submitted as part of the approved copy of certified test data. The failure of any conductor in an installed submarine cable to demonstrate satisfactory insulation resistance will be cause for the rejection of the submarine cable. If this should occur, the Contractor shall promptly remove the rejected cable and replace it with a new cable, subject to all the aforementioned tests and acceptances, all without additional cost to the Department.

4. Additional Testing Requirements
   a. If the insulation resistance test fails, the Engineer may request additional tests on the conductors in order to guarantee the quality of the installation.
   b. The test results shall be recorded and submitted for approval.
   c. The Contractor shall ensure that the Engineer receives at least 72 hours written notice before proceeding further with the work.
   d. After approval of the tests of the unconnected submarine cables, the Contractor shall connect the submarine cables and test the energized installation as directed in Section Wire and Cable for continuity testing.
   e. If a fault or defect is found to exist or a cable does not otherwise pass the tests, the Contractor shall identify and tag the faulty cable and conductor in question.
   f. If a fault or defect is located in a cable, the Contractor shall remove the defective cable and shall furnish and install new cable, subject to the aforementioned tests and acceptance requirements, all without additional cost to the Department.
   g. If it is determined that the fault or defect is due to a termination of the cables, the decision to correct or repair the cable or replace the section in question shall rest with the Engineer.
5. Submarine Cables Installation
   a. The cable installation shall be performed without damaging the bridge structure, fenders, pile clusters, or any existing substructure and as directed by the Engineer.
   b. During the installation of the cables, the Contractor shall arrange to have at the site a representative of the cable manufacturer. This representative shall be experienced in submarine cable handling and installation procedures, and he shall advise the Contractor and the Engineer in these matters.
   c. The Contractor shall determine and provide proper equipment for lifting or lowering the submarine cables, subject to approval by the Engineer. Proper technical consideration for the quantity and size of conductors in the submarine cable and distances involved shall be included in selecting this equipment. The Contractor shall exercise proper care so as not to over stress, score, or cut the conductors, insulation, outer jacket or armor, or otherwise damage the cable.
   d. Slack shall be provided for the submarine cables and their conductors in the terminal cabinets.

e. After the submarine cables have been installed in place and are awaiting termination, the ends of the conductors shall be test-capped and the ends of the submarine cables sealed to prevent entry of moisture.

6. Cable Installation Procedures
   a. See the requirements in the General Requirements section for locating existing utilities.
   b. Install in accordance with the NCDOT directed method.

4.0 MEASUREMENT AND PAYMENT

Submarine Cable will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Submarine Cable*.

Payment will be made under:

Pay Item	**Pay Unit**
Submarine Cable	Lump Sum

JUNCTION AND PULL BOXES (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish all pull boxes, junction boxes and terminal boxes to permit pulling and installation of wires. Furnish all pull boxes, junction boxes and terminal boxes to permit installation of terminal blocks when required, according to these Special Provisions, whether specifically shown on the plans or not.

B. RELATED WORK

1. Summary of Work
2. Field Measuring
3. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
4. Electrical Refurbishment
5. Raceway
6. Wire and Cable
7. Submarine Cable
8. Switches and Receptacles
9. Grounding
10. Siren
11. Bridge Control System

C. QUALITY ASSURANCE

1. All junction boxes shall be UL listed and labeled.

2. Comply with the provisions of NEMA (National Electrical Manufacturers Association.)

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. BOXES AND FITTINGS

1. All junction and terminal boxes and cabinets installed outside the confines of the control house shall be NEMA 4X, 14-gauge, type 316 stainless steel enclosures with hinged, 14-gauge, stainless steel doors supported by a continuous stainless steel hinge with removable pin. All boxes installed inside the control house shall be NEMA 12, 14-gauge, painted steel enclosures with hinged, 14-gauge, painted steel doors supported by a continuous stainless steel hinge with removable pin. Seams shall be continuously welded and ground smooth. Each enclosure shall be provided with stainless steel fast operating door clamp assemblies and oil-resistant gasket to insure a watertight seal. All boxes and enclosures shall be provided with a nameplate.
2. Surface mounted interior and exterior boxes shall be provided with external mounting lugs. No box shall be drilled for more conduits or cables than actually enter it. No conduits shall enter the top of an enclosure. All conduit entries shall be bottom entry if possible. Exterior boxes shall be provided with one-half inch combination drain and breather fittings. Fitting shall not affect the NEMA-4X enclosure rating of the enclosure.
3. Terminal boxes shall be of sufficient size to provide ample room for the terminal blocks and interior wiring, and for the installation of conduit terminations and multi-conductor cable fittings. Interior panels shall be provided for mounting the terminal blocks. Terminal blocks shall be provided in each terminal box for the connection of all conductors including spare conductors entering the box plus at least ten percent spare terminals.
4. Box drain fittings shall be located in all junction boxes outside the control house. Drain fittings shall be of stainless steel and shall be capable of passing 25 cc of water per minute. Drain fittings shall maintain the NEMA-4X rating of the boxes.
5. The interior of all boxes shall be provided with insulated supports from which bundled cables may be supported.

C. TERMINAL BLOCKS

1. Terminal blocks for conductors of Size No. 8 AWG and smaller shall be modular, DIN rail mounted, corrosion resistant, tubular screw clamp type with vibration proof pressure plates. Conducting parts shall be nickel plated copper and insulating material shall be flame retardant thermo plastic. Corrosion resistant marking strips shall be provided for conductor identification. At least ten- percent spare terminals shall be provided.
2. Terminal connectors shall be seamless, heavy-duty compression pin tongue terminals or ferrule type, manufactured from pure electrolytic copper tubing. Terminals shall be tin plated and provided with a double-thick tongue and insulation grip. Terminals and compression tools shall be as approved by the Engineer.
3. All terminal blocks and boards shall be mounted on suitable straps or structural steel brackets in such a manner as to permit routing the conductors behind the terminal blocks. Terminal blocks shall be one-piece blocks suitable for use in highly corrosive atmospheres and shall conform to the requirements herein specified. Each terminal block shall be equipped with a cover to make the terminal block finger safe.
4. Power terminal blocks for wires No. 6 AWG and larger shall be included in each terminal box as required for such conductors. Each terminal shall be a one-piece power distribution block of molded phenolic compound and shall conform to the requirements specified herein elsewhere. A cover of insulating material shall be provided for each block.

D. HEATERS

1. Provide a space heater in all boxes equipped with terminals located outside of the control house. Space heaters shall be heavy duty, thermostat controlled, rated for 120VAC, with a heater sized for the enclosure. All boxes shall be sized to accommodate the equipment. The heater shall be provided to prevent condensation.

E. HARDWARE AND SUPPORTS

1. Mounting bolts, nuts, washers and other detail parts used for fastening boxes, panels, cabinets, brackets and other electrical equipment shall be of stainless steel conforming to the requirements of ASTM A593, Type 316. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers. Bolts smaller than ½ inch in diameter shall not be used except as may be necessary to fit the mounting holes in small limit switches, boxes and similar standard devices.
2. Supports for boxes, panels, cabinets, and other separately mounted items of electrical equipment shall be fabricated from 316 stainless steel not less than ¼ inch in thickness. Channels, angles, bent plates, clip angles, other stainless steel supporting members, hardware and gaskets for supporting electrical equipment shall be paid for under this item.
3. 316 Stainless steel brackets, boxes and other equipment mounted on concrete surfaces shall be provided with a full neoprene gasket not less than 1/8-inch thick, between the equipment and the surface of the concrete.

4. Anchors for fastening equipment or brackets to concrete surfaces shall be epoxy resin bonded anchors.
5. Preformed metal framing channels, such as Kindorf, Unistrut, Superstrut, etc., will not be acceptable for mounting or fastening structural supports, conduits, boxes, or other electrical equipment. The use of J-bolts or beam clamps to fasten structural supports or to clamp conduits, boxes, or other electrical equipment will not be permitted.

F. CONCRETE PAD FOUNDATIONS

1. Concrete pads shall be provided for the equipment as shown on the plans.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. The Contractor shall submit in detail the proposed procedures and methods for the installation of the equipment.
3. The Contractor shall prepare and submit the following working drawings and catalog cuts:
   a. Catalog cuts, certified dimensioned prints, and a complete material list for all equipment.
   b. A complete schematic raceway diagram or diagrams showing the interconnection of all devices and equipment, including conduits, ducts and junction boxes, and showing all multi-conductor cables.
   c. Submit mounting details for all equipment, boxes, and raceway. Mounting details shall show all equipment required to support the equipment.
4. Mounting details for connections to the existing structural steel shall be detailed to show the location on the existing structure. Each mounting location shall be detailed and submitted to the Engineer for approval. Submittals showing the procedure for removing drilling and bolting to the steel shall be submitted to the Engineer. No work shall commence in the field until all locations and procedures are approved by the Engineer.

B. BOXES AND FITTINGS

1. No boxes nor fixtures shall be cantilevered from nor supported by conduit.
2. Warning labels shall be provided on any box that has 480VAC wiring that either passes through the box or is terminated inside the box indicating that 480VAC is present in a box. Warning labels shall clearly identify any arc flash dangers.
3. Watertight conduit hubs shall be provided at the ends of all conduits entering boxes and enclosures furnished with slip holes. Hubs shall be stainless steel when used in conjunction with stainless steel enclosures. Conduit entrances in sidewalk boxes shall be fastened with hubs so as to be concrete tight.
4. The ends of all conduits projecting into all boxes and enclosures shall be provided with bronze insulated grounding bushings, each bushing furnished with a screw type combination lug for bonding. All bushings in any box or enclosure shall be

bonded together and to the equipment ground conductor with approved bare copper wire.

5. Surface mounted interior and exterior boxes shall be fastened in position with approved stainless steel through bolts.
6. No box shall be mounted on walkways, gratings, etc. such that a tripping hazard is created. Also, boxes shall not be mounted in direct contact with structural steel or concrete. Steel stand-offs shall be furnished and installed by the Contractor for said equipment such that accumulation of debris between the structure and mounted component is minimized. A minimum of two-inches shall be maintained between surface and the mounted device for outdoor installations and a minimum of ¼ inch shall be maintained between surface and the mounted device for installations in controlled environments.
7. Exposed boxes on concrete surfaces shall be installed using approved anchors. Holes for the anchors shall be drilled to the size and depth recommended by the manufacturer using carbide tipped masonry drills providing six inch embedment minimum.
8. Mounting details for connections to the existing structural steel shall be detailed to show the location on the existing structure. Each mounting location shall be detailed and submitted to the Engineer for approval. Submittals showing the procedure for removing drilling and bolting to the steel shall be submitted to the Engineer. No work shall commence in the field until all locations and procedures are approved by the Engineer.
9. The Contractor shall prepare and submit details of all electrical equipment supports to the Engineer for approval.

C. TERMINAL BLOCKS

1. Terminal blocks shall be arranged in each terminal box, cabinet, and panel such that terminal blocks with different voltages are located and terminated separately from each other. The following are the categories by which the terminal blocks shall be separated are:
   a. 480VAC Terminals
   b. 208/120VAC Terminals
   c. Low Voltage Terminals
   d. DC Voltage Terminals
2. 480VAC Terminals shall be provided with covers to make them finger safe.

4.0 MEASUREMENT AND PAYMENT

Junction and Pull Boxes will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Junction and Pull Boxes*.

Payment will be made under:

Pay Item	**Pay Unit**
Junction and Pull Boxes	Lump Sum

SWITCHES AND RECEPTACLES **(SPECIAL)**

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish all switches, receptacles, and accessories as shown on the Plans and in accordance with these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Raceway
3. Junction and Pull Boxes
4. Grounding
5. Bridge Control System

C. QUALITY ASSURANCE

All wiring devices shall be by the same manufacturer, UL Listed and comply with the provisions of NEMA.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. RECEPTACLES

1. All receptacles shall be 20-ampere, 125-volt, three-wire, grounding type, polarized, ground fault current interrupting (GFCI) duplex convenience outlets. Each indoor receptacle (installed in the control house) shall be flush mounted in a new outlet box and shall be provided with a Type 304 stainless steel cover plate. Outdoor receptacles (installed outside of the control house) shall be similar except each receptacle shall be provided with waterproof cover plate and shall be mounted in a waterproof, UL Listed, cast-iron, hot-dipped galvanized, equipped with gaskets, surface mounted boxes with stainless steel spring loaded, gasketed, weather proof lid. Stab-in connection shall not be used. Receptacles shall be specification grade.

C. SWITCHES

1. All switches shall be specification grade, single pole or double pole, 3 or 4 way as required, non-mercury quiet, 20 amperes, 120VAC, UL Listed, silvered contacts, ivory nylon body, tumbler switch with endurance of 10,000 make-breaks. Indoor switches (installed in the control house) shall be flush mounted in new outlet boxes and shall be provided with Type 304 stainless steel plates. Outdoor switches (installed outside of the control house) shall be mounted in waterproof, cast iron, hot dipped galvanized, equipped with gaskets, surface mounted boxes with covers. Switches shall be mounted three and half feet (3.5 feet) above the adjacent floor or platform. All new lights shall be LED type and the switches shall be rated to properly control the LED lights. The switches for the control room shall be dimmable.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.

1. Catalog cuts, certified dimensioned prints, and a complete material list for all electrical equipment.
2. A complete schematic raceway diagram or diagrams showing the interconnection of all devices and equipment, including conduits, ducts and junction boxes, and showing all multi-conductor cables.
3. Submit mounting details for all equipment, boxes, and raceway. Mounting details shall show all equipment required to support the equipment.

B. GENERAL

1. Switches shall be flush mounted and a 1-inch separation shall be maintained from door casings and other switches.
2. Outlet boxes shall be sized in accordance with the NEC Section 370 with a minimum box size of 4 inches square by 1-1/2 inch.
3. Do not use a switch or receptacle as a terminal block. All field wiring shall be terminated on individual terminals and individual conductors run to the respective equipment. Do not terminate more than two conductors on a single terminal. Internal jumpers between equipment in the same enclosure is permissible.

4.0 MEASUREMENT AND PAYMENT

Switches and Receptacles will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Switches and Receptacles*.

Payment will be made under:

Pay Item	**Pay Unit**
Switches and Receptacles	Lump Sum

HEATING VENTILATION AND AIR CONDITIONER (HVAC) UNIT (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install a split system ductless heating, ventilation, and air conditioning (HVAC) system in the control house. Provide all equipment and accessories as shown on the Plans and in accordance with these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Field Measuring
3. Raceway
4. Wire and Cable
5. Junction and Pull Boxes
6. Disconnect Switches
7. Grounding

C. QUALITY ASSURANCE

1. All wiring devices shall be by the same manufacturer, UL Listed and comply with the provisions of NEMA.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. HEATING VENTILATION AND AIR CONDITIONING (HVAC) UNIT

1. Furnish and install a multi-zone 24,000 BTU HVAC system powered by an energy efficient inverter and a variable speed compressor. These units shall be capable of heating and cooling up to 3 zones without distribution boxes. The system shall be as manufactured by GREE+MULTIZONE, LG, Samsung, or Mitsubishi.
2. There shall be one outdoor compressor unit that shall be energy efficient and shall be rated to prevent coil corrosion in a corrosive environment.

3. There shall be three indoor air handling units, one for each room in the control house. Each indoor air handling shall be equipped with a wired tether controller.
4. Universal Piping Assembly/Line-sets shall be provided for this system. The Contractor shall fully wire and connect the system. All gas, refrigerant, liquid lines shall be sized and connected in accordance with the manufactures recommendations.
5. Coordinate with Section 'Disconnect Switches' to provide a disconnect switch for each unit in the system.
6. The unit shall be a ductless combination unit that provides both heating and cooling.
7. HVAC System shall be rated 208VAC, 60-hertz. Coordinate rating with the manufacturer recommendations.
8. Provide a drain line for the outdoor compressor unit to route the water to the safe water collection drainage system on the roof.
9. The Air Handler Units shall be supplied with a wall mounting bracket supplied by the manufacturer. The bracket shall be rated for the unit and allow the unit to positioned to allow for air circulation.

3.0 CONSTRUCTION METHODS

A. SHOP/WORKING DRAWINGS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. Submit certified dimension prints of all indoor units, outdoor units, and other electrical apparatus. All pertinent electrical data, ratings, and calculations are to be included on the prints.
3. The Contractor shall prepare an interconnection diagram to show the connection of the equipment. The Contractor shall identify all wiring and piping connections for the system.
4. The Contractor shall prepare and submit details of all electrical equipment supports to the Engineer for approval.

B. GENERAL

1. Unit mounting brackets and equipment shall be in accordance with the manufacturer's recommendation. All mounting hardware, bolts, and associated equipment shall be stainless steel.
2. All electrical equipment shall be mounted to provide a minimum surrounding air space in accordance with the manufacturers recommendations.
3. The Contractor shall prepare and submit details of all electrical equipment supports to the Engineer for approval.

4.0 MEASUREMENT AND PAYMENT

Heating Ventilation and Air Conditioner (HVAC) Unit will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Heating Ventilation and Air Conditioner (HVAC) Unit.*

Payment will be made under:

Pay Item	**Pay Unit**
Heating Ventilation and Air Conditioning (HVAC) Unit	Lump Sum

DISCONNECT SWITCHES (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install disconnect switches and accessories in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Raceway
3. Junction and Pull Boxes
4. Heating Ventilation and Air Conditioning (HVAC) Units
5. Motors
6. Grounding
7. Siren
8. Bridge Control System

C. QUALITY ASSURANCE

1. All switches furnished shall be the end product of one manufacturer. All switches shall bear a UL Label.

D. CONTROL SYSTEM VENDOR

1. This item shall be part of the equipment supplied by the control system vendor.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. MOTOR AND BRAKE DISCONNECT SWITCHES

1. A total of 5 disconnect switches shall be installed, one for each brake motor, wedge motor and span drive motor.
2. The switches shall be non-fusible, 3 phase, heavy-duty, safety switches in watertight and dust-tight NEMA-4X, 304 stainless steel enclosures with a lockable handle. The switches shall be rated for the horsepower as shown on the plans. The disconnect switch blades shall open each ungrounded conductor, shall be single throw, and clearly visible when in the 'off' position with the door open. The switch shall be rated for a short circuit current of 10 KAIC.
3. The disconnect lugs shall be copper, UL Listed for copper cables, and front removable.
4. The disconnect switch operating handle shall be an integral part of the box, not the cover. Switches shall have a dual cover interlock to prevent opening the of the switch door while in the 'on' position or placing the switch in the 'on' position while the door is open. The door interlock shall include a bypass method and the switch shall be pad lockable in the 'off' position.
5. Each disconnect switch shall be equipped with two auxiliary contacts. One auxiliary contact shall be used to disconnect the motor heater rated for 10A at 120VAC and the other auxiliary disconnect shall be used as an input to the PLC.
6. Boxes shall be bonded and grounded with ground stud fitting. Boxes shall be provided with drain fitting to maintain the NEMA-4X enclosure rating, but shall allow for proper drainage.

C. HVAC UNIT DISCONNECT SWITCHES

1. Each unit in the split ductless system shall be provided a disconnect switch.
2. The switches shall be non-fusible, heavy-duty, safety switches in watertight and dust-tight NEMA-4X, enclosures. The switches shall be rated for the HVAC equipment and the manufacturer recommendations. The switch shall be rated for a short circuit current of 10 KAIC.
3. Switches shall have a cover interlock to prevent opening the of the switch door while in the 'on' position or placing the switch in the 'on' position while the door is open. The door interlock shall include a bypass method and the switch shall be pad lockable in the 'off' position.
4. Boxes shall be bonded and grounded with ground stud fitting. Boxes shall be provided with drain fitting to maintain the NEMA-4X enclosure rating, but shall allow for proper drainage.

D. SIREN

1. The siren shall be provided a disconnect switch.
2. The switch shall be non-fusible, single phase, heavy-duty, safety switches in watertight and dust-tight NEMA-4X, enclosures. The switch shall be rated for the air horn and the manufacturer recommendations. The switch shall be rated for a short circuit current of 10 KAIC.
3. The switch shall have a cover interlock to prevent opening the of the switch door while in the 'on' position or placing the switch in the 'on' position while the door is

open. The door interlock shall include a bypass method and the switch shall be pad lockable in the 'off' position.

4. Boxes shall be bonded and grounded with ground stud fitting. Boxes shall be provided with drain fitting to maintain the NEMA-4X enclosure rating, but shall allow for proper drainage.

E. NAMEPLATES

1. Each disconnect switch shall have a corrosion – resisting metal nameplate on which is stamped the name of the manufacturer and the rating or capacity of the equipment or apparatus. This nameplate shall clearly identify the equipment and the electrical qualities for ease of inspection, repair and replacement at a later date. The nameplate shall also clearly identify the piece of equipment in relation to the Plans by providing the alphanumeric designation of the equipment as shown in the Plans or the approved shop drawings.

F. HARDWARE AND SUPPORTS

1. Mounting bolts, nuts, washers and other detail parts used for fastening disconnect switches shall be of 316 stainless steel conforming to the requirements of ASTM A593, Type 316. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers. Bolts smaller than ½ inch in diameter shall not be used except as may be necessary to fit the mounting holes in small limit switches, boxes and similar standard devices.
2. Supports for disconnect switches shall be fabricated from stainless steel not less than ¼ inch in thickness. Channels, angles, bent plates, clip angles, other stainless steel supporting members, hardware and gaskets for supporting electrical equipment shall be paid for under this item.
3. Preformed metal framing channels, such as Kindorf, Unistrut, Superstrut, etc., will not be acceptable for mounting or fastening structural supports, conduits, boxes, or other electrical equipment. The use of J-bolts or beam clamps to fasten structural supports or to clamp conduits, boxes, or other electrical equipment will not be permitted.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings for the disconnect switches in accordance with Section Electrical Summary of Work.

The Contractor shall prepare and submit the following working drawings and catalog cuts:

1. Catalog cuts, certified dimensioned prints, and a complete material list for all equipment.
2. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on

the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.

3. Submit mounting details for all equipment, boxes, and raceway. Mounting details shall show all equipment required to support the equipment. Each mounting location shall be detailed and submitted to the Engineer for approval. No work shall commence in the field until all locations and procedures are approved by the Engineer.

B. MOUNTING

1. Surface mounted interior and exterior boxes shall be fastened in position with approved stainless steel through bolts. Disconnect switches that are not surface mounted shall be fastened and supported as shown on the plans.
2. Boxes shall not be mounted in direct contact with structural steel or concrete. Steel stand-offs shall be furnished and installed by the Contractor for said equipment such that accumulation of debris between the structure and mounted component is minimized. A minimum of ¼ inch shall be maintained between surface and the mounted device.
3. No work shall commence in the field until all locations and procedures are approved by the Engineer.

4.0 MEASUREMENT AND PAYMENT

Disconnect Switches will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Disconnect Switches*.

Payment will be made under:

Pay Item	**Pay Unit**
Disconnect Switches	Lump Sum

GROUNDING (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

All metallic enclosures, raceways, and electrical equipment shall be grounded with a dedicated ground wire, and the ground wires shall be connected to a ground rod system, in accordance with the requirements of the National Electric Code, Article 250.

B. RELATED WORK

1. Summary of Work
2. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
3. Electrical Demolition

4. Electrical Refurbishing
5. Raceway
6. Wire and Cable
7. Submarine Cable
8. Junction and Pull Boxes
9. Switches and Receptacles
10. Heating Ventilation and Air Conditioning (HVAC) Unit
11. Disconnect Switches
12. Grounding
13. Dry Type Transformer
14. Motors
15. Panelboard
16. Motor Control Center
17. Lighting
18. Siren
19. Bridge Control System

C. QUALITY ASSURANCE

1. Comply with NFPA (including NEC) and UL standards pertaining to electrical grounding and bonding.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)
8. Grounding Conductors
9. Equipment ground conductors shall be as specified in Section Wire and Cable. When required by the National Electrical Code, equipment ground conductors shall be provided with approved insulation.

B. GROUND RODS

1. Ground rods shall be copper clad stainless steel rods, with a minimum dimension of 1-inch diameter and 10-feet in length.

C. GROUNDING EQUIPMENT

1. All connections to ground rods and bonding to steel shall be Cadweld connections sized for the equipment being connected.

2. Grounding system terminals shall be solderless lugs made from high copper content alloy and shall be secured by means of hexagonal-head, copper plated, steel machine bolts with lock washers or lock nuts.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.

The Contractor shall submit in detail the proposed procedures and methods for the installation of the ground wire system and the ground rod system.

The Contractor shall prepare and submit the following working drawings and catalog cuts:

1. Catalog cuts, certified dimensioned prints, and a complete material list for all grounding equipment.
2. A complete schematic diagram or diagrams showing the interconnection of all ground rods and major equipment.
3. Type of ground testing equipment and certification of calibration for all test equipment.
4. All test results.

B. BONDING AND GROUNDING

1. Furnish and install at a minimum one dedicated ground rod at the service to ground the utility service ground wire.
2. Provide additional ground rods as required to achieve the ground resistance requirements in this Section. This ground connection shall maintain a resistance to ground of 10 ohms in accordance with the NEC. Provide additional ground rods until the ground resistance of 10 ohms is achieved at the service.
3. Equipment ground conductors shall be provided in each raceway, conduit, and flexible cable or cord. No equipment ground conductors shall be smaller than #12 AWG.
4. All bonding shall be made by molded fusion exothermic welds, unless specified otherwise. Exothermic welds for bonding of equipment shall be molded fusion type, with molds as required. Where physical limitations prevent exothermic welding, NCE approved pressure crimps shall be installed.
5. Ground system conductors shall be continuous unspliced connections between welds and terminal lugs. Paint, rust, and scale shall be removed over the entire contact area. All connections shall be made up as tightly as possible, and any bare metal or paint undercoat remaining exposed shall be spot painted to restore the surface with the same coating and number of coats as applied to the adjacent metal.
6. All control enclosures, limit switches, conduits, boxes, and all other metal parts in the proximity of current carrying conductors or equipment installed on the bridge shall be bonded and solidly connected together via equipment ground conductors and connected to the existing grounding electrode conductor.
7. The steel work shall be solidly bonded and grounded to the ground network using No. 1/0 AWG bare, stranded, tinned copper cable.

8. Ground all equipment in accordance with the manufacturers recommendations and NEC Section 250 requirements. Care shall be taken to ground the transformers neutrals in accordance with the NEC Section 250 and the Utility requirements.

C. CONNECTION TO THE GROUND BUS

1. Furnish and install connections in accordance with the codes; including but not limited to conduit system, electrically operated equipment and devices. Neutral conductor and ground conductor shall be separate in all equipment and shall be bonded at service panel only.

D. CONNECTION TO THE GROUND ROD

1. Furnish and install connections in accordance with the codes. All cable routed to the ground rods shall be bonded to the rods with approved methods. All bonding shall be made by molded fusion exothermic welds, unless specified otherwise. Exothermic welds for bonding of equipment shall be molded fusion type, with molds as required. Where physical limitations prevent exothermic welding, approved mechanical solderless bonding lugs shall be installed.

E. TESTING

1. Submit the device and latest certification for calibration to the Engineer for approval, prior to scheduling the testing. Notify the Engineer in writing 72 hours before the testing shall be performed. All tests shall be performed in the presence of the Engineer. The Contractor shall submit the results of the tests in writing to the Engineer for approval. The testing shall consist of the following:
   a. Resistance to Ground Measurements
      Measure the resistance to ground at the service entrance, each ground rod, and each motor control center on the bridge. Use a hand held ground resistance meter and leakage current meter. The contractor shall record the resistance to ground and leakage current at each location. Failure of the ground resistance to be 10 ohms or less shall result in the Contractor providing additional ground rods until the correct resistance is achieved, at no additional cost to the Department.
   b. Ground Fault Interrupting Receptacle Tests
      Test all ground fault interrupting receptacles for proper connection and operation with methods and instruments prescribed by the manufacturer. The Contractor shall record each location of the receptacle and each receptacle identifier, and whether the equipment passed or failed the test. Failure of a receptacle to pass the test shall result in the replacement of the faulty receptacle at no additional cost to the Department.

4.0 MEASUREMENT AND PAYMENT

Grounding will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Grounding*.

Payment will be made under:

Pay Item	Pay Unit
Grounding	Lump Sum

DRY TYPE TRANSFORMER **(SPECIAL)**

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install one dry type transformers in the control house, in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Raceway
3. Wire and Cable
4. Junction and Pull Boxes
5. Grounding
6. Bridge Control System

C. CONTROL SYSTEM VENDOR

1. This item shall be part of the equipment supplied by the control system vendor.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. TRANSFORMER

1. Furnish and install one transformer in the control house. The transformer shall be a UL listed transformer. The transformer core shall be constructed from high grade electrical steel and all windings shall be copper. Coil and core shall be mounted on rubber insulation mounting pads. Sound levels are not to exceed 45db as measured by NEMA ST20. The windings and core and coil assembly shall be treated and built to resist the effects of dirt and moisture. The enclosure is to be rated NEMA-3R with a weathershield.
2. The transformer shall meet the following specifications:

a. KVA rating: 30
b. Temperature rise: 65 Degree C rise above a 30 Degree C ambient average.
c. Cycles: 60 Hz.
d. Phase: 3
e. Primary voltage rating: 480 Volts Delta
f. Taps: The taps shall be on the primary winding as specified at 2 above and 2 below rated voltage, each rates at 2½%
g. Impedance ratings: under 5.0% on rated KVA base with a max. tolerance of 7.5%.
h. Secondary voltage rating: 120/208 Volts.

C. NAMEPLATE

1. The nameplate is to be constructed of 316 stainless steel. The plate shall have the complete diagrammatic layout and information required by ANSI specifications. The nameplate shall also have stamped upon it the name of the manufacturer and the rating or capacity of the equipment or apparatus. This nameplate shall clearly identify the equipment and the electrical qualities for ease of inspection, repair and replacement at a later date. The nameplate shall also clearly identify the piece of equipment in relation to the Plans by providing the alphanumeric designation of the equipment as shown in the Plans or the approved shop drawings.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.
2. The Contractor shall submit in detail the proposed procedures and methods for the installation of the equipment. Working drawings shall be included with the procedures and methods.
3. The Contractor shall prepare and submit the following working drawings and catalog cuts:
   a. Catalog cuts, certified dimensioned prints, and a complete material list for all transformers.
   b. Tap-settings and voltages at the transformer.
   c. Submit mounting details for all transformers. Mounting details shall show all equipment required to support the equipment.

B. MOUNTING

1. The transformer shall be floor mounted. Provide a rubber pad on which to mount the transformer.
2. 316 Stainless steel brackets, boxes and other equipment mounted on concrete surfaces shall be provided with a full neoprene gasket not less than 1/8-inch thick, between the equipment and the surface of the concrete.
3. Anchors for fastening equipment or brackets to concrete surfaces shall be epoxy resin bonded anchors.

C. CONNECTIONS

1. Connect the transformer neutral to the bridge electrical ground system, as recommended by the manufacturer.
2. Connect the transformer at normal tap positions initially. When the electrical system is completely energized, measure secondary voltages at all transformers and lighting panels. Submit this list in writing to the Engineer for evaluation. Reconnect taps as subsequently requested. Include a copy of the tap settings in the O & M manuals.

4.0 MEASUREMENT AND PAYMENT

Dry Type Transformer will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Dry Type Transformer*.

Payment will be made under:

Pay Item	**Pay Unit**
Dry Type Transformer	Lump Sum

MOTORS (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install one wedge motor, disc brake, manual brake release and all accessories in accordance with the Plans and these Special Provisions.

Furnish and install one span drive motor, encoder, and all accessories in accordance with the Plans and these Special Provisions.

Furnish and install one motor brake and two machinery brakes, with a hand release mechanism, three limit switches for set, released, and hand released monitoring, and all associated accessories in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Raceway
3. Wire and Cable
4. Junction and Pull Boxes
5. Disconnect Switches
6. Grounding
7. Motor Control Center
8. Bridge Control System

C. CONTROL SYSTEM VENDOR

1. This item shall be part of the equipment supplied by the control system vendor.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. WEDGE MOTOR

1. The wedge motor shall be AC induction type, squirrel cage, marine duty motor. The motors shall be built in strict accordance with NEMA publication MG-1. They shall be 3-phase 60-Hertz, with moisture resistance insulation, 50° C temperature rise. Ratings shall be as follows:
   a. Horsepower: 7.5 HP
   b. Nominal Voltage: 480 VAC primary
   c. Duty: 30 Minute
   d. Insulation: HHH
   e. Service Factor: 1.15
   f. Environmental: Marine
   g. RPM 900
   h. Shaft Carbon Steel
   i. NEMA Design D
2. The motors shall be totally enclosed non-ventilated (TENV) construction, with re-greaseable ball bearings, moisture resistant insulation and internal space heater sized by the manufacturer. The space heater shall be rated for 120VAC.
3. All windings shall be copper. The motor shall be capable of having a minimum breakdown torque of 300%.
4. The conduit boxes shall be liberally sized and located to avoid interference with the machinery. The conduit boxes shall be sized in accordance with the requirements of the NEMA MG 1-1987 PART 11.
5. The motor shall be equipped with a through shaft and with a factory assembled and installed disk brake. The disc brake shall be equipped with a manual release lever for emergency disengagement when power is off. The manual release shall allow the motor to be rotated freely when released. The manual release shall reset upon power being delivered to the motor and then set normally once power is removed.
6. The motors shall be designed and manufactured in the United States of America. All motors shall be hand wound and assembled.
7. All motors shall be manufactured to the following standards:
   a. IEEE Marine Standards No. 45.
   b. American Bureau of Shipping (A.B.S.).

c. U.S. Coast Guard Inspection Service.

C. WEDGE MOTOR SHOP TESTS

1. The motor shall be subjected to the short commercial (routine) test at the plant of manufacture in accordance with the current requirements of the NEMA MG 1 1987 PART 12, and IEEE STD 112 1984.
2. The motor shall be subjected to an insulation resistance test per NEMA standard MG 1, Section Nos. 12.02 and 12.03 or IEEE 4. Insulation resistance values and test voltage shall be included on the test reports.
3. Tests shall be reported on the standard forms for induction motors of the National Electrical Manufacturers Association. All test reports and curve sheets shall be certified by the manufacturer, and three copies of each shall be submitted. Motors shall not be shipped from the plant of the manufacturer until the test reports have been approved by the Engineer.

D. SPAN DRIVE MOTOR

1. The span drive motor shall be AC induction type, vector inverter duty motor. The motor shall be supplied with the drive specified in Section Motor Control Center as a matched pair. The motors shall be built in strict accordance with NEMA publication MG-1 and designed for use with IGBT AC closed loop vector controllers. They shall be 3-phase 60-Hertz, with moisture resistance insulation, 50° C temperature rise, and capable of instant reversing. Motor frame shall be constructed of cast aluminum. Ratings shall be as follows:
   a. Horsepower: 25 HP
   b. Nominal Voltage: 480 VAC primary
   c. Motor Rated RPM: 900 RPM
   d. Duty: 30 Minute
   e. Frame type: TENV
   f. Insulation: HHH
   g. Service Factor: 1.15
2. The motors shall be totally enclosed non-ventilated (TENV) construction, with re-greaseable ball bearings, moisture resistant insulation and internal space heater sized by the manufacturer. The space heater shall be rated for 120VAC. The motor shall have a special extended shaft as shown on the mechanical contract drawings to accommodate the motor coupling and encoder on one side of the motor and a special extended shaft on the other side of the motor to accommodate the motor brake. The shaft end with the motor brake shall be equipped with a nut so the brake torque can be verified., the motor coupling on one end and a rear mounted encoder on the other. The motor shafts shall be carbon steel. A drain hole of not less than ½ inch diameter shall be provided at the bottom of the motor, fitted with a suitable drain plug.
3. All windings shall be copper. The motor shall be capable of having a minimum breakdown torque of 300%. Motor must have a speed range of 1000:1 and be capable of providing full torque at zero speed. Motor design shall be low inertia and slip design.
4. Motor encoder shall be an industrial type (aluminum and glass encoder wheels are not acceptable). The encoder shall have a resolution of 1024 pulses per rotation

with 12 volt DC power and be compatible with the Rockwell Automation Powerflex 753 Drive or approved equal. A separate terminal box with terminal strip for feedback unit shall be provided. Encoder shall be factory-installed at the plant of the motor manufacturer. The encoder shall be powered from the motor drive panel from the drive power supply.

5. The conduit boxes shall be liberally sized and located to avoid interference with the machinery. The conduit boxes shall be sized in accordance with the requirements of the NEMA MG 1-2014.
6. The motors shall be designed and manufactured in the United States of America. All motors shall be hand wound and assembled.
7. All motors shall be manufactured to the following standards:
   a. IEEE Marine Standards No. 45.
   b. American Bureau of Shipping (A.B.S.).
   c. U.S. Coast Guard Inspection Service.
8. Span drive motors shall also be provided with the following features in order to meet the requirements of these Specifications:
   a. All aluminum parts-chemical film (MIL-C-5541) and zinc chromate primer (MIL-P- 8595).
   b. Cadmium plate shaft and hardware (FED-QQ-P-416).
   c. Double Sealed ball bearings.
   d. Seal all joints and eye bolt holes.
   e. Sealed leads in terminal box.
   f. Shaft seals.
   g. Removable drain plugs.
   h. Final coat of epoxy paint.
   i. Corrosion resistant coating-rotor and stator laminations.
   j. Stainless steel nameplate.
   k. Super ‘H' insulation including protection against fungus growth per MIL-V173B.
9. The motor frame shall be finished with a corrosion-resistant paint or coating. Exposed unpainted metal surfaces shall be of a corrosion-resistant material.
10. Motor must be designed to operate at carrier frequencies up to 30 kHz. All motors shall be dynamically balanced.

E. SPAN DRIVE MOTOR SHOP TESTS

1. A complete set of speed torque current curves for the span drive motor shall be prepared and submitted to the Engineer for approval. The Contractor shall shop test the motor at a facility equipped with a dynamometer. Curves corresponding to full load speed shall be provided. The curves shall cover the interval from breakaway torque to breakdown driving torque, referred to full load motor torque. Acceptable torque values shall be no less than 95% of the manufacturer’s data for any given speed. Perform a full load heat run test, which shall consist of operation at 150% of rating for three minutes without suffering thermal or mechanical damage.
2. If motor fails to pass the above tests, the motor shall be rejected.
3. The wedge motor and span drive motor shall be subjected to the short commercial (routine) test at the plant of manufacture in accordance with the current requirements of the NEMA MG 1 2014.

4. The motor shall be subjected to an insulation resistance test per NEMA standard MG 1, Section Nos. 12.02 and 12.03. Insulation resistance values and test voltage shall be included on the test reports.
5. Tests shall be witnessed by the Engineer. The Contractor shall provide 30 working day notice to the Engineer for scheduling purposes.
6. Tests shall be reported on the standard forms for induction motors of the National Electrical Manufacturers Association. All test reports and curve sheets shall be certified by the manufacturer, and three copies of each shall be submitted. Motors shall not be shipped from the plant of the manufacturer until the test reports have been approved by the Engineer.

F. BRAKES

1. The Contractors shall furnish and install one motor brake and two machinery brakes.
2. The motor brake shall be have a 10" wheel diameter, three phase thrustor motor, fitted with an external torque spring, and a 0.5 to 8.0 second adjustable time delay on setting. The brakes shall be Mondel Hi-Tork 300M Series part 10" BT/E-ED30/5S or approved equal.
    - Current Rating: 0.42 Amperes
    - Nominal Voltage: 460 VAC primary
    - Torque Rating: 260 foot-pounds
    - Torque Setting: 200 foot-pounds
3. The machinery brakes shall be have a 13" wheel diameter, three phase thrustor motor, fitted with an external torque spring, and a 0.4 to 8.0 second adjustable time delay on setting. The brakes shall be Mondel Hi-Tork 300M Series part 13" BT/E-ED80/6S or approved equal.
    - Current Rating: 1.2 Amperes
    - Nominal Voltage: 460 VAC primary
    - Torque Rating: 660 foot-pounds
    - Torque Setting: 550 foot-pounds
4. The conduit boxes shall be liberally sized and located to avoid interference with the machinery. The conduit boxes shall be sized in accordance with the requirements of the NEMA MG 1-2014.
5. Each brake shall be equipped with an emergency hand release.
   Each brake shall be equipped with a set and a released limit switch with a normally close and normally open contact. Each limit switch shall be provided with a lever and actuated directly by the metal tripping plate. Each limit switch shall be a heavy-duty, epoxy-filled, submersible, factory sealed, proximity limit switch rated NEMA 6P. Each limit switch shall be furnished with N.O. and N.C. contacts as shown on the plans. The enclosure shall be provided with Viton gaskets and seals and factory-installed Type SEO or STOOW cord. The cord shall be routed to a junction terminal box within 18 inches of the brake and terminated in the junction terminal box, and then the wiring shall be routed in conduit to the PLC control system.
6. Brake shoe holders shall be ductile iron with fabricated steel linkages. Brake shoes shall be self aligning.
7. Brakes shall be corrosion protected and tropicalized.

8. Motors shall be rated for continuous duty, provided class H insulation, integral terminal box with cover plate rated NEMA-4X.
9. Actuators shall waterproof and dustproof, and made from cast aluminum alloy.
10. Brakes shall be equipped with a heater mounted to the insulated bracket on the frame of the brake, on the opposite side of the hand release below the actuator. The heaters shall be rated for 120VAC operation. The heater shall fit inside the removable cover.
11. Each brake shall be equipped with a removable cover that shall be stainless steel and protect the brake and associated equipment.

G. NAMEPLATES

1. Each motor shall have a corrosion – resisting metal nameplate on which is stamped the name of the manufacturer and the rating or capacity of the equipment or apparatus. This nameplate shall clearly identify the equipment and the electrical qualities for ease of inspection, repair and replacement at a later date. The nameplate shall also clearly identify the piece of equipment in relation to the Plans by providing the alphanumeric designation of the equipment as shown in the Plans or the approved shop drawings.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.

The Contractor shall prepare and submit the following working drawings and catalog cuts:

1. Catalog cuts, certified dimensioned prints, and a complete material list for the motor, brakes, limit switches, enclosures, heaters, disc brakes, and encoders to be supplied.
2. Test results.
3. Submit mounting details for the motors and brakes. Mounting details shall show all equipment required to support the equipment. The mounting of the motors and brakes shall conform to and be paid for under the requirements specified for Mechanical Work.

B. INSTALLATION

1. The alignment and fastening of the motors shall conform to and be paid for under the requirements specified for Mechanical Work.
2. Each motor shall be installed with approved sizes and types of wire terminals and splice fittings for the connection of the motors to the circuit wiring. Connections between the rigid conduit system and the motors and brakes shall be made with approved flexible conduit sections not exceeding eighteen inches in length

4.0 MEASUREMENT AND PAYMENT

Motors will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Motors*.

Payment will be made under:

Pay Item	**Pay Unit**
Motors	Lump Sum

PANELBOARD (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install one panelboard and accessories in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Raceway
3. Junction and Pull Boxes
4. Grounding

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. PANELBOARD

1. The panelboard shall be furnished and installed for distribution of the service lighting circuits. Furnish and install one panelboard in the control house. The panel boards shall be as manufactured by Eaton-Cutler Hammer or Square D.
2. The panelboard shall be rated NEMA 12 and be of the dead-front type and shall be provided with circuit breakers. Each panelboard enclosure shall be code gauge

galvanized steel with ANSI 61 light gray enamel finish. Each panelboard shall have a screw cover with a hinged door and flush lock.

3. The panelboard shall be provided with copper lugs in the mains, copper bus and with a full-sized copper neutral bar. The panelboard shall be provided a copper ground bus. All branch circuits shall be numbered, and a typewritten directory shall be provided on the inside of each door. The panelboard shall be provided with number of spaces as indicated on the Contract Plans.
4. Each circuit breaker shall be a quick-make, quick-break, thermal-trip, ground fault current interrupting, branch circuit breakers. Each circuit breaker shall have the short circuit interrupting capacity of 25,000 amperes. Each breaker shall trip free of the operating handle, and the handle shall indicate the position of the breaker. Circuit breakers shall meet the requirements of UL Standard 489.
5. The panelboards shall be a 120/208-Volt, 3-phase, 4-wire panel with number of spaces and breakers as shown on the Contract Plans.

C. NAMEPLATES

1. The panelboard shall have a corrosion – resisting metal nameplate on which is stamped the name of the manufacturer and the rating or capacity of the equipment or apparatus. This nameplate shall clearly identify the equipment and the electrical qualities for ease of inspection, repair and replacement at a later date. The nameplate shall also clearly identify the piece of equipment in relation to the Plans by providing the alphanumeric designation of the equipment as shown in the Plans or the approved shop drawings.
2. Hardware and Supports
3. Mounting bolts, nuts, washers and other detail parts used for fastening panelboards shall be of stainless steel conforming to the requirements of ASTM A593, Type 316. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers. Bolts smaller than ½ inch in diameter shall not be used.
4. Supports for panelboards shall be fabricated from 316 stainless steel not less than ¼ inch in thickness. Channels, angles, bent plates, clip angles, other stainless steel supporting members, hardware and gaskets for supporting electrical equipment shall be paid for under this item.
5. Preformed metal framing channels, such as Kindorf, Unistrut, Superstrut, etc., will not be acceptable for mounting or fastening structural supports for panelboards. The use of J-bolts or beam clamps will not be permitted.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.

The Contractor shall submit in detail the proposed procedures and methods for the installation of the conduit. Working drawings shall be included with the procedures and methods.

The Contractor shall prepare and submit the following working drawings and catalog cuts:

1. Catalog cuts, certified dimensioned prints, and a complete material list for all equipment.
2. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.
3. Submit mounting details for all panelboards. Mounting details shall show all equipment required to support the equipment.
4. Submit test result as specified in this Section.
5. Submit the final panelboard directories.

B. INSTALLATION

1. The top of the panelboard shall not be located more than 6-feet above the finished floor.
2. Revise the typed or computer printed panelboard directory when any loads are added or changed as required for balancing the phases.
3. Provide cover plates for any unused spaces in the panelboard.
4. Surface mounted interior and exterior boxes shall be fastened in position with approved stainless steel through bolts.
5. Mounting bolts, nuts, washers and other detail parts used for panelboards shall be of stainless steel conforming to the requirements of ASTM A593, Type 316. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers. Bolts smaller than ½ inch in diameter shall not be used except as may be necessary to fit the mounting holes in standard devices.
6. Supports for panelboards shall be fabricated from stainless steel not less than ¼ inch in thickness. Channels, angles, bent plates, clip angles, other stainless steel supporting members, hardware and gaskets for supporting electrical equipment shall be paid for under this item.

C. TESTING

1. Visually inspect the panelboards for any damage, proper alignment, anchorage and grounding. Check for proper installation and tightness of connection for circuit breakers and switches.
2. Prior to energizing the panelboards, check the insulation resistance (each phase to phase and each phase to ground), electrical continuity, and for short circuits. Record the measurements and submit the tabulated information to the Engineer for approval.
3. Record the current loading on each phase, and reconnect loads as required to correct for unbalanced loads. Submit the final loading information to the Engineer for approval.

4.0 MEASUREMENT AND PAYMENT

Panelboard will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Panelboard*.

Payment will be made under:

Pay Item	**Pay Unit**
Panelboard	Lump Sum

MOTOR CONTROL CENTER (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install one Motor Control Center and accessories in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Field Measuring
3. Start Up and Commissioning
4. Operation & Maintenance Manuals, Training and As-Built Documentation
5. Raceway
6. Wire and Cable
7. Submarine Cable
8. Junction and Pull Boxes
9. Disconnect Switches
10. Grounding
11. Dry Type Transformer
12. Motors
13. Bridge Control System

C. CONTROL SYSTEM VENDOR

This item shall be part of the equipment supplied by the control system vendor.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)

4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. MOTOR CONTROL CENTER

1. Furnish and install one Motor Control Center (MCC) that shall be constructed to meet or exceed the requirements within NEMA ICS2-322, 1999 NEC, and UL845 for motor control centers. The MCC shall be designed, manufactured, and tested in facilities registered to ISO 9001 quality standards. The MCC enclosure shall be NEMA/EEMAC Type 12. Gasketing shall be closed cell neoprene material. Open cell gasketing shall not be acceptable. The MCC shall be rated for a 480-Volt, 3-Phase, 4-Wire, 60-Hertz system. The starter/contactor coils shall be rated 120 VAC. All mounting hardware and all wire and cable terminals shall be vibration proof.
2. The MCC shall consist of the following components:
   a. Each vertical section shall be a rigid, freestanding structure, approximately 90 inches high and 15 inches deep. Vertical sections shall have internal base mounting angles at the bottom and external lifting angles at the top running continuous within each shipping block. Lifting eyelets at the top are not acceptable. The Contractor shall consider a reduced height MCC for ease of installation. The Contractor shall be responsible for verifying the installation requirements and shipping splits of the MCC for installation at the final location.
   b. To minimize the chance of fault propagation to adjacent sections, each vertical section shall have side sheets extending the full height and depth of the section. Incoming line lug compartment shall be bottom entry. The size and quantity of incoming cables shall be shown on the drawings.
   c. Horizontal wireways of standard sections, both top and bottom, shall be not less than 5 inches high. To prevent damage to cable insulation, the wireway opening between sections shall have rounded corners and the edges shall be rolled back.
   d. A full height vertical wireway and hinged door shall be provided in each standard vertical section, and shall be isolated from the horizontal and vertical bus. Vertical wireways shall be an integral part of each section and shall be independent of plug-in units.
   e. The power bus system shall be copper, supported, braced, and isolated by a bus support molded of a high strength, non-tracking glass polyester material. Minimum bus bracing shall be 42 kA RMS symmetrical.
   f. The horizontal bus shall be continuously braced within each section. Minimum bus bracing shall be 42 kA RMS symmetrical. It shall be copper with silver plating and rated at 600A. Splicing horizontal buses shall be accomplished using a splice kit of at least the same ampere rating as the horizontal bus bar. These horizontal bus splices shall have at least two (2) bolts, and each bolted connection, and shall be independently capable of handling the load.
   g. The vertical bus shall be continuously braced and sandwiched in a glass-filled polyester molding. Minimum bus bracing shall be 42 kA RMS symmetrical. The bus shall be isolated from the other phases. The vertical bus shall be copper

with the same plating as the horizontal bus, and shall accommodate plug-in loads totaling up to 600A.

h. The horizontal ground bus bar shall be tin-plated copper and located in the top horizontal wireway. The size of the horizontal ground bus shall be .25 inches x 1 inch, with an effective 600 A continuous rating. A mechanical screw-type ground lug shall be mounted on the ground bus in the incoming line section.

i. The vertical ground bus bar shall be tin-plated copper and supplied in each standard section. The vertical ground bus bar shall be connected to the horizontal ground bus bar and shall form a continuous internal grounding system.

j. A grounding stab shall be provided on each plug-in unit, such that the stab engages onto a tin-plated copper vertical ground bus before the power stabs are engaged, and shall be maintained as the unit is withdrawn until after power stabs are disengaged.

k. A grounding point shall be provided at each starter unit for purposes of landing the ground wire coming from the motor. A vertical tin-plated copper unit load ground bus shall be provided and connected to the horizontal ground bus bar. The vertical load ground bus with the unit load ground connector shall provide a termination point for the load ground cable at the unit.

l. Shutters shall automatically open when a unit is inserted and automatically close when a unit is removed, so that personnel are not exposed to live vertical bus bars and so that the bus is isolated from arcing faults.

m. All units shall be plug-in types. Plug-in units shall consist of a unit assembly, unit support pan and unit door assembly. After insertion, each plug-in unit shall be held in place by a latch that is located at the front of the unit. Multi-turn latches requiring more than ten (10) turns per latch shall not be acceptable.

n. Plug-in power stab assemblies shall be tin-plated copper and designed to tighten during heavy current surges. The stabs shall be backed by stainless steel spring clips to provide a high-pressure connection to the vertical bus. Wiring from the unit disconnecting means to the plug-in stabs shall be routed into this molding such that the wiring is not be exposed at the rear of the unit. Stab assemblies shall be sized to match the rating of the units. Automatic shutters shall be made available for isolation of unused stab openings.

o. The unit door shall be fastened to the stationary structure (not the unit itself), so that the door can be closed when the unit has been removed. The door shall be hinged on the left-hand side so that it opens away from the vertical wireway.

p. The operator handle of all units shall be interlocked with the MCC frame, so that a unit insert cannot be withdrawn or inserted when the operator is in the ON position.

q. Each motor controller shall be custom wired as shown on the plans to interface with the PLC controls. Each motor controller shall also be equipped with a black reset pushbutton to reset the motor overload. Each motor controller shall also be equipped with a red indicator light that shall energize when the motor overloads.

r. Terminal blocks shall be mounted within the unit and located near the front for accessibility. They shall not be located at the rear of the vertical wireway.

Power terminal blocks shall be provided. Control terminal blocks shall be pull-apart style. Control pull apart terminal shall be rated 25A, 600V, with a maximum wire size of No. 12 AWG. Provide sufficient terminals in each MCC bucket for the control wiring interconnections as shown on the wiring diagrams, with a minimum of 10 terminals in each bucket. All terminal blocks shall with stand vibration and all pull apart terminal blocks shall be held together with captive screws. All terminal block shall be marked to identify the terminations.

s. Wiring within the MCC shall be stranded copper with Type SIS insulation, 90 degrees C rated minimum. Control conductor wiring shall be No. 14 AWG minimum. All wires and terminal blocks within the MCC shall be tagged by the vendor in accordance with the approved working drawings. Manufacturer's standard wiring designations shall not be acceptable in lieu of custom tagging.

t. The MCC shall be designed as an arc containing low voltage MCC to help reduce arc flash hazards in accordance with the requirements of NFPA 70-2014 "Standard for Electrical Safety in the Workplace", NFPA 70E-2015 and the IEEE. The MCC shall be designed and constructed to reduce arc flash hazard. The arc flash protection shall improve personnel protection against internal arcing faults when the doors and covers are closed and secured and with Type 2 accessibility as defined by ANSI C37.20.7-2007. The designed and installed arc protection shall protect personnel when at the front, side and the rear of the MCC enclosure. Arc resistance baffles shall be furnished to allow required venting as for the specified for the individual MCC components. Arc resistant baffles shall allow air flow to help dissipate the heat and still provide Type 2 accessibility. The MCC arc flash protection shall consist of but not be limited to:
    i. Arc-resistant latches on all doors that provides pressure relief and assists in keeping doors latched to the MCC during an arcing fault.
    ii. Arc resistant baffles to allow for the full specified range of MCC equipment for the NEMA 12 enclosure.
    iii. Copper vertical ground bus on all plug-in structures and heavy duty ground stab on plug-in units shall be furnished that provides an effective path for ground fault currents to minimize fault clearing times of installed overcurrent protective devices.
    iv. Automatic shutters shall be provided to act as protection against potential electrical shock hazards from unused plug-in stab openings.
    v. Insulating covers on horizontal bus closing plates shall be provided to assist in preventing "burn through" which potentially could result from arcing faults in the horizontal bus compartments.

u. Power monitoring shall be provided on the MCC. Provide a current transformer and voltage tap on each phase and ground. This shall be fed to a power monitor on the MCC. The power monitor shall be capable of transmitting the information to be displayed on the control desk mounted meter. The power monitor shall be rated for 120VAC input power, and power shall be supplied internally in the MCC. The power monitor shall monitor:
    i. Kilowatt, kilovolt-ampere, Kilo-var
    ii. Voltage values for each phase

iii. Current values for each phase
iv. Kilowatt-hour, kilovolt-ampere-hour
v. Total Harmonic Distortion metering
vi. Ground Fault/Ground Loss

v. The meter shall be a digital meter and shall be flush mounted on the control desk. The fiber optic cables shall provide communication to the display module. The display module shall be capable of being left in one mode of display, such as voltage metering, so that the meter screen can be continuously read during the bridge operation.
w. Provide a surge suppression unit, TVSS style, on the incoming service.
x. The incoming section of the MCC shall house the incoming terminal lugs, the surge suppression unit, the power monitoring equipment, and the phase failure-reversal power failure relay.
y. Wiring diagrams shall be provided at a centralized location in the MCC. Each modular unit shall also be supplied with wiring diagrams and product data. The diagrams shall show the exact devices inside the unit and shall not be a generic diagram. Each diagram shall show the wire numbering and PLC interface information as part of the wiring diagram.
z. Control apparatus shall conform to the applicable requirements of NEMA Pub. No. ICS Industrial Controls and Systems, latest revision, and to the following:
    i. Circuit Breakers: All branch circuits from the buses shall be protected by molded-case circuit breakers mounted on the control panels. All breakers shall have quick-make, quick-break contacts and the mechanism shall be trip-free and trip indicating. Frame sizes shall be not less than 100 amperes. The breakers shall be equipped with thermal-magnetic trips or adjustable instantaneous magnetic trip units. Molded case circuit breakers shall meet the requirements of NEMA Standard AB1, latest revision. Instantaneous magnetic trip circuit breakers, when used, shall only be used for motors and shall be part of a listed combination controller per NEC Article No. 430-52. All circuit breakers shall be equipped with an auxiliary contact to be wired as an input to the PLC.
    ii. Motor Starters and Magnetic Contactors: The continuous current rating of contactors and starters shall be adequate for the connected loads, and no starter shall be smaller than NEMA Size 1. Reversing contactors shall be electrically and mechanically interlocked. IEC style contactors shall not be acceptable.
    iii. Each starter and contactor shall be furnished complete with an electronic overload relay to provide expanded protection, control and preventative maintenance functions. These function shall include:
        A. Thermal overload protection
        B. Phase loss protection
        C. Stall/jam monitoring
        D. Under load monitoring
        E. Current imbalance
        F. Remote trip
        G. Motor diagnostics

H. Ethernet Communications interface
I. Two auxiliary PLC operated contacts
J. Human Machine Interface Ethernet operation

iv. MCC Control System Coordination with the Programmable Logic Controller (PLC): A PLC system shall be furnished in a separate panel, but be fully integrated in the MCC to monitor and control the equipment. The PLC equipment shall be such that it is compatible with the specified Ethernet communications system.

v. MCC Intelligent Communications System: The MCC shall be provided with an integrated communications network distributed throughout each vertical section of each MCC. Each motor starter shall be furnished with a means of communicating through the installed communications network. The communications network shall be Ethernet or Engineer approved equal.

vi. The communication system in the MCC shall include a power supply that conforms to the communication requirements. Communication cables shall be routed through the MCC line-up, behind barriers that isolate the cables from the unit space and wireways to prevent accidental mechanical damage during MCC installation. Provide Ethernet ports in the rear of each full height vertical wireways in each MCC vertical section to simplify installation, relocation, and addition of plug-in MCC units. Adding or removing an Ethernet connections shall not interfere with the operation of the other units in the Ethernet system. Each Ethernet control module shall have two ports to allow connection to the Ethernet.

vii. The MCC shall be provided with pre-configured software. The software communication driver shall allow the software to be installed and operated on Ethernet. The software shall be capable of functioning as stand alone software package and fully integrate with the Human Machine Interface (HMI). The software shall be capable of displaying current and historical equipment status and alarms.

viii. Power Failure Relay: Phase Failure and Reversal Relay: This relay shall prevent energizing the bridge controls in the event of:

A. Reversed phase sequence
B. Loss of one phase
C. Under or over voltage conditions
D. Ground fault or ground loss
E. The relays shall be rated for 480VAC service nominal. The over voltage shall be adjustable between 109% to 113% of the service voltage. The under voltage shall be adjustable between 92% to 88% of the service voltage. The output shall be a 120VAC SPDT isolated 10A relay contact.

ix. Control Transformers: Control transformers shall be high voltage regulation type, low temperature rise, rated 480/120VAC. The transformer shall be sized as shown on the Contract Plans Each transformer shall have a cover to prevent accidental contact with the energized components. The transformer shall be de-energized when the unit operator handle is in the off position.

x. Control Switches and Pushbuttons: hand-off-auto switches and overload reset pushbuttons shall be provided on each motor starter bucket and shall be heavy-duty, oil-tight contact blocks operated by glove handle (pistol grip) selector knobs, selector knobs, or push-buttons as indicated in the Plans. Contacts shall be fine silver, capable of interrupting 6 amperes at 120 volts AC and of continuously carrying 10 amperes. The switches shall be used to transfer to the Ethernet HMI plug in units. Each motor control center bucket with an Ethernet enabled overload shall be wired such that the hand-off-auto switch such that the local HMI controller can be connected to the overload and allow manual operation of the motor.

xi. Indicating Lights: Indicating lights shall be heavy-duty, oil-tight sockets provided with 6-watt lamps rated 120 volts AC. All lenses shall be glass, with color and escutcheon plates as shown in the Plans or called out in this Section.

xii. Nameplates: Nameplates shall be made of laminated phenolic plastic with white front and back and black core and shall be not less than 3/32 inches thick. All electrical equipment shall be provided with a nameplate. The lettering shall be etched through the front layer to show black engraved letters on a white background. Lettering shall be not less than one-quarter inch high, unless otherwise detailed in the Plans. Nameplates shall be securely fastened to the equipment with stainless steel screws.

C. SPECIFIC MOTOR CONTROLS FOR EACH BUCKET

Each motor control bucket shall be equipped with:

1. A factory installed hand-off-auto maintained switch as shown the plans.
2. A circuit breaker auxiliary contact to be wired as an input to the PLC.
3. HMI Ethernet Manual Operator: An operator that will connect to the Ethernet port in each motor starter overload to allow the operator to manually start-stop-forward-reverse operate each motor.
4. Overload Reset Pushbutton

D. SPAN DRIVE MCC SECTION

1. Provide a dedicated section, sized as required by the Manufacturer, in the MCC for the span motor drive. Furnish and install one Flux Vector-Controlled Drive (FVD) system with operating voltages and current rating as shown on the Contract Plans. FVD's shall be UL listed. FVD Systems shall be UL508. Drive shall be Allen-Bradley Heavy Duty Powerflex 753 or approved equal.
2. The flux vector drive shall be sized as part of a span drive system. The motor, drive, and dynamic braking resistor system shall meet the following torque, braking, and overload requirements:
   a. Normal Running Torque: 150 ft-lbs
   b. Starting Torque: 125% for 3 seconds
   c. Overload Torque: 150% for 15 seconds
   d. Motor Full Speed: 850 RPM
   e. Motor Creep Speed: 50 RPM

f. Worst Case Dynamic Braking Cycle Bridge Operation Under Wind Load: 100% Counter Torque Overhauling for 76.1 seconds

Time of Normal Bridge Operation

g. Fully Closed to Fully Open:	76.1 seconds
h. Fully Open to Fully Closed:	76.1 seconds
i. Speed Ramp from Zero to Full Speed:	15 seconds
j. Speed Ramp from Full to Creep Speed:	15 seconds
k. Input Voltage:	3 Phase - 480VAC
l. Speed Ramp from Full Speed to Full Stop	5 seconds
m. Drive Minimum HP Equivalency Rating	Heavy Duty Rated 25 HP

The above ratings shall be the minimum drive ratings for the system equipment. During start-up the Contractor shall tune the drive, but may use lower settings for initial drive start up. The Contractor shall then tune the drive to meet these standards in the field.

3. Each FVD System shall be sized to insure the motor full load amps (FLA) do not exceed the FVD's continuous current rating, with a minimum overload torque of 150% for 15 seconds.
4. Submit a certification letter from the drive and motor manufacturers stating that the components selected can be expected to meet the torque and, overload and control requirements of this specification.
5. FVD Systems specifications and plans are based upon a Rockwell Automation Allen-Bradley 753 Drive and a matched 25HP motor.
6. It is the intent of this specification to describe the minimum performance requirements of the FVD systems. Any deviation from these Contract Documents shall be detailed in writing and submitted to the Engineer for approval, to verify the alternative drive system is an approved equal. No payment for the drives and no equipment may be brought on site until the alternative drive system is approved. Otherwise the Contractor shall submit a letter in writing stating that no deviations from these Contract Documents is required.
7. External reactors, transformers, filters or other components shall be installed inside the MCC section. Only the dynamic braking units may be located outside of the enclosure.
   a. FVD must be a four quadrant drive. FVD shall be capable to run in speed and torque mode with adjustable torque limits in all four quadrants. FVD shall be supplied with encoder feedback through a hardwired connection to the motor encoder. Coordinate the requirements and verify this is compatible with the drive motor.
   b. The FVD shall not "cog" at any frequencies with a 1,000:1 speed regulation. There shall be no sudden frequency shifts and associated acoustical noise shifts as the output frequency is varied between 0 and 60Hz. The motor and FVD shall be able to produce full torque at zero speed.
   c. The FVDs shall have, but not be limited to the following protective features:
      i. Solid state output ground fault protection shall be provided.
      ii. Adaptive electronic motor overload protection shall be provided which shall protect both the motor and the FVD at all frequencies. This overload

must be UL approved. Electronic thermal overload circuits which only protects the motor at full speed shall not be acceptable. The FVD shall sense the load and speed and shall recalibrate the thermal trip curve to insure low speed motor protection. The initial trip point shall be adjustable from at least 40% of the FVD continuous rating to account for motor magnetizing current.

iii. Input surge protection
iv. Input and output phase loss detection
v. Output short circuit protection

d. The FVD shall be provided with the following features:
   i. Ethernet communication and compatibility with the Rockwell Automation Allen Bradley PLC Control Logix equipment. The drive shall full communicate with and be compatible to the Control System, as described in Section Bridge Control System.
   ii. Eight programmable Ethernet inputs for Open, Close, Full Speed, Reduced Speed, Creep Speed, Reduced Torque, and Spare. One dry contact input for Emergency Stop.
   iii. Four programmable digital Ethernet outputs for Drive Trouble, Drive Running, Drive Ready, Spare.
   iv. Programmable current limit.
   v. Remote drive reset contact.
   vi. Minimum of 1,000:1 controllable constant torque speed range. Speed regulation shall be 0.01% or better over the entire speed range.
   vii. Minimum of 2 second power loss ride-through capability, for units 5 HP and larger. In the event of a loss of three-phase power lasting 2 seconds or less, the FVD must maintain operation and prevent nuisance trips upon return of power.
   viii. Provide ammeters and voltmeters on the panels and control desk, as shown on the contract plans.

e. The ‘Drive Trouble’ fault condition shall cause the FVD to shut off and shall be annunciated to the PLC control system through the Ethernet communication network (as described above). The conditions that shall cause a fault condition are as follows:
   i. Blown fuse.
   ii. Instantaneous overcurrent trip.
   iii. DC bus overvoltage.
   iv. DC bus undervoltage.
   v. Excessive ambient. FVD heatsink overtemperature.
   vi. External fault input.
   vii. Internally diagnosed, control failure.
   viii. Motor thermal overload.
   ix. FVD thermal overload.

f. Door Mounted Keypad
   The MCC FVD shall be provided with a door-mounted digital operator control station with the following features:

i. Local/Remote switch for selecting operation either from the digital operators control station or from a remote location. Both start/stop and speed reference signals shall be selected by a single switch.
ii. Jog push button.
iii. Reset push button.
iv. Start push button.
v. Stop push button

Red LED's shall be supplied as a standard on the digital operators station for indication of Hand, Auto, Running, stopped, and drive running with no speed reference signal applied (zero speed).

All drive functions shall be programmable from the door mounted keypad. The keypad shall be equipped with removable EEPROM and be removable so that the parameters that can be downloaded into another drive.

g. Door Ammeters and Voltmeter
The MCC FVD shall be provided with three switchboard type ammeters, one for each phase of the motor, to display real time RMS current load.

h. Input Line
The FVD's shall be supplied with AC input line reactors with a minimum impedance of 5% to smooth the input current waveform and reduce harmonics. Typically this is provided as part of the drive internally.

i. Motor Cable Lengths
The FVD shall be provided with a dV/dT filter mounted and wired in the FVD enclosure or the FVD must have a dV/dT internal circuit. The manufacturer must guarantee the motor/drive system with motor cable lengths of 700 feet. Typically this is provided as part of the drive internally.

j. Drive Output Contactor
The FVD shall be provided with an output contactor to disconnect the load from the drive when the drive is not running and to allow an emergency stop. The output contactor and drive system shall be rated to disconnect the motor while shutting off the drive instantaneously. Contactors must be NEMA rated for across the line motor starting.

k. FVD and Motor Disconnect Switch Interface
The FVD drive system shall be capable of being used with a local motor disconnect switch. The FVD drive shall be rated to safely shutdown when the disconnect switch is opened and sense when the disconnect switch is open in order to not operate. An auxiliary contact in the disconnect switch shall be provided to the PLC to prevent the PLC from operating the drive with the disconnect switch in the disconnected position.

l. Speed Settings
The drive shall be equipped with a minimum of three pre-set speeds that each shall have a unique speed ramp. The speed shall be identified as Full Speed, Reduced Speed, and Creep Speed. Full speed and creep speed shall be as listed above. Reduced speed shall be available, but not initially required. All control set points and connections with the PLC control system shall be coordinated

with Section Bridge Control System and as shown on the Plans. All logical control shall be as described in Section Bridge Control System and as shown on the Plans. The drive shall be equipped with a speed ramp of five seconds from full speed to full stop. The drive shall be equipped with a speed ramp of one second from either creep speed or reduced speed to full stop.

m. Torque Settings

The FVD shall be capable of operating in two distinct torque limiting modes as dictated by PLC Ethernet inputs. The motor torque shall be either limited by the capability of the drive or the torque of the motor shall be limited to zero torque output of the 25-HP motor. The reduced torque setting shall initially be set to zero and shall be adjusted in the field at the direction of the Engineer. This reduced torque limit shall be field adjustable from zero percent to 100% of motor output. The drive manufacturer shall provide all hardware and programming necessary to provide reduced torque function.

n. Dynamic Braking and Overhauling

The FVD shall be capable of handling and controlling overhauling loads on the leaves motors. Independent speed and torque controls shall be provided for each of the four quadrants of motor operation. Dynamic braking resistors and associated interface cards shall be provided by the drive manufacturer such that the drive can operate in the regenerative mode for the entire open or close cycle at normal speed (870RPM) and may last for approximately 90 seconds. The dynamic brakes shall be sized for operation and cooling. If additional cooling, such as fans, are required then fan starting contactors and controls shall be provided as part of the FVD system.

E. BRIDGE CONTROL CONSIDERATIONS

1. The complete flux vector drive, drive motor, associated tachometer encoder, dynamic braking resistor, and all accessories shall be capable of meeting these bridge control considerations.
2. The span machinery is an open and enclosed gear drive train with an accumulated gear lash wind up of approximately one motor revolution from tooth to tooth contact at final reduction. The motor, drive, and encoder feedback must be tunable to allow for this no load zone.
3. Wind loads can cause the load to reverse from being driven to overhauling. The load reversal, combined with the machinery wind up, creates a condition in which the final drive pinion looses contact with the rack tooth and a moment later contact is remade on the opposite side of the pinion and rack teeth. The drive control must be capable of maintaining constant motor speed when the load drops off and smoothly ramping up torque, in the proper direction, when the load returns.
4. The balance of the bridge varies with ice and snow loading. The dynamic load of the machinery may also vary with wind conditions. The drive must be capable of responding to these variations without inducing oscillations into the system.
5. The drive keypad shall be capable of operating the span in the event of a PLC failure, operating the span manually.

F. MOUNTING HARDWARE

1. Anchors for fastening equipment or brackets to concrete surfaces shall be epoxy resin bonded anchors.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare and submit the following working drawings and catalog cuts:

1. Catalog cuts, certified dimensioned prints, and a complete material list for all MCC equipment and accessories. Catalog cuts shall be cross referenced to an equipment schedule detailing all components of each bucket.
2. A complete one line and three line schematic wiring diagram or diagrams showing the interconnection of all devices and equipment.
3. Complete MCC bucket wiring diagrams shall show all wiring and interconnection with other devices outside of the MCC. The diagrams shall use wire numbers and terminal number consistent with the wiring diagrams submitted by the Control System Vendor. Generic bucket wiring diagrams shall not be acceptable.
4. Submit a complete elevation and dimensioned outline drawing of each MCC section, detailing bucket arrangement, wireway and conduit entry.
5. Submit shipping split information and installation path into the control house. Provide procedure for moving the MCC inside the control house without damaging the equipment or the houses.
6. Nameplate engraving schedule.
7. A complete dimensioned drawing showing the interconnection of all drives, resistors, motors, devices and equipment, including ducts and junction boxes, and showing all conduit locations.
8. Submit a certification letter from the drive and motor manufacturers stating that the components selected can be expected to meet the torque, overload and control requirements of this specification.

B. INSTALLATION

1. Install the MCC as shown on the plans. Provide shipping splits as shown on the plans. Provide splice kits in order to re-attach the MCC on site. Field verify that the Motor Control Center can be delivered into the control house by measuring the route through the stairs, handrails, etc. to verify proper fit. Coordinate and schedule the work with other disciplines in order allow proper fit.
2. Provide a full sized rubber pad to mount the equipment on. The MCC unit shall be bolted with epoxy resin bonded anchors to the floor.

C. DRIVE MOTOR TESTING

1. Perform the specified testing required in Motors.

D. DRIVE FIELD TESTING AND TUNING START-UP SERVICES

1. The drive shall be tuned by manufacturer representative as part of the Start-up Services. The drive manufacturer shall submit documentation on the representative

to be selected for the start-up services. The drive manufacturer representative shall be onsite a minimum of on three complete days in order to provide start-up service. During start-up the drive manufacturer representative shall fully tune the drives for proper operation. Operating speeds, times, ramps, ramp times and torque limits shall be submitted to the Engineer during the tuning process and shall be modified at the direction of the Engineer.

4.0 MEASUREMENT AND PAYMENT

Motor Control Center will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Motor Control Center*.

Payment will be made under:

Pay Item	**Pay Unit**
Motor Control Center	Lump Sum

LIGHTING (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish all lighting fixtures, lamps and accessories in accordance with the Plans and these Special Provisions.

B. RELATED WORK

1. Summary of Work
2. Raceway
3. Junction and Pull Boxes
4. Switches and Receptacles
5. Grounding
6. Bridge Control System

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)

7. American Association of State Highway and Transportation Officials (AASHTO)

B. EMERGENCY LIGHTING FIXTURES

1. Battery-operated emergency lighting units shall be furnished and installed in the control house. The lights shall be arranged to turn on automatically and instantaneously upon failure of the a-c power supply, and shall remain on until power is restored.
2. Each emergency light shall consist of two 12-watt equivalent LED style lamp with a solid-state dropout circuit for instantaneous load transfer on A-C failure. The emergency power source shall consist of two sealed, long-life, 10-year minimum, lead-acid batteries which shall be kept at full charge by a solid-state, pulse type battery charger. The battery shall have sufficient capacity to operate the specified lamps for a period of not less than 5 hours. All components shall be furnished in a sheet-steel housing suitable for wall mounting and provided with a permanent conduit connection. Refer the contract plans for part number and manufacturer for approved equal manufacturer.

C. LIGHTING FIXTURES

1. New fixtures shall be provided at the control house where indicated on the Plans. Refer the contract plans for part number and manufacturer for approved equal manufacturer. Fixture types as designated on the Plans shall be as follows:

D. OUTDOOR LUMINAIRES

1. Outdoor service lighting shall be enclosed, gasketted, 150W equivalent LED bulb, completely sealed, and listed for wet locations. The fixture casting shall be die cast aluminum. Each fixture shall be provided with a polycarbonate front.
2. Fixtures shall be wall mounted fixtures and be provided with junction boxes and wall brackets. All exterior hardware shall be Type 316 stainless steel.

E. INDOOR LUMINAIRES

1. Indoor fixtures shall be LED ceiling fixture with painted steel housing, with white powder painted reflector, with prismatic acrylic with light diffusing finish. Furnish with 2-40 Watt equivalent LED tube style lamps. Fixture shall be supplied with stainless steel hubs and factory installed universal ceiling mount brackets. Each fixture shall be four feet in length.
2. The fixtures in the control room shall be dimmable and controlled by a dimmable controller in the room. The Contractor shall coordinate the selection of dimmable fixtures and the switch for proper operation.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.

The Contractor shall submit in detail the proposed procedures and methods for the installation of the equipment. Working drawings shall be included with the procedures and methods. The Contractor shall prepare and submit the following working drawings and catalog cuts:

1. Catalog cuts, certified dimensioned prints, and a complete material list for all equipment.
2. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.
3. Submit mounting details for all equipment, boxes, and raceway. Mounting details shall show all equipment required to support the equipment.
4. Submit details of all penetrations through concrete. Indicate locations for the penetrations, size and quantity of conduits, and procedure for drilling through the concrete. No work shall commence in the field until all locations and procedures are approved by the Engineer.
5. Submit details of all conduit through walls. Indicate locations for the penetrations, size and quantity of conduits, and procedure for drilling through the wall. Submit procedure and material to seal the penetration completely and watertight. No work shall commence in the field until all locations and procedures are approved by the Engineer.

B. MOUNTING OUTDOOR FIXTURES

1. Light fixtures mounted on concrete surfaces shall be installed using approved anchors. Holes for the anchors shall be drilled to the size and depth recommended by the manufacturer using carbide tipped masonry drills providing six inch embedment minimum. Anchors for fastening equipment or brackets to concrete surfaces shall be epoxy resin bonded anchor.
2. Stainless steel brackets, boxes and other equipment mounted on concrete surfaces shall be provided with a full neoprene gasket not less than 1/8-inch thick, between the equipment and the surface of the concrete.
3. Fixtures mounted to the control house or the pivot pier shall be supported securely and safely in accordance with the manufacturers recommendations for the wall mount brackets. All mounting hardware shall be stainless steel. Furnish and install accessories, such as straps, mounting plates, nipples or brackets for workmanlike installation.
4. No new holes shall be drilled into the structural steel. Bolts, accessories, and hole preparation as directed by the Engineer. Submittals showing the procedure for attaching to the steel shall be submitted to the Engineer. No work shall commence in the field until all locations and procedures are approved by the Engineer.

C. MOUNTING INDOOR FIXTURES

1. Support fixtures securely and safely in accordance with the manufacturer’s recommendations. Emergency lights shall be wall mounted in accordance with the

manufacturer's recommendations and the indoor fluorescent fixtures shall be ceiling mounted in accordance with the manufacturers recommendations. All mounting hardware shall be stainless steel. Furnish and install accessories, such as straps, mounting plates, nipples or brackets for workmanlike installation.

4.0 MEASUREMENT AND PAYMENT

Lighting will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Lighting*.

Payment will be made under:

Pay Item	**Pay Unit**
Lighting	Lump Sum

SIREN (SPECIAL)

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install a new siren mounted to the control house.

B. RELATED WORK

1. Summary of Work
2. Bridge Control System

C. CONTROL SYSTEM VENDOR

1. This item shall be part of the equipment supplied by the control system vendor.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. SIREN

1. Furnish and install a new siren. The siren shall be an air horn with a compressor and dual projectors, as manufactured by B&B Roadway Model AHR-2, or approved equal.
2. The siren shall be mounted such that one projector is aimed up the channel and the other project away from the channel.
3. The projectors shall be of stainless steel, approximately 16" in overall length each, and shall feature a diaphragm designed for high pressure operation and low air consumption. The projectors shall be capable of producing a tone between 260 and 300 Hz with a decibel rating of 120db at 10 feet. Tone and volume shall be field adjustable.
4. Compressor motor shall be 1HP, 120V, 60Hz. Compressor shall be a weatherproof, rapid response, direct drive piston type compressor. Piston and cylinder shall be an oil-less, nonlubricated type, with a Teflon compound piston ring. Compressor valves shall be stainless steel. Bearings shall be permanently sealed, pre-lubricated ball type, requiring no maintenance. All components and fasteners shall be corrosion resistant.
5. The standard air horn assembly shall be a single unit comprised of compressor and horns and shall be suitable for outdoor mounting.
6. The air horn shall be directly wired to the pushbutton on the control desk for operation of the air horn.
7. All equipment shall conform to all Coast Guard Requirements.

3.0 CONSTRUCTION METHODS

A. SUBMITTALS

The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work.

The Contractor shall prepare and submit the following working drawings and catalog cuts:

1. Catalog cuts, certified dimensioned prints, and a complete material list for all equipment.
2. A complete schematic conduit and cable diagram or diagrams showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multi-conductor cables. The size of each conduit, and the wire number of each conductor in conduit and multi-conductor cables, shall be shown on the diagrams. Each conduit and multi-conductor cable shall be suitably numbered or lettered, and percent wire fill shall be shown.
3. Submit mounting details for all equipment, boxes, and raceway. Mounting details shall show all equipment required to support the equipment.

4.0 MEASUREMENT AND PAYMENT

Siren will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Siren*.

Payment will be made under:

Pay Item	**Pay Unit**
Siren	Lump Sum

BRIDGE CONTROL SYSTEM **(SPECIAL)**

1.0 DESCRIPTION

A. WORK INCLUDED

Furnish and install a new complete electrical control system for bridge operation.

B. RELATED WORK

1. Summary of Work
2. Field Measuring
3. Start Up and Commissioning
4. Operation & Maintenance Manuals, Training and As:Built Documentation
5. Utility Service, Medium Voltage Equipment, Automatic Transfer Switch and Generator
6. Electrical Demolition
7. Wire and Cable
8. Switches and Receptacles
9. Disconnect Switches
10. Grounding
11. Dry Type Transformer
12. Motors
13. Motor Control Center

C. CONTROL SYSTEM VENDOR

1. This item shall be part of the equipment supplied by the control system vendor.

2.0 MATERIALS

A. REGULATORY REQUIREMENTS

In addition to Section Electrical Summary of Work, the Contractor shall perform all work and install all materials and equipment in accordance with the applicable sections of the following:

1. Institute of Electrical and Electronic Engineers
2. International Cable Engineers Association (ICEA)
3. Life Safety Code (NFPA 101)
4. National Electric Safety Code
5. National Electrical Manufacturers Association (NEMA)
6. National Fire Protection Agency 70 National Electric Code (NEC)
7. American Association of State Highway and Transportation Officials (AASHTO)

B. GENERAL REQUIREMENTS

1. All metal parts of the electrical installation, except structural steel, shall be of corrosion–resisting material, such as bronze or 316 stainless steel. Cast-iron, malleable iron, or steel with a hot-dip galvanized finish shall be used where specified in the Plans and these Special Provisions. Structural steel shall conform to the requirements given elsewhere in the Plans and these Special Provisions.
2. No electrical components shall be mounted on walkways, gratings, etc. such that a tripping hazard is created. Also, equipment shall not be mounted in direct contact with structural steel or concrete. Steel stand-offs shall be furnished and installed by the Contractor for said equipment such that accumulation of debris between the structure and mounted component is minimized. A minimum of two-inches air space shall be maintained between surface and the mounted device for outdoor installations and a minimum surrounding air space of ¼ inches for all installation in controlled environments.

C. HARDWARE AND SUPPORTS

1. Mounting bolts, nuts, washers and other detail parts used for fastening boxes, disconnect switches, limit switches, conduit clamps, cable supports, brackets and other electrical equipment shall be of stainless steel conforming to the requirements of ASTM A593, Type 316. Bolt heads and nuts shall be hexagonal, and shall be provided with medium series lock washers. Bolts smaller than ½ inch in diameter shall not be used except as may be necessary to fit the mounting holes in small limit switches, boxes and similar standard devices.
2. Supports for cables, boxes, cabinets, disconnect switches, limit switches and other separately mounted items of electrical equipment shall be fabricated from 316 stainless steel not less than ¼ inch in thickness. Channels, angles, bent plates, clip angles, other stainless steel supporting members, hardware and gaskets for supporting electrical equipment shall be paid for under this item.
3. Stainless steel brackets, boxes and other equipment mounted on concrete surfaces shall be provided with a full neoprene gasket not less than 1/8-inch thick, between the equipment and the surface of the concrete.
4. Anchors for fastening equipment or brackets to concrete surfaces shall be epoxy resin bonded anchors.
5. Preformed metal framing channels, such as Kindorf, Unistrut, Superstrut, etc., will not be acceptable for mounting or fastening structural supports, conduits, boxes, or other electrical equipment. The use of J-bolts or beam clamps to fasten structural supports or to clamp conduits, boxes, or other electrical equipment will not be permitted.

D. CONTROL APPARATUS AND MISCELLANEOUS EQUIPMENT

Control apparatus shall conform to the applicable requirements of NEMA Pub. No. ICS Industrial Controls and Systems, latest revision, and to the following:

1. Circuit Breakers: All branch circuits from the buses shall be protected by molded-case circuit breakers mounted in the control panels on DIN rails. All breakers shall have quick-make, quick-break contacts and the mechanism shall be trip-free and trip indicating. The breakers shall be equipped with thermal-magnetic trips or

adjustable instantaneous magnetic trip units. Molded case circuit breakers shall meet the requirements of NEMA Standard AB1, latest revision. Instantaneous magnetic trip circuit breakers, when used, shall only be used for motors and shall be part of a listed combination controller per NEC Article No. 430-52.

2. Master Control Relays: Master control relays shall be multicontact magnetic machine tool relays with contacts rated at 10 amperes, 600 volts on a continuous basis. Each control relay shall be equipped with surge suppression.
3. Industrial Control Relays: Industrial control relays shall be multicontact magnetic machine tool relays with contacts rated at 10 amperes or 20 amperes, 600 volts on a continuous basis. The contact rating shall be selected to coordinate with the rating of the protection device on the wiring diagrams. Each control relay shall be equipped with surge suppression.
4. Timing Relays: Time-delay relays shall be of the electro-pneumatic type providing time delay intervals as required with a linear timing range in the ratio of 1:10. Each timing relay shall be provided with a timing head calibrated in linear increments. The number and type of poles shall be as shown in the Plans.
5. Control Switches, Key Operated Switches, Selector Switches and Push-buttons: Control switches, key operated switches, selector switches and push-buttons on the control desk and panels shall be heavy-duty NEMA type, 1.2 inch diameter base, oil-tight contact blocks operated by glove handle (pistol grip) selector knobs, selector knobs, or push-buttons as indicated in the Plans. All switches and pushbuttons shall be equipped with escutcheon plates as shown on the plans. Contacts shall be fine silver, capable of interrupting 6 amperes at 120 volts AC and of continuously carrying 10 amperes. Key operated switches shall be wired and configured such that the key can only be removed in the off position.
6. Emergency Stop Push-button: Buttons on the control desk shall be heavy-duty, 1.2 inch diameter base, 2.25 inch diameter mushroom head, oil-tight contact blocks operated by pushing in and pulling out the button mushroom head as indicated in the Plans. The Emergency Stop button shall illuminate when the button mushroom head is pulled out to clearly indicate the emergency stop button has been de-activated. Pulling out the button mushroom head shall deactivate the emergency stop condition. The pushbutton shall be equipped with an escutcheon plate as shown on the plans. Contacts shall be fine silver, capable of interrupting 6 amperes at 120 volts AC and of continuously carrying 10 amperes. The quantity of contacts shall be as shown on the plans. The push-button shall be equipped with surge suppression.
7. Indicating Lights: Indicating lights shall be heavy-duty NEMA type, 1.2 inch diameter base, oil-tight sockets provided with 6-watt lamps rated 120 volts AC. All lenses shall be glass, with color and escutcheon plates as shown in the Plans.
8. Terminal Blocks: Terminal blocks for conductors of Size No. 8 AWG and smaller shall be modular, DIN rail mounted, corrosion resistant, tubular screw clamp type with vibration proof pressure plates. Conducting parts shall be nickel plated copper and insulating material shall be flame retardant thermo plastic. Corrosion resistant marking strips shall be provided for conductor identification. At least ten- percent spare terminals shall be provided.
9. Terminal Connectors: Terminal connectors shall be seamless, heavy-duty compression pin tongue terminals manufactured from pure electrolytic copper

tubing. Terminals shall be tin plated and provided with a double-thick tongue and insulation grip. Terminals and compression tools shall be as approved by the Engineer.

10. Nameplates Plates: Nameplates shall be made of laminated phenolic plastic with white front and back and black core and shall be not less than 3/32 inches thick. All electrical equipment shall be provided with a nameplate. The lettering shall be etched through the front layer to show black engraved letters on a white background. Lettering shall be not less than one-quarter inch high, unless otherwise detailed in the Plans. Nameplates shall be securely fastened to the equipment with a waterproof epoxy.
11. Receptacles: All receptacles shall be 20-ampere, 125-volt, three-wire, grounding type, polarized, ground fault current interrupting (GFCI) duplex convenience outlets. Each indoor receptacle shall be flush mounted in existing a new stainless steel outlet box and shall be provided with a Type 304 stainless steel cover plate. Outdoor receptacles shall be similar except each receptacle shall be provided with waterproof cover plate and shall be mounted in a waterproof, cast-iron, hot-dipped galvanized, surface mounted box. Receptacles shall be specification grade.
12. 24VDC Power Supplies: All 24V DC power supplies shall be rated for 120VAC input at 60 hertz, and 4A, 24V DC output. The power supplies shall be single output, regulated linear DC power supply. The power supply shall be convection cooled, constant voltage, short circuit proof, current limiting (automatic reset) unit with an output voltage adjustment of +/- 5%, and input/output isolation of 1,000 mega-ohms DC. The power unit shall operate over a temperature range of 0° Celsius through 55° Celsius. Units shall be DIN rail mountable, finger safe for mounting in the control desk, main PLC panel, and Remote I/O PLC panel.
13. Flasher Unit: Flasher units shall be digital solid state flashers, type B&B Roadway FL-120 or approved equal. The circuitry shall be encapsulated and rated up to 10A at 120VAC.

E. CONTROL DESK

1. A bridge control desk shall be furnished and installed in the control house where shown on the Contract Plans. On the desks shall be mounted all devices for controlling operation of the bridge and its associated equipment.
2. The desk shall be of neat, substantial construction. The desk shall be fabricated from No. 11 gauge sheet-steel, properly formed and suitably reinforced to provide adequate strength. The desk top shall be fabricated of No. 11 gauge, Type 302, stainless steel sheet with a non-glare, satin finish. Removable doors shall be provided in the front and side panels of the desk, pivoted on 90 degree hinges, and secured with flush type, three-point latches. The desk shall be neatly fitted up with close joints, all rough edges or corners shall be ground off smooth, and all projecting edges rounded off. All metal hardware shall be of substantial construction and shall have a satin-chrome plate finish. All equipment mounting screws and bolts shall be stainless steel.
3. The control desk top shall be hinged to allow the desk to be lifted open as shown on the plans. Provide hydraulic supports that will extend to secure the desk top in a raised position, but can be compressed manually to lower the desk top. Provide one

support on each side of to the desk. The supports shall be rated to fully support the weight of the desk top.

4. The sheet-steel portions of the desk and all metal reinforcing shall be painted inside with two coats and outside with three coats of paint, consisting of one coat of primer followed by two coats of enamel on the outside surfaces and one coat of white enamel inside. The finish coat shall be ANSI 61 light grey enamel. of a color to match the house interior. Color samples shall be submitted for approval to the Engineer. The stainless steel desk tops shall not be painted.
5. Special care shall be taken throughout the construction to insure that the stainless steel desk top and the equipment mounted thereon are completely protected from damage or defacement at all times.
6. Meters shall be mounted on the inclined panel at the rear of the main control desk stainless steel top. All meters shall have uniformly spaced graduations in black on a white background. The meters shall be approximately 4½ inches square, with circular scales about 7 inches long, and shall be mounted semi-flush. The meters shall be switchboard rated, shock and vibration resistant, complying with ANSI C39.1 specifications and UL recognized. All meters shall provide 270° rotation with 1% accuracy.
7. The power monitor display meter shall be as specified in Section Motor Control Center. They shall be mounted and installed in the control desk as shown on the plans.
8. The desk interior shall be suitably lighted and controlled by a switches mounted near and operated by the front doors. One duplex GFCI receptacle shall be mounted in the desk's interior.
9. The control desk top surface shall be illuminated by a desk light. The light shall be equipped with a gooseneck to allow the light to be moved easily and then remain in that location. The light shall be 10W at 120VAC and equipped with a built in dimmer switch at the base of the unit.
10. All contact blocks for control switches, push-buttons, and other control devices shall be mounted within the body of the desk. The operators for these devices shall protrude through the desk top. The indicating lights for each operation shall be mounted adjacent to the control device governing that operation.
11. The escutcheon plates of all control switches, push-buttons, tumbler switches and bypass switches shall be made of a hot-polished, laminated phenolic compound identical in construction to the nameplates herein before specified. All corners shall be rounded, and the edges of the plates shall be chamfered. All engraving shall be upper case, standard gothic characters, cut through the white surface into the intermediate black layer. All plates shall be securely fastened to the desk top with stainless steel screws.
12. The wiring within the control desk shall be insulated switchboard wire conforming to the requirements of Section Wire and Cable for wiring on the control panels. The wiring shall be arranged systematically so that all circuits can be readily traced. All conductors shall be terminated on easily accessible terminal blocks mounted inside the desk at the rear. Spare terminals totaling at least 10 percent of those actually used shall be provided. Wiring shall be identified at equipment terminals by

marking the adjacent area with machine printed black Mylar labels to correspond to conductor designations appearing on the Contractor's wiring diagrams.

13. Indicating lights shall be mounted on the control desk to show that the various steps in the sequence of operation have taken place so that the operator may proceed to subsequent steps at the proper time. The functions to be indicated and the color of the lenses shall be as shown on the Contract Plans.
14. The position transmitter shall be connected to a three digit field filed programmable LED digital display mounted on the control desk to indicate the position in degrees of each of the leaves. The display shall be capable of being linearly scaled to set opening degrees. It shall be fully compatible with the position transmitter output provided and PLC transmission of the signal. It shall be powered by a 24 volt DC power supply located in the control desk.
15. The PLC remote I/O node, including a rack and all associated equipment, shall be mounted within the control console to incorporate the selector switches, pushbuttons, indicating lights, and console meters with the PLC. That equipment shall be as specified below in section Programmable Logic Controller.
16. Furnish and install locks on the panels that are not located inside the control house and in accordance with the requirements in Section Electrical Summary of Work. See Section Electrical Summary of Work for items that require locks.
17. A PanelView terminal shall be mounted on the Control Desk in the control house. The panel shall be color and provide a display for alarm messages. The panel view shall be equipped with touch screen. The PanelView shall have a real time clock to time and date stamp alarms. It shall communicate via Ethernet. The PanelView shall be equipped with a serial port for connection to the Alarm Printer. The PanelView shall be fully programmed by the Control System Vendor, and alarm messages shall be programmed into the PanelView memory and displayed on the screen in response to receiving individual bits from the defined bit arrays from the PLC processor. Upon receiving an individual bit from the defined bit array the bit arrays the Panel View will display the alarm, store the alarm in the internal register, and print the alarm in order that the alarms bit arrays are received.

F. PROGRAMMABLE LOGIC CONTROLLER

1. The programmable logic controller (PLC) shall be an Allen Bradley (AB) ControlLogix brand PLC with components, hardware and remote input/output drops. No substitutions shall be accepted. The PLC shall be of fully modular construction, provide high speed peer-to-peer networking, and be programmable with ladder logic.
2. The PLC system will consist of two redundant 1756-L72 CPU’s with a ‘Hot-Backup’ redundancy module configuration.
3. The PLC shall be provided with the following features:
   a. 1.5M of battery backed static RAM.
   b. 1.5M of Nonvolatile RAM.
   c. Ethernet communication
4. Each PLC remote input/output rack will be connected to both CPU’s by means of a communication bus that will use Ethernet as the method of communication.
5. Each PLC rack shall be supplied with a ControlLogix chassis as shown on the plans.

6. Each input and output card shall be equipped with cage clamp removable terminal blocks wiring arms, oversized housings, and covers. The contractor shall provide terminal blocks as needed.
7. Each PLC chassis shall be provided with an Allen Bradley power supplies.
8. All parts shall be as shown on the planes.
9. The alarm printer shall be an Epson LQ-590 or approved equal, 300 cps, printer with a tractor drive for continuous feed. The printer shall be rated for 120VAC, equipped with a power cord, and equipped with a serial RS-232 port printer cable to connect to the PanelView unit. The printer shall be compatible with PanelView unit and shall connect with the unit to print reports directly from the PanelView unit. The printer shall be supplied with a printer stand and paper supply.
10. The Contractor shall furnish and install three active line filters, one on the Main PLC power supply, one on the Remote I/O PLC panel, and one on the Control Desk power supply to protect the PLC equipment and controls. The noise filter shall be a series connected high frequency noise filter with transient protection. It shall offer hard wired connection to all critical loads and rated for an industrial environment and equipment. It shall reduce mode transient to +/- 2 volts, have a surge capacity of 45,000 amps, provide transient protection in all modes (line to neutral, line to ground, and neutral to ground), have an LED power indication, and be UL approved. The 120VAC MCOV shall be rated 150 VRMS. The line frequency response time shall be less than 0.5 nano-seconds. The operating temperature shall be –40°C to 45°C at full load. The unit shall be capable of protecting against a peak surge current of 15,000 amps in all modes.
11. Furnish and install Ethernet switches in the MPLC Panel, the RPLC Panel, and the Control Desk. The switches shall be Rockwell Automation Allen Bradley Stratix Switch with fiber optic connections and a minimum of 10 Ethernet ports.

G. COMPUTER AND SOFTWARE

1. Furnish and install a semi-rugged, outdoor, environmentally protected laptop computer with specified software, suitable for programming the PLC, PanelView and flux vector drive systems. The computer shall be the latest commercially available unit Panasonic ToughBook 53 or approved equal. It shall meet the minimum requirements of Intel® Core™ i5-4310U vPro™ Processor, 2.0GHz with Turbo Boost up to 3.0GHz, and Intel Smart Cache 3MB. The RAM memory shall be 8GB SDRAM (DDR3L-1600MHz), and equipped with a shock-mounted flex-connect hard drive with quick-release, 500GB. The unit shall be wi-fi and Bluetooth enabled. The unit shall be equipped with all ports and connectors required for the PLC software and the Drive software to utilize the programming software and connect to the equipment. The unit shall be an intelligent terminal, functioning both as a PLC/vector drive programming and data monitoring terminal. It shall permit PLC programming, including loading, editing, and monitoring ladder diagram programs in memory by entering through the keyboard and monitoring on the display. PLC program instructions shall be in ladder logic.
2. Furnish and install a portable printer that shall be both battery and AC operated. The portable computer shall be a Cannon Bubble Jet BJC-80 or approved equal. The portable computer shall be equipped with a paper feeder. Furnish and install a

"Starter" kit including at a minimum serial/parallel connection cables, surge protector, tool kit, etc.

3. The following software applications shall be loaded onto the computer and made fully operational by the Contractor:
   a. Windows operating system. Contractor shall verify all software can operate properly on the operating system and coordinate with the software vendors and the operating platform requirements to select the proper software version.
   b. PanelVeiwBuilder32 – PanelView programming software, Allen Bradley Part No 2711-ND3.
   c. Factory PLC Processor and Network Communication Software in the RS Logix line Studio 5000 Logix Designer from Rockwell Software® for ControlLogix Processor Programming
   d. PanelView Programming Software: FactoryTalk View Studio Machine Edition from Rockwell Software® Version 8.1
   e. Vector drive monitoring software.
4. The Contractor shall demonstrate operation and use of the software as part of the personnel training as specified in Section Operation & Maintenance Manuals, Training and As-Build Documentation.

H. ENCLOSED CONTROL PANELS

1. Control panels shall be enclosed in free standing cabinets that shall be furnished and installed in the control house and where shown on the Contract Plans. All circuit breakers, drives, switches, contactors, starters, relays, and other apparatus for control of the span and ancillary equipment shall be mounted on these enclosed panels. The arrangement and line up of the individual control cabinets shall be as shown on the Contract Plans.
2. All equipment in each control cabinet shall be mounted on sheet-steel back plates, and each device shall be front-connected, front-wired, and removable from the front. The equipment in all cabinets shall be arranged for ease of access and for safety and convenience of operation. Special care shall be taken to obtain a systematic and neat arrangement of the equipment. Each device shall be suitably named and plainly marked by a laminated nameplate mounted near the device on the panel. Each nameplate shall show an approved descriptive title for the apparatus, together with the device designation appearing on the schematic wiring diagrams.
3. Each control cabinet shall be rated NEMA 12 when installed in temperature controlled areas, otherwise they shall be rated NEMA 4X stainless steel. The NEMA 12 enclosures shall be constructed of No. 12 gauge sheet-steel and shall be reinforced with steel angles or channels so as to provide a rigid, free-standing structure. The control cabinets shall be provided with hinged doors on the front of each panel section. Door panels shall be gasketed and shall be provided with three-point, vault-type latches. All hardware shall be corrosion resistant. Each panel shall be provided with suitable interior light fixtures and a duplex receptacle.
4. The NEMA-4X stainless steel enclosures shall be constructed of 316 stainless steel and shall be reinforced with steel angles or channels so as to provide a rigid, free-standing structure. The control cabinets shall be provided with hinged doors on the front of each panel section. Door panels shall be gasketed and shall be provided

with three-point, vault-type latches. All hardware shall be corrosion resistant. Thermostatically controlled strip heaters shall be provided in each cabinet to prevent build up of excess moisture. The strip heater shall be rated for 120 VAC.

5. Each control panel enclosure shall be sized as shown on the plans, with a maximum height of 90 inches. The length of each assembly shall be such as to permit mounting in the available space along the walls of the control house. If the final cabinet dimensions, as established by the manufacturer, should necessitate rearrangement or modification of the equipment in order to fit in the available space, such rearrangement or modifications shall be made and at no extra cost to the contracting agency. The final arrangement of all equipment in the control house shall be subject to the approval of the Engineer.
6. The control panel enclosures, back plates, and all metal reinforcing shall be painted inside with two coats and outside with three coats, consisting of one coat of primer followed by one coat of gray or white enamel on the inside surfaces and two coats of gray enamel outside. The finish exterior coat shall be ANSI 61 light gray enamel.
7. All contactors, relays, and other devices shall be of required current carrying and interrupting capacity. All apparatus shall be of substantial construction and shall conform to the requirements of NEMA Standards Publications ICS 1 and 2, latest revision, for industrial control devices.
8. All wiring installed within the control cabinets shall be flame-retardant, ethylene-propylene insulated, switchboard wire, Type SIS. Conductors shall be stranded copper not smaller than No. 14 American Wire Gauge.
9. For each assembled control panel, all outgoing wire, No. 8 AWG or smaller, shall be connected to terminal blocks installed at the sides of in the cabinet. The control panels shall also provide sufficient extra terminals to allow connection of all wires coming from limit switches and other devices that go on to the bridge control desk and other locations as required, even though these wires do not connect to apparatus on the control panels. Spare terminals totaling at least ten (10) percent of those actually used shall be provided. Each terminal shall be identified per wire number shown on the Contractor's schematic wiring diagrams.
10. All panel wiring shall be arranged systematically so that circuits can be readily traced. The wiring shall be installed in a network of troughs consisting of horizontal and vertical sections securely bolted to the panels. The troughs shall be fabricated from heavy duty Noryl plastic shaped into a channel cross-section. After installation of the wiring, an insulated, flanged cover shall be fitted over the open side of each trough section.
11. Furnish and install locks on the panels as shown on the Contract Plans in accordance with the requirements in Section Electrical Summary of Work.

I. LIMIT SWITCHES

1. Existing Span Rotary Cam Limit Switches
   Straight drive rotary limit switches are used on the bridge for span position. The limit switch shall be reused and integrated in to the control system. Limit switch cams shall be adjusted as required for proper operation in the new control system.
2. Wedge Rotary Cam Limit Switches

Furnish and install a single straight drive rotary limit switch shall be furnished and installed in the wedge gearing where indicated on the Contract Plans. The limit switch shall be a rotary, cam-operated limit switch and shall be driven by gearing furnished with the wedge machinery which shall rotate the input shaft. Integral gearing shall be provided to coordinate with the field gearing. The limit switch shall have the number of circuits as shown on the plans, and each shall be individually micro-adjustable and provisions for internal vernier adjustments. The limit switch shall allow for a one-quarter (¼) degree contact operation repeatability. Each contact of the limit switch shall be single-pole, double-throw, precision-type, snap-action switches. Each limit switch shall be installed within a NEMA 4X enclosure. Each switch shall be preset at the factory to the settings shown on the Contract Plans. It shall be the Contractor's responsibility to determine the proper direction of rotation of each switch and to advise the manufacturer accordingly.

3. Span Position Proximity Limit Switches
   A total of six proximity limit switches shall be furnished and installed, two on the near pier and two on the pivot pier to provide circuits for sequence interlocking and indication. Six switches, two on the near pier and four on the pivot pier as shown on the Plans, shall be installed for:

   a. Fully Open Indication
   b. Fully Closed Indication
   c. Fully Open Overtravel Indication
   d. Fully Closed Overtravel Indication
   e. Auxiliary Drive Interlocking Limit Switch
   f. Wedge Hand Crank Limit Switch

   Each limit switch shall be actuated directly by the metal tripping plate.

4. Position Transmitter Resolver
   Furnish and install one position transmitter resolver and wire as an input to the PLC to span position information. This signal shall be converted into a 4-20 mA signal format and be transmitted via the PLC to the Control Desk. The unit shall be rated NEMA-4X and connect as shown on the plans.

   The position resolver shall produce an analog signal via a brushless resolver. This signal shall be converted into a 4-20 mA signal format by a radiometric-tracking converter. The position resolver shall retain positional information, even in the event of a power failure to provide a fully absolute position resolver system. The position resolver shall be a single turn, heavy-duty, Size 40, and mounted in a NEMA-4X enclosure. The outputs shall be furnished with short-circuit proof PNP transistors. The unit shall be furnished with a lockable, external toggle switch to allow changing of count direction without opening the housing. The unit shall be powered by a separately protected 24-volt DC source, located in the Remote I/O PLC panel. The unit shall provide a 4-20 mA output with end mount connector and multiconductor cable as provided by the manufacturer.

5. Waste Water Holding Tank Float Switch
   Furnish and install a tilt activated float switch tethered to the inside of the waste water tanks with a factory sealed waterproof cable. The unit shall be rated for

120VAC, 10A contacts, and shall be provided with a normally closed contact that shall be wired into the PLC inputs as shown on the plans. The unit shall be submersible and rated NEMA-6P. The float switch shall be mounted such that it provides a waste water full alarm when the tank is approximately 85% full, allowing time to schedule corrective action. All connections to the tank shall be watertight. Furnish and install a NEMA-4X terminal box adjacent to the tank to transition from conduit and single conductor wire to the limit switch provide waterproof cable. The Contractor shall field verify the float switch factory installed cable length with the mounting location of the tethered float switch inside the tank and the terminal box.

3.0 CONSTRUCTION METHODS

A. SHOP/WORKING DRAWINGS

1. The Contractor shall prepare the shop/working drawings in accordance with Section Electrical Summary of Work. The list of submittal requirements is provided in Section Electrical Summary of Work.

B. CONTROL SYSTEM VENDOR

1. All apparatus and equipment of the bridge control system, including, but not limited to, limit switches, motor control equipment (Motor Control Center, Motor Drives, etc.), control panels, panelboards, Control Desk, PLC hardware, PLC ladder programs and other apparatus required to provide proper functioning of the control system, shall be manufactured and/or furnished, assembled, integrated and programmed by a single qualified control system vendor. The vendor shall assemble the control panels at an Underwriters Laboratory approved facility in accordance with UL 508. The control system vendor is completely responsible for providing and coordinating all programmable controllers, panels, and field instrumentation specified in this section and the following sections:
   a. Field Measuring
   b. Start Up and Commissioning
   c. Operation & Maintenance Manuals, Training and As-Built Documentation
   d. Electrical Refurbishing
   e. Disconnect Switches
   f. Dry Type Transformer
   g. Motors
   h. Motor Control Center
   i. Siren
   j. Bridge Control System
2. All of the above listed equipment and equipment listed in this Section Bridge Control System shall be furnished, integrated, programmed, tested, and supplied by the control system vendor. The control system vendor shall name an individual who shall assume the responsibilities. The individual and control system vendor shall be interchangeable where action is required of the control system vendor. This person shall be the sole contact between the Contractor and the Engineer for the purposes

of coordination of the electrical control systems and resolving conflicts. This person shall be present during and in charge of all control system related activities during the installation and start-up of all critical elements and shall be present during all testing, calibration and acceptance testing.

3. Due to the critical and complex technical requirements of this section, only those suppliers who can demonstrate that they possess the requisite knowledge, capabilities and experience with the equipment being installed shall be acceptable. The control system vendor shall have experience in providing electrical control systems for movable bridges of various types, including bascule, vertical-lift, floating, and swing bridges, and control systems, incorporating Programmable Logic Controllers (PLC) and modern drive systems. In addition to this the control system vendor must have successfully designed, manufactured and commissioned flux vector drive systems for heavy movable structures and high inertia overhauling loads. Such experience shall be demonstrated by identifying a minimum of five movable bridges for which the system vendor has provided complete systems, including PLC based movable bridge and auxiliary controls hereinafter specified.
4. The control system vendor shall assume complete system responsibility for the integrated functioning of all components to provide a satisfactory system operating in accordance with specified requirements. The control system vendor shall be responsible for the detailed schematics and fabrication of the modified control and power distribution system to ensure compatibility of equipment and suitability for the intended system functioning. The control system vendor shall provide supervisory assistance in the installation of equipment at the bridge site to ensure maximum reliability and ease of maintenance.
5. The system vendor shall provide a warranty as specified in Section Electrical Summary of Work.
6. The Contractor shall provide a control system vendor qualification package. This shall include written certification of compliance with specified requirements for his control system vendor. This certification shall be submitted immediately after award of the Contract and shall be subject to approval by the Engineer. No work shall begin on the bridge control system or motor control equipment, or payments to the Contractor shall be made prior to submission and approval of the certification of compliance for the control system vendor by the Engineer.

C. CONTROL SYSTEM VENDOR RESPONSIBILITIES

1. The Control System Vendor shall assume complete system responsibility for the integrated functioning of all components to provide a satisfactory system operating in accordance with specified requirements. The Control System Vendor shall be responsible for developing the detailed schematics and fabrication of the control and power distribution system to ensure compatibility of equipment and suitability for the intended system functioning. The Control System Vendor shall provide supervisory assistance in the installation of equipment at the bridge site to ensure maximum reliability and ease of maintenance.
2. The Control System Vendor shall provide field service staff capable of providing field coordination of construction and final adjustments to the bridge control system. Field staff shall be capable of responding to an emergency within 24 hours.

D. CONTROL SYSTEM VENDOR QUALIFICATIONS

1. Due to the critical and complex technical requirements of this section, only those suppliers who can demonstrate that they possess the requisite knowledge, capabilities and experience with the equipment being installed shall be acceptable.
2. The Control System Vendor shall have experience in providing electrical control systems for movable bridges of various types, including bascule, vertical-lift, and swing bridges incorporating Programmable Logic Controllers (PLC) and AC-Thyristor drive systems, DC and AC Flux Vector (VFD) drive systems. In addition to this the Control System Vendor must have successfully designed, manufactured and commissioned flux vector drive systems for movable bridges. Such experience shall be demonstrated by identifying a minimum of 5 movable bridges for which the system vendor has provided complete systems, for electrical motor Drives and PLC based movable bridge and auxiliary controls hereinafter specified.
3. The Contractor must provide a submittal showing written certification that the proposed Vendor meets the experience requirements described above. No work shall begin on the bridge control system or motor control equipment prior to submission and approval of the certification of compliance for the Control System Vendor by the Engineer. The certification letter will include the following information:
   a. Documentation of 5 movable bridge projects for which the Control System Vendor has provided complete systems for electrical motor Drives and PLC based movable bridge and auxiliary controls. The projects shall demonstrate the Control System Vendors experience with AC Flux Vector drive systems.
   b. The documentation of the five movable bridge projects shall include the bridge owners name, contact person, phone number, address, bridge type, PLC type and drive type. The documentation shall also include, written documentation from the owners of the ten movable bridges addressing the following questions:
      i. Did the Control System Vendor supply a complete electric motor drive and PLC based control system for the movable bridge?
      ii. At the completion of the project, did the control system operate as specified in the project specifications?
   c. Provide the names of the individual persons who are responsible, under this contract, for office engineering and project management, field-testing, calibration and start-up, and maintenance training. The movable bridge projects called for in the previous item shall include recent projects of these individual persons.
   d. Provide UL File Number for verification of UL 508 certification of the control panel assembly facility.

E. CONTROL SYSTEM VENDOR FACTORY INSPECTION AND TESTING

1. The enclosed control panels, PLC panels, motor control centers, motor drive cabinets, control desk, motors, brakes, and other apparatus supplied, assembled or fabricated by the vendor of the electrical control system shall be subjected to shop inspections to demonstrate compliance with all specified requirements. The inspection is intended as a means of facilitating the work and avoiding errors, and it

is expressly understood that it will not relieve the Contractor of responsibility for imperfect material or workmanship.

2. The enclosed control panels, motor drive cabinets and control desk shall be completely assembled at the factory, and shall be subjected to the manufacturer's standard inspections and testing. The manufacturer's standard testing for the enclosed control panels and control desk shall comprise of at least the following:
   a. Inspection of materials, fit of parts, finishes and adjustments
   b. Wire continuity tests, either visual or verified with continuity tester
   c. Operational check of devices to determine proper pick-up and drop-out voltages and contact operation
   d. Operational check of circuits to determine proper interlocking of circuits and operator's devices
   e. Polarity of connections to instruments and other polarity-sensitive devices
   f. Dielectric test in accordance with applicable NEMA standards
3. The enclosed control panels, PLC panels, motor control centers, motor drive cabinets, control desk, motors, brakes, and other apparatus supplied shall be completely interconnected and shall be subjected to electrical and operational testing to ensure accuracy of connections and to demonstrate proper functioning of equipment. Limit switch contacts shall be simulated using the actual limit switches. The actual drive motors, drive systems, motor brakes, machinery brakes, and wedge motor shall be utilized for the factory tests.
4. The factory testing shall also include a complete sequenced, simulated operation of the bridge auxiliaries and span drive, and shall include complete adjustment, verification and testing of the motor drives, PLC, Alarm Panel, manual control stations, control relays and contactors to demonstrate operation in accordance with specified requirements.
5. The factory inspection and special testing required herein shall be witnessed by the Engineer or his authorized representative, and no equipment shall be shipped from the factory until it has been released for shipment by the Engineer. The Contractor shall provide thirty days notification in advance of the date of tests so that arrangements can be made for the Engineer to be present at the tests. The Contractor shall submit to the Engineer for review, 10 working days prior to the testing date, a copy of all standard and all special tests to be performed.
6. During the witnessed inspections, nameplate legends, conductor identifications, instrument scales, escutcheon plate engraving and all other details of construction shall be checked for conformity with specified requirements.
7. Additional factory tests for equipment shall be as specified in the Special Provisions of the Contract Documents.

F. START UP AND COMMISSIONING

1. Start-Up and Commissioning shall be as specified in Section Start-Up and Commissioning. Refer to Appendix A for minimum start-up and commissioning requirements a sample test procedure.

G. SUPPORTS FOR ELECTRICAL EQUIPMENT

1. Bent plates, clip angles and other supporting members shall be fabricated from structural steel plates and shapes for supporting conduits, cables, boxes, cabinets,

disconnect switches, limit switches and other separately mounted items of electrical equipment. All electrical equipment shall be mounted to provide a minimum surrounding air space of 1/4 inch.

2. The Contractor shall prepare and submit details of all electrical equipment supports to the Engineer for approval.
3. Motors and limit switches shall be fastened to structural steel supports with approved shim packs and mounting fasteners.
4. Each electrical device and enclosure shall be provided with a rigid structural steel support. No enclosure or device shall be permitted to be cantilevered from conduit unless specifically permitted by the Engineer.
5. Preformed metal framing channels, such as Kindorf, Unistrut, Superstrut and so forth will not be acceptable for mounting or fastening structural supports, conduits, boxes, or other electrical equipment. The use of J-bolts or beam clamps to fasten structural supports or to clamp conduits, boxes, or other electrical equipment will not be permitted.

H. PAINTING OF ELECTRICAL EQUIPMENT

1. Stainless steel components, galvanized surfaces, and equipment which are given a factory-applied coating other than paint shall not be painted.
2. All unfinished surfaces of electrical equipment shall be cleaned and painted in the shop and field as specified.
3. All surfaces shall be cleaned of all chips, dirt, rust, scale, sand, grease, and other foreign matter by solvent cleaning, wire brushing, hand tools or other approved means prior to painting. After proper surface preparation, all surfaces, except for the above-specified equipment, shall be given one shop coat of primer. Affected components remaining in the field or damaged paint coatings shall be hand brushed and given one coat of primer. The final coat color shall be approved by the Contracting Agency.
4. After completion of the operating tests and acceptance of the electrical system, all accumulated oil, grease, dirt, and other foreign matter shall be washed with benzene from exposed surfaces, except rubbing surfaces. Any damaged paint surfaces shall be touched up to the satisfaction of the Engineer.
5. Stainless steel enclosures, RGS conduit and fittings, and nameplates shall not be field painted. These devices shall be adequately protected from all field painting operations. If any coating material is applied to the surfaces indicated as not to be painted, the paint shall be completely removed.

I. INSTALLATION OF LIMIT SWITCHES

1. The Contractor shall provide all structural steel, shims, fasteners and hardware required to install the limit switches and those items shall be as specified in the Mechanical Special Provisions. Payment for steel supports, shims, fasteners and hardware shall be as specified under this item.

J. EQUIPMENT INSTALLATION

1. Install all electrical equipment as shown on the plans. Field verify the equipment can be brought into the control house, piers and pivot pier. Determine the route the equipment will take to the control house and verify the equipment can be brought

into the room, measuring stairs, hand rails, etc. to verify proper fit. Coordinate and schedule the work with other disciplines in order allow proper fit.

2. Provide a full sized rubber pad to mount all the free standing equipment on. Each free standing enclosure shall be bolted with epoxy resin bonded anchors to the floor.

K. SPARE PARTS

1. Spare Parts for Electrical System - The Contractor shall furnish the following spare parts for the bridge electrical system:

   a. Two packages of six fuses of each kind and size installed.
   b. One circuit breaker of each kind and size installed for every 5 of each kind and size installed, with a minimum of one.
   c. A set of contacts and contact fingers for each kind or size of contactor and starter installed.
      Note: For units that do not incorporate replaceable contacts, furnish a complete unit with coil.
   d. One coil for every five of each size relay, contactor, and motor starter installed, with a minimum of one.
   e. One complete relay, timer, contactor and starter for every five of each kind and size installed, with a minimum of one.
   f. Three heaters for overload relays of each size and type installed.
   g. Two brake limit switches
   h. For the control desk:
      i. 4 indicating lamps
      ii. 1 digital meter of each type installed
      iii. 2 lens caps of each color installed
      iv. 4 switches of each type installed
      v. 4 pushbuttons of each type installed
      vi. 1 analog meter of each type installed
      vii. 1 position indicator display transmitter meter
   i. One spare PLC card for each type furnished including processors, I/O, power and communication cards.
   j. One spare PLC Power Supply of each time.
   k. One spare PCMCIA card of each type supplied.
   l. One spare PanelView of each type supplied.
   m. One spare computer cable and printer cable of each type furnished.
   n. One spare power conditioner.
   o. One spare UPS.
   p. One spare encoder.
   q. Two proximity limit switches
   r. Two spare Ethernet Stratix Switches.
   s. One spare complete FVD drive system
   t. One spare power supply for each type supplied.
   u. B&B Roadway Barrier Gates
      i. Provide two sets of spare sprockets for drive and drive wheel

ii. Provide two spare drive roller chains
iii. Provide two spare drive wheels

L. SOFTWARE PROGRAMMING

1. The control system vendor shall be fully responsible to generate a complete operating system and develop the PLC program and alarm messages using:
   a. The Software Programming, Sequence of Operation, Other PLC Functions, and Alarm sections provided in this section
   b. All logic and wiring shown on the plans
   c. The testing requirements shown in Start Up and Commissioning Requirements.
   d. Allowing for specific requirements of the Allen-Bradley PLC as supplied, the program ladder logic shall follow the above items and this Specification as closely as possible.
2. The control system vendor shall furnish a laptop computer, interconnection cables, power supplies, software, PanelView programming, and PLC programming to accomplish the specified operation of the bridge and its auxiliaries. Software for the PLC, PanelView, drives, and laptop computer shall be loaded and coordinated by the Contractor to achieve the correct designed operation of all software.
3. The control system vendor shall be fully responsible for developing the PLC, and PanelView, and desktop computer software and software programming to accomplish the specified operation of the bridge and its associated equipment. The Contractor shall assume software debugging will occur in the shop as well as in the field during start-up and subsequent testing. No additional payment shall be made for software debugging due to logic changes made in the field.
4. The PLC program shall be in accordance with the following items:
   a. The ladder logic shall be easy to understand and troubleshoot.
   b. The ladder logic shall be fully documented, including rung comments and address comments.
   c. The ladder logic shall be written with regards to the operational sequence of the bridge, containing separate sections for each of the major equipment areas such as gates, wedges, etc.
   d. From the Operator’s standpoint, the bridge shall operate as before in terms of sequence of operation.
   e. The ladder logic shall not utilize or contain the following flaws:
      i. Latched coils: PLC logic shall be based upon real world conditions and reset when required. When the PLC loses power, and then power is returned, the PLC will determine the position of the leaves and other electrical equipment, but not expect the bridge to be in the exact same position. If any equipment was operated manually, the PLC program will determine the new position of the equipment and operate normally.
      ii. Unnecessary internal coils: PLC logic shall be as simplified as possible and not use multiple relays for a single function. The intent of this is to make the program easy to troubleshoot and understand.
      iii. Improper bypass logic: When the bypass switch is utilized the bypass will bypass only the required interlocks. The intent of this item is to provide programming that will utilize the bypasses and only bypasses the correct

interlock, but does not remain active in the logic or bypass other interlocks in the program.

iv. Loss of alarms: PLC logic shall be written to record and store the alarms in the PanelView.

v. Switch and Push button time delays: PLC logic shall not add time delays to control desk switches and pushbuttons.

vi. Problems transferring between automatic and manual modes of operation: PLC logic shall allow simple transfer from automatic and manual modes without generating unnecessary alarms for causing failures in the program. The intent of this item is to provide programming that transfers between manual and automatic mode without problems or inaccurate alarms.

vii. Faulty timing logic: The intent of this item is to provide programming that does not have internal timers to determine when problems occur or provide inaccurate alarms.

f. All timer settings shown in the sequence of operation shall be clearly documented in the program. They shall be adjusted to match the selected equipment and adjusted during shop and field testing for proper operation.

g. Modify and add alarm messages and associated alarm ladder logic as required.

h. The PLC shall communicate information through the Ethernet connections with multiple pieces of equipment, such as drives and overload relays. The information shall be identified as an Ethernet input into the PLC.

5. Contractor shall submit a fully documents and cross-referenced copy of the new PLC program for review and approval.

6. The PanelView alarm panel shall be programmed to timestamp, print, and store each PLC alarm. The alarms shall be stored in chronological order and the operator shall be able to scroll through the alarm screen to review alarms. The alarms shall be stored in the PanelView and being identified by a numerical identifier. When the PLC processor transmits the numerical identifier alarm bit to the PanelView the PanelView shall display the alarms, print the alarms, and store the alarms in an alarm history screen chronological order.

7. In the event of CPU failure, all outputs shall turn off.

M. SEQUENCE OF OPERATION

The sequence of operation for the bridge shall be as described below.

When the PLC is required to generate provide an alarm, this means to send a bit from the defined bit array to the PanelView. When the PanelView receives the alarm bit numeric identifier the PanelView will display the alarm, provide the time and date of the alarm, print the alarm, and store the alarm in an alarm history screen. A screen will be provided to allow the operator to scroll down the alarm history.

The operation example is for a complete bridge operation. It is the intent of the control logic that the operator can stop the operation at any time while attempting to open the bridge, and ‘back out’ of the operation to safely allow vehicular traffic on the bridge. ‘Back out’ of an operation means to change the operation from opening to closing the bridge, and example would be after lowering the on-coming traffic gate the operator could ‘back out’ of the operation by raising the on-coming traffic gate and turn the red traffic warning signal off to release vehicular traffic.

Start of Operation:

1. Control Power Key Selector Switch (CS-CP)
    a. The operator shall turn the control desk key operated Control Power (CS-CP) switch to the ‘On’ position.
    b. Control Power switch in the ‘On’ position is provided as an energized input ‘Control Power On’ to the PLC. The Control Power On (IL-CP) indicating light shall be hard wired to be energized as long as the Control Power switch is in the ‘On’ position and there is no power failure condition (as shown on the Plans).
    c. The Control Power switch (CS-CP) activates Bridge Control relay as long as there is no power fault condition in the service power.
    d. When the PLC has control power, the PLC shall verify all PLC Input card circuit breaker check inputs are energized.
    e. If at any time during an operation, a single or multiple of the above PLC inputs are de-energized while the ‘Control Power On’ PLC input is energized, the PLC shall de-energize all outputs, generate provide an alarm, and shall not attempt any bridge operation until the PLC inputs are energized.
    f. The PLC input Power Fault Alarm shall be energized if there is a power fault. If there is a power fault the PLC shall de-energize all outputs, generate provide an alarm, and shall not attempt any bridge operation until the PLC input is de-energized.
    g. Bridge Power Available IL-PWR indicating light shall be hard wired to be energized as long as bridge power is available (as shown on the Plans).
2. Emergency Stop Push-button PB-ES
    a. As long as PLC input ‘Control Power On’ is energized and the Emergency Stop push-button is not depressed, the PLC shall have the following inputs energized:
        i. All Emergency Stop Relays CR- (Emergency Stop)
    b. If at any time during an operation, any of the above PLC inputs are de-energized while the ‘Control Power On’ PLC input is energized and the ‘Emergency Stop’ PLC input is energized (the ‘Emergency Stop’ button is pulled out), the PLC shall de-energize all outputs, generate provide an alarm, and shall not attempt any bridge operation until the PLC inputs are energized.
    c. If the Emergency Stop push-button is depressed, or becomes depressed during the bridge operation, then the PLC input ‘Emergency Stop’ from PB-ES shall de-energized. The PLC shall stop all bridge operations, and generate provide an alarm. The PLC shall not allow any other operation until the Emergency Stop push-button is pulled out to the not depressed position.
    d. The hardwired Master Control Relays will de-energize the control output power busses. The PLC shall verify that the emergency stop inputs are de-energized.
    e. If any of the inputs are not de-energized when the ‘Emergency Stop’ PLC input is de-energized, then the PLC shall generate provide an alarm.
3. Bridge Status Indication
    a. Upon the ‘Control Power On’ PLC input energizing, the PLC will scan the bridge for the status of the following items to illuminate or de-energize the control desk indicating lights as follows:
        i. Span Position Indication Lights

The PLC shall verify that the span position and illuminate the appropriate lights on the control desk.

ii. Brake Hand Release Status Indication
The PLC shall verify that the Machinery Brakes and Motor Brakes are not hand released. One brake may be hand released and it is still safe to operate the bridge. If more than one machinery brake is hand released, or become hand released at any time during the bridge operation, then the PLC shall illuminate the indicating light for that brake on the control desk, prevent span operation, send an alarm to the PanelView and store the alarm.

iii. Brake Release Status Indication
The PLC shall verify that the Machinery Brakes and Motor Brakes are not released. One brake may be hand released (and therefore provide a brake released indication) and it is still safe to operate the bridge. If more than one machinery brake is released, then the PLC shall illuminate the indicating light for that brake on the control desk, prevent span operation, send an alarm to the PanelView and store the alarm.

iv. Ethernet Communication Capable Equipment: Motor Overloads and Drives
The PLC shall verify the Ethernet inputs to determine the status of each motor overload and drive. If there are any alarms or fault then the PLC shall prevent span operation, send an alarm to the PanelView and store the alarm. The PLC shall continuously monitor the equipment and scan for issues.

v. Circuit Breaker
The PLC shall monitor the inputs for each MCC circuit breaker auxiliary contact. If any circuit breaker trips, the PLC shall prevent span operation, send an alarm to the PanelView and store the alarm.

Bypass Operation:

If there is a circuit breaker tripped, the circuit breaker tripped interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

If the PLC inputs for any brake set or released limit switch are energized, then the corresponding indicating light shall be energized.

4. Drive Trouble Status Indication
   a. The PLC shall verify that the Span Drive does not have a Trouble alarm. If the drive does have a trouble alarm, then the PLC shall illuminate the indicating light for that drive on the control desk, prevent drive operation with that drive, send an alarm to the PanelView and store the alarm. (Refer to the span operation for the requirements of a Drive Trouble Alarm during an operation and the hard stop requirements.
5. Position Transmitter Status Indication

a. The PLC input ‘Position Resolver’ shall receive an analog input from the resolver (position transmitter) PLC remote I/O rack in the RPLC panel. The PLC shall transmit the analog signal position information to the PLC remote I/O rack in the control desk. The PLC output ‘Span Position (Degrees)’ shall transmit the resolver signal to the control desk display meter Span Position Indicator. The display shall provide the span position in degrees, from zero degrees while fully closed to 90 degrees when fully open. The PLC shall continually update the position information while control power is on.
b. The PLC shall monitor the resolver analog input and internally monitor the span position in degrees. The PLC shall compare the resolver position to the PLC inputs for span rotary limit switch contacts. If the PLC resolver analog degree is more than 5 degrees off from the rotary limit switch contacts (as shown on the Plans) the PLC shall generate provide an alarm.
c. If no analog signal is received from a position transmitter, then the PLC shall generate print an alarm.

6. MCC Manual Control HMI
   a. The PLC shall verify that no equipment is being operated manually. The PLC shall verify that the following PLC inputs from the MCC hand-off-auto switches are in the ‘auto’ position. If the switches are not in the ‘auto’ position and in the ‘hand’ or ‘off’ position, then the PLC shall de-energize all outputs, generate an alarm, and shall not attempt any bridge operation until the PLC inputs are energized.
7. Disconnect Switch Status for All Motors
   a. The PLC shall verify that no motors are disconnected.
   b. At any time, if any of the PLC disconnect switch inputs are de-energized, the PLC shall de-energize all outputs, generate provide an alarm identifying the specific motor that has had its disconnect operated, and shall not attempt any bridge operation until the PLC inputs are energized.
      Bypass Operation:

      If there is a motor disconnect switch operated, the disconnect operated interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.
8. Drive Ready Status Indication
   a. The PLC shall verify that all drives are ready. If the motor drives are ready and the motor is not disconnected, then the PLC shall illuminate the drive ready indicating light.
   b. If any disconnect switch is placed in the ‘Off’ position, the PLC program shall generate provide an alarm.
   c. If any drive is not ready, the PLC program shall generate provide an alarm.
9. Wedge Manual Operation and Span Auxiliary System Operation
   The wedges can be operated manually and a limit switch LS-WED-HCK provides indication this system has been activated. The span can be operated with the auxiliary system and a limit switch LS-MSD-MO provides indication this system has been activated. When the system is activated the PLC shall provide an alarm and prevent operation of the associated equipment.

10. Span Drive Ammeters
    a. The PLC drive Ethernet input Span Drive Motor Ammeter motor current analog signal shall be transmitted to the control desk ammeter. The PLC shall transmit the analog value to the remote I/O rack in control desk. The PLC output 'Span Drive Amps' shall transmit the ammeter signal from the drive and provide that analog output to the control desk ammeter. The PLC shall continually update the ammeter information while control power is on.
11. Lamp Test Push-Button (PB-LT)
    a. The PLC shall energize all control desk indicating lights while the lamp test push-button (PB-LT) is pressed and the PLC input 'Lamp Test' is energized at any time. The PLC shall de-energize all indicating lights that are not immediately required to be energized when the push-button is released.
12. Siren (PB-SIREN)
    a. When the Siren push button (PB-SIREN) is pressed at any time during the bridge operation it shall serve as an input to the PLC. The PLC monitor the siren operation and the pushbutton shall directly operate the new siren.
13. Traffic Warning Control Switch (CS-TW)
    a. When control switch Traffic Warning (CS-TW) is in the 'Off' position the PLC shall:
        i. Energize the control desk indicating light IL-TW-OFF if control power is on, all gates are raised, all barriers are closed, the wedges are driven, and the span is fully closed.
        ii. De-energize the control desk indicating light IL-TW-ON if all gates are raised, all barriers are closed, the wedges are driven, and the span is fully closed.
        iii. De-energize the PLC outputs to activate the advance warning flashing light, traffic signals, and gongs.
    b. When control switch Traffic Warning (CS-TW) is placed in the 'On' position the PLC shall:
        i. De-energize the control desk indicating light IL-TW-OFF.
        ii. Energize the control desk indicating light IL-TW-ON.
        iii. Energize the PLC outputs to activate the advance warning flashing light by energizing CR-FLASHER, and the gongs by energizing CR-GONG. The timing for the traffic signals shall be operated by control relays to ensure safe operation when the equipment is operated without PLC control.
        iv. The PLC shall monitor the inputs from CR-RSR and CR-YSR as shown on the plan to verify proper operation of the traffic signals. The PLC shall generate an alarm if the relays operate out of sequence.
    c. Interlocks:
        i. The only interlock to prevent the operator from activating the traffic warnings is that bridge control power is on.
14. Near Oncoming Gate Control Switch (CS-WG-NON)

General Near Oncoming Gate Controls

a. When the PLC input ‘Near Oncoming Gate Limit Switch Fully Raised’ is energized, the gate is fully raised and the PLC shall energize the control desk indicating light IL-WG-NON-RSD.
b. When the PLC input ‘Near Oncoming Gate Limit Switch Fully Lowered’ is energized, the gate is fully lowered and the PLC shall energize the control desk indicating light IL-WG-NON-LWR.
c. When both PLC inputs ‘Near Oncoming Gate Limit Switch Fully Raised’ and ‘Near Oncoming Gate Limit Switch Fully Lowered’ are de-energized, the PLC shall flash alternately the control desk indicating lights IL-WG-NON-RSD and IL-WG-NON-LWR.
d. The PLC shall monitor the inputs for the gate door open and hand crank inputs for the gate. If either gate door is open or the hand crank activated, then the PLC shall prevent gate operation, send an alarm to the PanelView and store the alarm.
e. When the control switch Near Oncoming Gate (CS-WG-NON) is in the ‘Off’ position, both PLC inputs ‘Near Oncoming Gate Raise’ and ‘Near Oncoming Gate Lower’ shall be de-energized. While both inputs are de-energized, the PLC shall not attempt to operate the oncoming gate.
    i. De-energize the PLC output Near Oncoming Gate Lower command to the gate motor coil through the Ethernet enabled overload.
    ii. De-energize the PLC output Near Oncoming Gate Raise command to the gate motor coil through the Ethernet enabled overload.
f. Turn Near Oncoming Gate Control Switch (CS-WG-NON) to Lower
g. When the control switch Near Oncoming Gate (CS-WG-NON) is held in the ‘Lower’ position, PLC inputs ‘Near Oncoming Gate Lower’ shall be energized. While PLC input ‘Near Oncoming Gate Lower’ is energized and the PLC input ‘Near Oncoming Gate Limit Switch Fully Lowered’ is de-energized, the PLC shall:
    i. Energize the PLC output ‘Near Oncoming Gate Lower’ to the gate motor lower coil through the Ethernet enabled overload.
    ii. De-energize the PLC output ‘Near Oncoming Gate Raise’ to the gate motor raise coil through the Ethernet enabled overload.
h. Note: If PLC input ‘Near Oncoming Gate Lower’ is energized continuously for more than 10 seconds and the PLC input ‘Near Oncoming Gate Limit Switch Fully Lowered’ has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
   Interlocks:

   The oncoming gate shall be interlocked such that it cannot be lowered unless there is bridge control power and the traffic warnings are red.

   Bypass Operation: There is no bypass operation for the loss of control power or traffic signals red.

15. Far Oncoming Gate Control Switch (CS-WG-FON)
    a. General Far Oncoming Gate Controls
    b. When the PLC input ‘Far Oncoming Gate Limit Switch Fully Raised’ is energized, the gate is fully raised and the PLC shall energize the control desk indicating light IL-WG-FON-RSD.

c. When the PLC input ‘Far Oncoming Gate Limit Switch Fully Lowered’ is energized, the gate is fully lowered and the PLC shall energize the control desk indicating light IL-WG-FON-LWR.
d. When both PLC inputs ‘Far Oncoming Gate Limit Switch Fully Raised’ and ‘Far Oncoming Gate Limit Switch Fully Lowered’ are de-energized, the PLC shall flash alternately the control desk indicating lights IL-WG-FON-RSD and IL-WG-FON-LWR.
e. The PLC shall monitor the inputs for the gate door open and hand crank inputs for the gate. If either gate door is open or the hand crank activated, then the PLC shall prevent gate operation, send an alarm to the PanelView and store the alarm.
f. When the control switch Far Oncoming Gate (CS-WG-FON) is in the ‘Off’ position, both PLC inputs ‘Far Oncoming Gate Raise’ and ‘Far Oncoming Gate Lower’ shall be de-energized. While both inputs are de-energized, the PLC shall not attempt to operate the oncoming gate.
    i. De-energize the PLC output Far Oncoming Gate Lower command to the gate motor coil through the Ethernet enabled overload.
    ii. De-energize the PLC output Far Oncoming Gate Raise command to the gate motor coil through the Ethernet enabled overload.
g. Turn Far Oncoming Gate Control Switch (CS-WG-FON) to Lower
h. When the control switch Far Oncoming Gate (CS-WG-FON) is held in the ‘Lower’ position, PLC inputs ‘Far Oncoming Gate Lower’ shall be energized. While PLC input ‘Far Oncoming Gate Lower’ is energized and the PLC input ‘Far Gate Limit Switch Fully Lowered’ is de-energized, the PLC shall:
    i. Energize the PLC output ‘Far Oncoming Gate Lower’ to the gate motor lower coil through the Ethernet enabled overload.
    ii. De-energize the PLC output ‘Far Oncoming Gate Raise’ to the gate motor raise coil through the Ethernet enabled overload.
i. Note: If PLC input ‘Far Oncoming Gate Lower’ is energized continuously for more than 10 seconds and the PLC input ‘Far Oncoming Gate Limit Switch Fully Lowered’ has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
Interlocks:

The oncoming gate shall be interlocked such that it cannot be lowered unless there is bridge control power and the traffic warnings are red.

Bypass Operation: There is no bypass operation for the loss of control power or traffic signals red.

16. Near Offgoing Gate Control Switch (CS-WG-NOF)
    a. General Near Offgoing Gate Controls
    b. When the PLC input ‘Near Offgoing Gate Limit Switch Fully Raised’ is energized, the gate is fully raised and the PLC shall energize the control desk indicating light IL-WG-NOF-RSD.
    c. When the PLC input ‘Near Offgoing Gate Limit Switch Fully Lowered’ is energized, the gate is fully lowered and the PLC shall energize the control desk indicating light IL-WG-NOF-LWR.

d. When both PLC inputs ‘Near Offgoing Gate Limit Switch Fully Raised’ and ‘Near Offgoing Gate Limit Switch Fully Lowered’ are de-energized, the PLC shall flash alternately the control desk indicating lights IL-WG-NOF-RSD and IL-WG-NOF-LWR.
e. The PLC shall monitor the inputs for the gate door open and hand crank inputs for the gate. If either gate door is open or the hand crank activated, then the PLC shall prevent gate operation, send an alarm to the PanelView and store the alarm.
f. When the control switch Near Offgoing Gate (CS-WG-NOF) is in the ‘Off’ position, both PLC inputs ‘Near Offgoing Gate Raise’ and ‘Near Offgoing Gate Lower’ shall be de-energized. While both inputs are de-energized, the PLC shall not attempt to operate the oncoming gate.
    i. De-energize the PLC output Near Offgoing Gate Lower command to the gate motor coil through the Ethernet enabled overload.
    ii. De-energize the PLC output Near Offgoing Gate Raise command to the gate motor coil through the Ethernet enabled overload.
g. Turn Near Offgoing Gate Control Switch (CS-WG-NOF) to Lower
h. When the control switch Near Offgoing Gate (CS-WG-NOF) is held in the ‘Lower’ position, PLC inputs ‘Near Offgoing Gate Lower’ shall be energized. While PLC input ‘Near Offgoing Gate Lower’ is energized and the PLC input ‘Near Gate Limit Switch Fully Lowered’ is de-energized, the PLC shall:
    i. Energize the PLC output ‘Near Offgoing Gate Lower’ to the gate motor lower coil through the Ethernet enabled overload.
    ii. De-energize the PLC output ‘Near Offgoing Gate Raise’ to the gate motor raise coil through the Ethernet enabled overload.
i. Note: If PLC input ‘Near Offgoing Gate Lower’ is energized continuously for more than 10 seconds and the PLC input ‘Near Gate Limit Switch Fully Lowered’ has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
Interlocks:

The offgoing gate shall be interlocked such that it cannot be lowered unless there is bridge control power, the traffic warnings are red, and both oncoming gates are lowered.

Bypass Operation:

If there is a failure with either oncoming gate, the gate lowered interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

17. Far Offgoing Gate Control Switch (CS-WG-FOF)
    a. General Far Offgoing Gate Controls
    b. When the PLC input ‘Far Offgoing Gate Limit Switch Fully Raised’ is energized, the gate is fully raised and the PLC shall energize the control desk indicating light IL-WG-FOF-RSD.

c. When the PLC input ‘Far Offgoing Gate Limit Switch Fully Lowered’ is energized, the gate is fully lowered and the PLC shall energize the control desk indicating light IL-WG-FOF-LWR.
d. When both PLC inputs ‘Far Offgoing Gate Limit Switch Fully Raised’ and ‘Far Offgoing Gate Limit Switch Fully Lowered’ are de-energized, the PLC shall flash alternately the control desk indicating lights IL-WG-FOF-RSD and IL-WG-FOF-LWR.
e. The PLC shall monitor the inputs for the gate door open and hand crank inputs for the gate. If either gate door is open or the hand crank activated, then the PLC shall prevent gate operation, send an alarm to the PanelView and store the alarm.
f. When the control switch Far Offgoing Gate (CS-WG-FOF) is in the ‘Off’ position, both PLC inputs ‘Far Offgoing Gate Raise’ and ‘Far Offgoing Gate Lower’ shall be de-energized. While both inputs are de-energized, the PLC shall not attempt to operate the oncoming gate.
    i. De-energize the PLC Far Offgoing Gate Lower command to the gate motor coil through the Ethernet enabled overload.
    ii. De-energize the PLC output Far Offgoing Gate Raise command to the gate motor coil through the Ethernet enabled overload.
g. Turn Far Offgoing Gate Control Switch (CS-WG-FOF) to Lower
h. When the control switch Far Offgoing Gate (CS-WG-FOF) is held in the ‘Lower’ position, PLC inputs ‘Far Offgoing Gate Lower’ shall be energized. While PLC input ‘Far Offgoing Gate Lower’ is energized and the PLC input ‘Far Gate Limit Switch Fully Lowered’ is de-energized, the PLC shall:
    i. Energize the PLC output ‘Far Offgoing Gate Lower’ to the gate motor lower coil through the Ethernet enabled overload.
    ii. De-energize the PLC output ‘Far Offgoing Gate Raise’ to the gate motor raise coil through the Ethernet enabled overload.
i. Note: If PLC input ‘Far Offgoing Gate Lower’ is energized continuously for more than 10 seconds and the PLC input ‘Far Gate Limit Switch Fully Lowered’ has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
   Interlocks:

   The offgoing gate shall be interlocked such that it cannot be lowered unless there is bridge control power, the traffic warnings are red, and both oncoming gates are lowered.

   Bypass Operation:

   If there is a failure with either oncoming gate, the gate lowered interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

18. Near Barrier Gate Control Switch (CS-BG-N)
    a. General Near Barrier Gate Controls

b. When the PLC input ‘Near Barrier Gate Limit Switch Fully Open’ is energized, the gate is fully open and the PLC shall energize the control desk indicating light IL-BG-N-OP.
c. When the PLC input ‘Near Barrier Gate Limit Switch Fully Closed’ is energized, the gate is fully closed and the PLC shall energize the control desk indicating light IL-BG-N-CL.
d. When both PLC inputs ‘Near Barrier Gate Limit Switch Fully Open’ and ‘Near Barrier Gate Limit Switch Fully Closed’ are de-energized, the PLC shall flash alternately the control desk indicating lights IL-BG-N-OP and IL-BG-N-CL.
e. The PLC shall monitor the inputs for the gate door open and hand crank inputs for the gate. If either gate door is open or the hand crank activated, then the PLC shall prevent gate operation, send an alarm to the PanelView and store the alarm.
f. When the control switch Near Barrier Gate (CS-BG-N) is in the ‘Off’ position, both PLC inputs ‘Near Barrier Gate Raise’ and ‘Near Barrier Gate Lower’ shall be de-energized. While both inputs are de-energized, the PLC shall not attempt to operate the oncoming gate.
    i. De-energize the PLC output Near Barrier Gate Lower command to the gate motor drive interposing relay in gate enclosure.
    ii. De-energize the PLC output Near Barrier Gate Raise command to the gate motor drive interposing relay in gate enclosure.
    iii. Coordinate gate speed and control operation with gate manufacturer. There are interposing relays for all drive settings.
g. Turn Near Barrier Gate Control Switch (CS-BG-N) to Close
h. When the control switch Near Barrier Gate (CS-BG-N) is held in the ‘Close’ position, PLC inputs ‘Near Barrier Gate Close’ shall be energized. While PLC input ‘Near Barrier Gate Close’ is energized and the PLC input ‘Near Gate Limit Switch Fully Closed’ is de-energized, the PLC shall:
    i. Energize the PLC output ‘Near Barrier Gate Close’ to the gate motor drive interposing relay in gate enclosure.
    ii. De-energize the PLC output ‘Near Barrier Gate Open’ to the gate motor drive interposing relay in gate enclosure.
    iii. Coordinate gate speed and control operation with gate manufacturer. There are interposing relays for all drive settings.
i. Note: If PLC input ‘Near Barrier Gate Close’ is energized continuously for more than 30 seconds and the PLC input ‘Near Gate Limit Switch Fully Closed’ has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.

Interlocks:

The barrier gate shall be interlocked such that it cannot be closed unless there is bridge control power, the traffic warnings are red, both oncoming gates are lowered, and both offgoing gates are lowered.

Bypass Operation:

If there is a failure with either offgoing gate, the gate lowered interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the

manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

19. Far Barrier Gate Control Switch (CS-BG-F)
    a. General Far Barrier Gate Controls
    b. When the PLC input 'Far Barrier Gate Limit Switch Fully Open' is energized, the gate is fully open and the PLC shall energize the control desk indicating light IL-BG-F-OP.
    c. When the PLC input 'Far Barrier Gate Limit Switch Fully Closed' is energized, the gate is fully closed and the PLC shall energize the control desk indicating light IL-BG-F-CL.
    d. When both PLC inputs 'Far Barrier Gate Limit Switch Fully Open' and 'Far Barrier Gate Limit Switch Fully Closed' are de-energized, the PLC shall flash alternately the control desk indicating lights IL-BG-F-OP and IL-BG-F-CL.
    e. The PLC shall monitor the inputs for the gate door open and hand crank inputs for the gate. If either gate door is open or the hand crank activated, then the PLC shall prevent gate operation, send an alarm to the PanelView and store the alarm.
    f. When the control switch Far Barrier Gate (CS-BG-F) is in the 'Off' position, both PLC inputs 'Far Barrier Gate Raise' and 'Far Barrier Gate Lower' shall be de-energized. While both inputs are de-energized, the PLC shall not attempt to operate the barrier gate.
        i. De-energize the PLC output Far Barrier Gate Lower command to the gate motor drive interposing relay in gate enclosure.
        ii. De-energize the PLC output Far Barrier Gate Raise command to the gate motor drive interposing relay in gate enclosure.
        iii. Coordinate gate speed and control operation with gate manufacturer. There are interposing relays for all drive settings.
    g. Turn Far Barrier Gate Control Switch (CS-BG-F) to Close
    h. When the control switch Far Barrier Gate (CS-BG-F) is held in the 'Close' position, PLC inputs 'Far Barrier Gate Close' shall be energized. While PLC input 'Far Barrier Gate Close' is energized and the PLC input 'Far Gate Limit Switch Fully Closed' is de-energized, the PLC shall:
        i. Energize the PLC output 'Far Barrier Gate Close' to the gate motor drive
        ii. De-energize the PLC output 'Far Barrier Gate Open' to the gate motor drive
        iii. Coordinate gate speed and control operation with gate manufacturer. There are interposing relays for all drive settings.
    i. Note: If PLC input 'Far Barrier Gate Close' is energized continuously for more than 30 seconds and the PLC input 'Far Gate Limit Switch Fully Closed' has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.

    Interlocks:

    The barrier gate shall be interlocked such that it cannot be closed unless there is bridge control power, the traffic warnings are red, both oncoming gates are lowered, and both offgoing gates are lowered.

    Bypass Operation:

If there is a failure with either offgoing gate, the gate lowered interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

20. Wedge Lock Control Switch (CS-WM)
    a. General Wedge Lock Controls
    b. When the PLC input 'Wedge Lock Fully Withdrawn' is energized, the wedge lock is fully withdrawn and the PLC shall energize the control desk indicating light IL-WM-WTHDN.
    c. When the PLC input 'Wedge Lock Fully Driven' is energized, the wedge lock is fully driven and the PLC shall energize the control desk indicating light IL-WM-DRVN.
    d. When both PLC inputs 'Wedge Lock Fully Driven' and 'Wedge Lock Fully Withdrawn' are de-energized, the PLC shall flash alternately the control desk indicating lights IL-WM-WTHDN and IL-WM-DRVN.
    e. When the control switch Wedge Lock (CS-WM) is in the 'Off' position, both PLC inputs 'Wedge Lock Driven' and 'Wedge Lock Withdrawn' shall be de-energized. While both inputs are de-energized, the PLC shall not attempt to operate the Wedge Lock.
        i. De-energize the PLC output 'Wedge Lock Withdrawn' to the wedge lock motor coil through the Ethernet enabled overload.
        ii. De-energize the PLC output 'Wedge Lock Drive' to the wedge lock motor coil through the Ethernet enabled overload.
    f. Turn Wedge Lock Control Switch (CS-WM) to Withdraw
    g. When the control switch Wedge Lock (CS-WM) is held in the 'Withdraw' position, PLC input 'Wedge Lock Withdraw' shall be energized. While PLC input 'Wedge Lock Withdrawn' is energized and the PLC input 'Wedge Lock Withdrawn' is de-energized, the PLC shall:
        i. Energize the PLC output 'Wedge Lock Withdraw' to the wedge lock motor coil through the Ethernet enabled overload.
        ii. De-energize the PLC output 'Wedge Lock Driven' to the wedge lock motor coil through the Ethernet enabled overload.
    h. Note: If PLC input 'Wedge Lock Withdrawn' is energized continuously for more than 30 seconds and the PLC input 'Wedge Lock Fully Withdrawn' has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.

    Interlocks:

    The wedge lock shall be interlocked such that it cannot be withdrawn unless there is bridge control power, the traffic warnings are red, both oncoming gates are lowered, both offgoing gates are lowered and both barriers are closed.

    Bypass Operation:

    If there is a failure with either barrier gate, the gate closed interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

21. Drive Reset Push Button (PB-RE)
    a. The operator may attempt to reset a drive by pressing the Drive Reset push button (PB-RE).
    b. When the operator presses Drive Reset push button (PB-RE), the PLC input 'Reset Drive' shall energize momentarily. When the PLC input 'Reset Drive' energizes momentarily, the PLC use the Ethernet connection to the drive to reset the drive (coordinate with the drive manufacturer).
22. Span Opening Operation: Span control switch (CS-SPAN)
    a. The PLC shall verify it is safe to operate the span. The span shall not be operated if the auxiliary system is engaged, more than one machinery brake is hand released, more than one machinery brake has its motor disconnected, the motor brake is hand released, the motor brake has its motor disconnected, the wedge lock is not fully withdrawn, the barrier gates are closed, the offgoing gates are not fully lowered, the oncoming gate is not fully lowered, and the traffic warnings are off. (See prior steps for details.)
    b. Control Switch Span (CS-SPAN)
       When the control switch Span (CS-SPAN) is in the 'Off' position, both PLC inputs 'Span Open' and 'Span Close' shall be de-energized. While both inputs are de-energized, the PLC shall ensure the drive is in stop, not attempt to operate the drive and use the Ethernet connection to monitor the drive status.
    c. Turn and Hold control switch SPAN (CS-SPAN) to Open
       When Span control switch (CS-SPAN) is held in the Open position, the PLC input 'Span Open' will energize. When the PLC input 'Span Open' energizes, the PLC shall energize contactor M-SDM which shall connect the motor to the drive output. The PLC shall command the drive to energize the motor and verify proof of torque feedback from the motor drive, and then the PLC will release all motor and machinery brakes by energizing the PLC outputs through the Ethernet enabled overloads to energize the brake motor contactors.

       The PLC shall verify that the all motor and machinery brakes are released, by verifying the following PLC inputs for their associated limit switches are energized. If any brake does not release within 2 seconds, the PLC shall not attempt span operation and shall generate provide an alarm.

       When the PLC input 'Span Open' is energized and all brakes are released, the PLC shall use the Ethernet connection to command the drive to open the span, ramp in ten seconds to full operating speed. Command the drive to open shall initiate the drive to rotate the motor in the direction that opens the span. The PLC shall verify that the drive is operating through the Ethernet communication. The motor encoder shall be hardwired to the drive to provide speed control feedback. The PLC shall monitor the drive to verify proper motor control through the Ethernet communication with the drive.

       Note: If PLC command to open the span is sent continuously for more than 10 seconds and the PLC Ethernet monitoring does not indicate the drive is running or the encoder does not provide a signal that the motor is rotating, the PLC shall generate provide an alarm.
    d. Control Switch Span (CS-SPAN) to 'Off'

If the operator releases the control switch Span (CS-SPAN) while opening the span, the switch will spring return to 'Off.' (Alternately if the PLC is required to stop the span it will follow the same procedure.)

When the control switch Span (CS-SPAN) is in the 'Off' position, both PLC inputs 'Span Open' and 'Span Close' shall be de-energized. When both inputs are de-energized during a raising operation, the PLC shall continue to open the span and decelerate (ramp down) to stop in 5 seconds. Then the PLC shall de-energize all the brake contactors through the Ethernet enabled overloads to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

The span operation can be restarted by following the procedure as shown above.

e. Drive Trouble Operation
If at any time during an operation (both opening and closing) the Drive generates a Trouble Alarm, continue to open the span and decelerate (ramp down) to stop in 5 seconds. Then the PLC shall de-energize all the brake contactors through the Ethernet enabled overloads to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

f. Open the Span to Nearly Open
The PLC shall maintain the fast speed open of the span until the span reaches the nearly open position. When PLC input rotary limit switch contacts 'Span Limit Switch Nearly Open' is de-energized, then the span is nearly open.

When the span is nearly open the PLC shall command the drive to continue opening the span and reduce speed to creep speed. Once the span is at creep speed the PLC shall command the drive to enter reduced torque in the open direction.

The PLC shall monitor the drive through the Ethernet connection and monitor the motor speed to verify the drive motor speed is reduced to creep speed. If the motor speed does not decrease to creep, then the PLC shall continue to open the span and decelerate (ramp down) to stop in 5 seconds. Then the PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

g. Open the Span to Fully Open
The PLC shall maintain the creep speed open of the span until the span reaches the fully open position of 90 degrees. When PLC input for the span rotary limit switch contacts 'Span Fully Open' is de-energized, then the span is fully open.

The PLC shall monitor the proximity limit switches. When PLC input proximity limit switches input 'Span Open' is de-energized the span is fully open. The rotary limit switches shall actuate before the proximity limit switch contacts actuate. The proximity limit switches shall serve as a back-up system to the rotary limit switch. The PLC shall generate provide an alarm if the rotary limit switch contacts actuate after the proximity limit switches actuate.

When the span is fully open the PLC shall command the Drive to ramp from creep speed to zero RPM in less than one second. After one second the PLC shall de-energize the motor contactor M-SDM to isolate the motor from the drive. The PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

h. Span Overtravel Proximity Limit Switch
If the span is open overtravel proximity limit activates, the PLC shall command the Drive to ramp to a stop of zero (0) RPM in less than one second, and the PLC shall generate an alarm. After one second the PLC shall de-energize the motor contactor M-SDM to isolate the motor from the drive. The PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate an alarm.

i. Interlocks:
The span shall be interlocked such that span cannot be opened unless the wedge locks are fully withdrawn, both barrier gates are closed, both offgoing gates are fully lowered, both oncoming gates are fully lowered, the traffic warnings are red, and there is bridge control power.

j. Bypass Operation:
If the wedge lock fails to withdraw, the wedge lock withdrawn interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

23. Span Closing Operation: Span Control Switch CS-SPAN
The PLC shall verify it is safe to operate the span. The span shall not be operated if more than one machinery brake is hand released, the motor brake is hand released, more than one machinery brake has its motor disconnected, the motor brake has its motor disconnected, the wedge lock is not fully withdrawn, or the auxiliary system is engaged. (See prior steps for details.)

a. Control Switch Span (CS-SPAN)
When the control switch Span (CS-SPAN) is in the 'Off' position, both PLC inputs 'Span Open' and 'Span Close' shall be de-energized. While both inputs are de-energized, the PLC shall ensure the drive is in stop, not attempt to operate the drive and use the Ethernet connection to monitor the drive status.

b. Turn and Hold control switch SPAN (CS-SPAN) to Close
When Span control switch (CS-SPAN) is held in the Close position, the PLC input ‘Span Close’ will energize. When the PLC input ‘Span Close’ energizes, shall command the drive to energize the motor and energize contactor M-SDM which shall connect the motor to the drive output. The PLC shall verify proof of torque feedback from the motor drive, and then the PLC will release all motor and machinery brakes by energizing the PLC outputs to energize the brake motor contactors.

The PLC shall verify that the all motor and machinery brakes are released, by verifying the following PLC inputs for their associated limit switches are energized. If any brake does not release within 2 seconds, the PLC shall not attempt span operation and shall generate provide an alarm.

When the PLC input ‘Span Close’ is energized and all brakes are released, the PLC shall use the Ethernet connection to command the drive to close the span, ramp up in ten seconds to full operating speed. Command the drive to close shall initiate the drive to rotate the motor in the direction that close the span. The PLC shall verify that the drive is operating through the Ethernet communication. The motor encoder shall be hardwired to the drive to provide speed control feedback. The PLC shall monitor the drive to verify proper motor control through the Ethernet communication with the drive.

Note: If PLC command to close the span is sent continuously for more than 10 seconds and the PLC Ethernet monitoring does not indicate the drive is running or the encoder does not provide a signal that the motor is rotating, the PLC shall generate provide an alarm.

c. Control Switch Span (CS-SPAN) to ‘Off’
If the operator releases the control switch Span (CS-SPAN) while closing the bridge, the switch will spring return to ‘Off.’ (Alternately if the PLC is required to stop the span it will follow the same procedure.)

When the control switch Span (CS-SPAN) is in the ‘Off’ position, both PLC inputs ‘Span Open’ and ‘Span Close’ shall be de-energized. When both inputs are de-energized during a raising operation, the PLC shall continue to open the span and decelerate (ramp down) to stop in 5 seconds. Then the PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

The span operation can be restarted by following the procedure as shown above.

d. Drive Trouble Operation
If at any time during an operation (both opening and closing) the Drive generates a Trouble Alarm, continue to open the span and decelerate (ramp down) to stop in 5 seconds. Then the PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery

brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

e. Close the Span to Nearly Closed
The PLC shall maintain the fast speed close of the span until the span reaches the nearly closed position. When PLC input rotary limit switch contacts 'Span Limit Switch Nearly Closed' is de-energized, then the span is nearly closed.

When the span is nearly closed the PLC shall command the drive to continue closing the span and reduce speed to creep speed. Once the span is at creep speed the PLC shall command the drive to enter reduced torque in the close direction.

The PLC shall monitor the drive through the Ethernet connection to monitor motor speed to verify the motor speed is reduced to creep speed. If the motor speed does not decrease to creep, then the PLC shall continue to close the span and decelerate (ramp down) to stop in 5 seconds. The PLC shall de-energize the Drive Motor contactor M-SDM to isolate the motor from the Drive. The PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

f. Close the Span to Fully Closed
The PLC shall maintain the creep speed close of the span until the span reaches the fully open position of Zero (0) degrees. When PLC input for the span rotary limit switch contacts 'Span Fully Closed' is de-energized, then the span is fully closed.

The PLC shall monitor the proximity limit switches. When PLC input proximity limit switch input 'Span Closed' is de-energized the span is fully closed. The rotary limit switches shall actuate before the proximity limit switch contacts actuate. The proximity limit switches shall serve as a back-up system to the rotary limit switch. The PLC shall generate provide an alarm if the rotary limit switch contacts actuate after the proximity limit switches actuate.

When the span is fully closed the PLC shall command the Drive to ramp from creep speed to zero RPM in less than one second. After one second the PLC shall de-energize the motor contactor M-SDM to isolate the motor from the drive. The PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate provide an alarm.

g. Span Overtravel Proximity Limit Switch
If the span is open overtravel proximity limit activates, the PLC shall command the Drive to ramp to a stop of zero (0) RPM in less than one second, and the PLC shall generate an alarm. After one second the PLC shall de-energize the

motor contactor M-SDM to isolate the motor from the drive. The PLC shall de-energize all the brake contactors to set all brakes. De-energizing the brake motor contacts shall cause all the brakes to set. The PLC shall verify that the all motor and machinery brakes are set, by verifying the corresponding PLC limit switch inputs are de-energized. If any brake does not set within 2 seconds, the PLC shall generate an alarm.

h. Interlocks:
The span shall be interlocked such that span cannot be closed unless the wedges locks are fully withdrawn.

i. Bypass Operation:
If the wedge lock fails to withdraw, the wedge lock withdrawn interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

24. Wedge Lock Control Switch (CS-WM)
    a. Turn Wedge Lock Control Switch (CS-WM) to Drive
    b. When the control switch Wedge Lock (CS-WM) is held in the 'Drive' position, PLC input 'Wedge Lock Drive' shall be energized. While PLC input 'Wedge Lock Drive' is energized and the PLC input 'Wedge Lock Withdrawn' is de-energized, the PLC shall:
        i. Energize the PLC output 'Wedge Lock Drive' to the wedge lock motor coil through the Ethernet enabled overload.
        ii. De-energize the PLC output 'Wedge Lock Withdrawn' to the wedge lock motor coil through the Ethernet enabled overload.
    c. Note: If PLC input 'Wedge Lock Driven' is energized continuously for more than 30 seconds and the PLC input 'Wedge Lock Fully Driven' has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
    Interlocks:

    The wedge lock shall be interlocked such that it cannot be driven unless span is fully closed and there is bridge control power.

    Bypass Operation:

    If there is a failure with the span full closed position indication, the leaves seated interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

25. Near Barrier Gate Control Switch (CS-BG-N)
    a. Turn Near Barrier Gate Control Switch (CS-BG-N) to Open
    b. When the control switch Near Barrier Gate (CS-BG-N) is held in the 'Open' position, PLC inputs 'Near Barrier Gate Open' shall be energized. While PLC input 'Near Barrier Gate Open' is energized and the PLC input 'Near Barrier Gate Limit Switch Fully Closed' is de-energized, the PLC shall:
        i. Energize the PLC output 'Near Barrier Gate Open' to the gate motor drive

ii. De-energize the PLC output ‘Near Barrier Gate Close’ to the gate motor drive
iii. Coordinate gate speed and control operation with gate manufacturer. There are interposing relays for all drive settings.

c. Note: If PLC input ‘Near Barrier Gate Open’ is energized continuously for more than 30 seconds and the PLC input ‘Near Gate Limit Switch Fully Open’ has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
Interlocks:

The barrier gate shall be interlocked such that it cannot be opened unless the wedges are fully driven, the span is fully closed and there is bridge control power.

Bypass Operation:

If there is a failure with the wedges, the wedge drvien interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

26. Far Barrier Gate Control Switch (CS-BG-F)
    a. Turn Far Barrier Gate Control Switch (CS-BG-F) to Open
    b. When the control switch Far Barrier Gate (CS-BG-F) is held in the ‘Open’ position, PLC inputs ‘Far Barrier Gate Open’ shall be energized. While PLC input ‘Far Barrier Gate Open’ is energized and the PLC input ‘Far Gate Limit Switch Fully Open’ is de-energized, the PLC shall:
        i. Energize the PLC output ‘Far Barrier Gate Open’ to the gate motor drive
        ii. De-energize the PLC output ‘Far Barrier Gate Close’ to the gate motor drive
        iii. Coordinate gate speed and control operation with gate manufacturer. There are interposing relays for all drive settings.
    c. Note: If PLC input ‘Far Barrier Gate Open’ is energized continuously for more than 30 seconds and the PLC input ‘Far Barrier Gate Limit Switch Fully Open’ has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
    Interlocks:

    The barrier gate shall be interlocked such that it cannot be opened unless the wedges are fully driven, the span is fully closed and there is bridge control power.

    Bypass Operation:

    If there is a failure with the wedges, the wedge driven interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

27. Near Offgoing Gate Control Switch (CS-WG-NOF)
    a. Turn Near Offgoing Gate Control Switch (CS-WG-NOF) to Raise

b. When the control switch Near Offgoing Gate (CS-WG-NOF) is held in the 'Raise' position, PLC inputs 'Near Offgoing Gate Raise' shall be energized. While PLC input 'Near Offgoing Gate Raise' is energized and the PLC input 'Near Gate Limit Switch Fully Raised' is de-energized, the PLC shall:
   i. Energize the PLC output 'Near Offgoing Gate Raise' to the gate motor lower coil through the Ethernet enabled overload.
   ii. De-energize the PLC output 'Near Offgoing Gate Lower' to the gate motor raise coil through the Ethernet enabled overload.

c. Note: If PLC input 'Near Offgoing Gate Raise' is energized continuously for more than 10 seconds and the PLC input 'Near Gate Limit Switch Fully Raise' has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.

Interlocks:

The offgoing gate shall be interlocked such that it cannot be raised unless both barrier gates are opened, the wedges are fully driven, the span is fully closed and there is bridge control power.

Bypass Operation:

If there is a failure with the barrier gates, the barrier gate open interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

28. Far Offgoing Gate Control Switch (CS-WG-FOF)
   a. Turn Far Offgoing Gate Control Switch (CS-WG-FOF) to Lower
   b. When the control switch Far Offgoing Gate (CS-WG-FOF) is held in the 'Lower' position, PLC inputs 'Far Offgoing Gate Lower' shall be energized. While PLC input 'Far Offgoing Gate Lower' is energized and the PLC input 'Far Gate Limit Switch Fully Lowered' is de-energized, the PLC shall:
      i. Energize the PLC output 'Far Offgoing Gate Lower' to the gate motor lower coil through the Ethernet enabled overload.
      ii. De-energize the PLC output 'Far Offgoing Gate Raise' to the gate motor raise coil through the Ethernet enabled overload.
   c. Note: If PLC input 'Far Offgoing Gate Lower' is energized continuously for more than 10 seconds and the PLC input 'Far Gate Limit Switch Fully Lowered' has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.

   Interlocks:

   The offgoing gate shall be interlocked such that it cannot be raised unless both barrier gates are opened, the wedges are fully driven, the span is fully closed and there is bridge control power.

   Bypass Operation:

   If there is a failure with the barrier gates, the barrier gate open interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

29. Near Oncoming Gate Control Switch (CS-WG-NON)
    a. Turn Near Oncoming Gate Control Switch (CS-WG-NON) to Raise
    b. When the control switch Near Oncoming Gate (CS-WG-NON) is held in the 'Raise' position, PLC inputs 'Near Oncoming Gate Raise' shall be energized. While PLC input 'Near Oncoming Gate Raise' is energized and the PLC input 'Near Oncoming Gate Limit Switch Fully Raised' is de-energized, the PLC shall:
        i. Energize the PLC output 'Near Oncoming Gate Raise' to the gate motor coil through the Ethernet enabled overload.
        ii. De-energize the PLC output 'Near Oncoming Gate Lower' to the gate motor coil through the Ethernet enabled overload.
    c. Note: If PLC input 'Near Oncoming Gate Raise' is energized continuously for more than 10 seconds and the PLC input 'Near Oncoming Gate Limit Switch Fully Raised' has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
    Interlocks:

    The oncoming gate shall be interlocked such that they cannot be raised unless both offgoing gates are raised, both barrier gates are opened, the wedges are fully driven, the span is fully closed and there is bridge control power.

    Bypass Operation: If there is a failure with the offgoing gates, the offgoing gate raise interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

30. Far Oncoming Gate Control Switch (CS-WG-FON)
    a. Turn Far Oncoming Gate Control Switch (CS-WG-FON) to Raise
    b. When the control switch Far Oncoming Gate (CS-WG-FON) is held in the 'Raise' position, PLC inputs 'Far Oncoming Gate Raise' shall be energized. While PLC input 'Far Oncoming Gate Raise' is energized and the PLC input 'Far Gate Limit Switch Fully Raised' is de-energized, the PLC shall:
        i. Energize the PLC output 'Far Oncoming Gate Raise' to the gate motor raise coil through the Ethernet enabled overload.
        ii. De-energize the PLC output 'Far Oncoming Gate Raise' to the gate motor lower coil through the Ethernet enabled overload.
    c. Note: If PLC input 'Far Oncoming Gate Raise' is energized continuously for more than 10 seconds and the PLC input 'Far Oncoming Gate Limit Switch Fully Raised' has not been de-energized, the PLC shall generate provide an alarm and de-energize the gate motor coil.
    Interlocks:

    The oncoming gate shall be interlocked such that they cannot be raised unless both offgoing gates are raised, both barrier gates are opened, the wedges are fully driven, the span is fully closed and there is bridge control power.

    Bypass Operation: If there is a failure with the offgoing gates, the offgoing gate raise interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

31. Traffic Warning Control Switch CS-TW
    a. When control switch Traffic Warning (CS-TW) is placed in the ‘Off’ position the PLC shall:
        i. Energize the control desk indicating light IL-TW-OFF if all gates are raised, all barriers are closed, the wedges are driven, and the span is fully closed.
        ii. De-energize the control desk indicating light IL-TW-ON if all gates are raised, all barriers are closed, the wedges are driven, and the span is fully closed.
        iii. De-energize the PLC outputs to activate the advance warning flashing light, traffic signals, and gongs.
    b. De-energizing the PLC input ‘Traffic Warning On’ shall de-energize control relay CR-YSR and TR-RSR. This will de-activate the red and yellow traffic lights as shown on the Plans, and the green lights shall be energized. The PLC shall de-energize relay CR-FLASHER to de-energize the flashing lights as shown on the plans. The PLC shall de-energize relay CR-GONG to de-energize the gongs.
    Interlocks:

    The traffic warnings shall be interlocked such that they cannot be turned off unless both oncoming gates are raised, both offgoing gates are raised, both barrier gates are opened, the wedges are fully driven, the span is fully closed and there is bridge control power.

    Bypass Operation:

    If there is a failure with the oncoming and/or off going gate, the gate raised interlock ONLY can be bypassed by using the touchscreen bypass in conjunction with the manual key operated bypass switch CS-BP. Whenever a bypass is used shall the PLC shall generate provide an alarm.

32. Control Power Key Selector Switch
    a. The operator shall turn the control desk key operated Control Power (CS-CP) switch to the ‘Off’ position. The PLC shall de-energize all control desk indicating lights and all outputs (except IL-PWR).

    b. Control Power switch in the ‘Off’ position shall de-energized input ‘Control Power On’ to the PLC. The Control Power On (IL-CP) indicating light shall be hard wired to be de-energized as long as the Control Power switch is in the ‘Off’ position (as shown on the Plans).

    c. The Control Power switch (CS-CP) in the ‘Off’ position de-activates Bridge Control relay. All PLC inputs should be de-energized.

    d. All bypasses used during the operation of the span shall be reset and nothing shall be in a bypassed state for the next operation.

End of Operation

N. OTHER PLC FUNCTIONS:

1. PLC I/O Reserved for Future Expansion or Alternate Drive Configurations
   The PLC and Drive shall be capable of providing a separate speed setting and operating at that speed. This is provided for future expansion or alternate drive configuration requirements.
2. Bypass for Clockwise Opening Operation
   The normal span operating procedure for the bridge is open the span in the counter clockwise rotation and close in the clockwise direction, and all equipment is set up for that operation. The Contractor shall provide a bypass on the PLC touchscreen that allows the span to be opened in the clockwise direction and closed in the counter clockwise direction, at low speed and without automatic limit switch operation. The operation will rely on the operator stopping the span in the safe locations. However, when done with the operation, the operator will bring back the span in the counter clockwise direction past the full closed position. Then releasing the bypass will allow the span to operate in the normal operating configuration to fully close the span.

O. ALARMS

1. The PLC program shall generate provide alarms when they occur. The alarm shall be sent once to the PanelView and shall not be sent again until the next time the alarm condition occurs. The PanelView shall provide an audible tone with each alarm message until the PanelView acknowledge button is pressed.
2. All the standard PLC processor and equipment fault conditions and alarms, provided as part of the PLC equipment, shall generate provide an alarm.
3. All the standard fiber optic equipment fault alarms and conditions, provided as part of the fiber optic equipment, shall generate provided an alarm.
4. The Contractor shall be prepared to add an additional 250 alarms during the Factory Testing and another 250 during Start Up and Commissioning as directed by the Engineer.
5. The following is a list of the minimum alarms required. Some of the alarm descriptions are typical, provide a dedicated alarm for each piece of equipment.
   a. PLC Communication fault to Remote I/O Rack in RPLC.
   b. PLC Communication fault to Remote I/O Rack in the Control Desk.
   c. PLC Processor A Rack fault.
   d. PLC Processor B Rack fault.
   e. Rack fault in the Remote I/O Rack in RPLC.
   f. Rack fault in the Remote I/O Rack in the Control Desk
   g. Power fault alarm.
   h. Any Circuit Breaker in MCC Tripped
   i. Any Motor Overload Tripped
   j. Any Motor Overcurrent Status
   k. Check lost input control power for each Circuit Breaker for all PLC Panels.
   l. Control Power has been turned off.
   m. Emergency Stop pushbutton was de-pressed.
   n. Any Emergency Stop control relay operated when the Emergency Stop pushbutton was not depressed.

o. Any Emergency Stop control relay did not operated when the Emergency Stop pushbutton was depressed.
p. Any MCC Bucket Not In Auto
q. Any Warning Gate did not lower after 10 seconds.
r. Any Barrier Gate did not close after 30 seconds.
s. Any Wedge did not withdraw after 30 seconds.
t. Any Warning Gate did not raise after 10 seconds.
u. Any Barrier Gate did not open after 30 seconds.
v. Any barrier or warning gate door open.
w. Any barrier or warning hand crank operation.
x. Any Wedge did not drive after 30 seconds.
y. Wedge motor manual operation
z. Drive did not start running after 10 seconds.
aa. Any Brake hand released.
bb. Any Brake released improperly.
cc. Auxiliary system operation
dd. Drive has a trouble alarm.
ee. Drive is not ready.
ff. Drive or any motor is disconnected at the local motor disconnect switch.
gg. Position transmitter failure.
hh. Any Brake failed to release while operating span.
ii. Span fully closed proximity limit switch indication tripped before the rotary cam limit switch while operating the span.
jj. Span fully open proximity limit switch indication tripped before the rotary cam limit switch while operating the span.
kk. Position transmitter is not in synch with rotary limit switch.
ll. Span decel check during span operation failed.
mm. Any Bypass was activated.
nn. PLC Communication Fiber Optic Cable Fault Tracking Alarm
oo. PLC Communication Fiber Optic Cable Failure
pp. Generator On
qq. ATS not in Auto
rr. ATS Failure
ss. Generator Failure/Alarm
tt. Generator Low Fuel
uu. Generator Low Battery
vv. Waste Water Tank 85% Full

4.0 MEASUREMENT AND PAYMENT

Bridge Control System will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Bridge Control System*.

Payment will be made under:

Pay Item	**Pay Unit**

Bridge Control System	Lump Sum

Project Special Provisions
Mechanical Equipment

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DocuSigned by:
Scott Reynolds
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GENERAL MACHINERY **(SPECIAL)**

1.0 DESCRIPTION

A. SCOPE OF WORK

This section shall apply to Item (SPECIAL) "Stabilizing Machinery", (SPECIAL) "Turning Machinery", (SPECIAL) "End Wedge Machinery", (SPECIAL) "Center Wedge Machinery", (SPECIAL) "Centering Device Machinery", (SPECIAL) "Auxiliary Operating System" and (SPECIAL) "Operating and Maintenance Manuals" and gives the general requirements which apply to all bridge machinery and is given here to avoid repetition in each of the individual machinery sections. Also, this section applies to the installation of electric motors, brakes, instrument drives and limit switches to be mounted with the machinery but supplied under separate items.

The cost of work required by this "General Machinery" is included in the bridge machinery pay items.

B. BASIS OF MACHINERY DESIGN

The design of new machinery conforms to the 1988 Standard Specifications for Movable Highway Bridges published by the American Association of State Highway and Transportation Officials, 1992 and 1993 Revisions (hereinafter referred to as the AASHTO Standard), except as otherwise noted on the Plans or otherwise specified herein.

C. SUBMITTALS

Manufacturer's data and/or shop drawing data shall be submitted for all manufactured and purchased items of bridge machinery.

Submittals for each manufactured item shall be manufacturer's descriptive literature, drawings, diagrams, performance and characteristic curves, and catalog cuts, and shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, certified layout dimensions, capacity, specification reference, applicable Federal and Military Specification references and all other information necessary to establish Contract compliance.

Temporary means needed to complete machinery items, including but not limited to temporary end wedges and center wedges, shall be developed by the contractor and submitted to the engineer for review. Submittals shall include all necessary information to illustrate and confirm safe operation and support of the machinery and/or swing span. Submittals should include shop and working drawings, installation and erection drawings, catalog and specification sheets, and checked calculations. Submittals shall be signed and sealed by a Professional Engineer licensed in the appropriate discipline by the State of North Carolina.

D. SHOP DRAWINGS

1. Shop drawings shall conform to NCDOT Standards and as supplemented and amended elsewhere herein and to the special requirements specified hereinafter.

2. Shop drawings shall show all parts completely detailed and dimensioned. The grade and amount of finish machining, with all tolerances and allowances, shall be stated for each part for which a specific fit is required. Finished surfaces shall be as defined by the ANSI B46.1, "Surface Texture"; and fits shall be as defined by the ANSI B4.1, "Preferred Limits and Fits for Cylindrical Parts," unless otherwise stated herein or on the Plans. ANSI B4.1 shall also apply to fits for non-cylindrical parts.
3. All proprietary items shall be shown in outline on the drawings, which shall also indicate the method and sequence to be employed in assembly of bridge machinery and installation of necessary utilities support and service facilities. Shop drawings shall show all external dimensions and clearances necessary for installation and operation of each item of machinery in the bridge. All catalog cuts are considered as shop drawings. After approval, all catalog cuts are to conform to shop drawing format requirements and scanned as a PDF file format in accordance with the requirements of NCDOT.
4. For all bridge machinery shown on the Plans or listed herein, the Contractor shall furnish complete assembly diagrams showing each part contained within the item and the manufacturer's part number assigned to each part. The diagram shall be sufficient to enable complete disassembly and reassembly of the item covered. In the event that any part is modified in any manner from the way it is described or delivered by its original manufacturer, the Contractor shall deliver a drawing that details each modification; and the part shall be assigned a unique part number to preclude the supply of replacement parts not modified in similar fashion. The assembly drawings of each item shall, in addition to identifying and describing each internal part, contain dimensions of all principal elements within the item; certified external dimensions affecting interfaces or installations; gross weight capacity and normal operating ratings; method and recommended type of lubrication, including location and type of fittings and provisions for adding, draining and checking the level of each lubricant employed; inspection openings, seals, and vents; and details of all fasteners used to mount the equipment to its foundation.
5. Complete shop bills of materials shall be made for all machinery parts. If the bills are not shown on the shop drawings, prints of the bills shall be furnished for approval in the same manner as specified for the shop drawings.
6. The material and material specifications shall be stated for each part. Where American Society for Testing and Materials Specifications or any other Standard Specifications are used, the designating numbers of such Specifications shall be given. The following abbreviations will be used herein and on the Plans to designate Standard Specifications for materials and workmanship:

    a. American Association of State Highway and Transportation Officials, AASHTO
    b. American Bearing Manufacturers Association, ABMA
    c. American Gear Manufacturers Association, AGMA
    d. American Iron and Steel Institute, AISI
    e. American National Standards Institute, ANSI
    f. American Railway Engineering and Maintenance-of-Way Association, AREMA
    g. American Society for Testing and Materials, ASTM

h. National Lubricating Grease Institute, NLGI
i. National Electrical Manufacturers Association, NEMA
j. Society of Automotive Engineers, SAE

7. Complete assembly and erection drawings shall be furnished. These drawings shall give identifying marks and essential dimensions for locating each part or assembled unit with respect to the bridge structure or foundation. Use of mirror image or opposite hand erection drawings will not be allowed.
8. Each shop drawing shall be given a suitable title to describe the parts detailed thereon and shall state by whom shop inspection will be made.
9. The Contractor shall allow the Department or their authorized inspectors to audit their facilities prior to start of any fabrication, casting, machining, etc. in order to expedite inspection procedures by all inspection agencies and authorized personnel.
10. Standard Compliance: Where equipment or materials are specified to conform to requirements of the standards of an organization, such as American Society for Mechanical Engineers (ASME), Underwriters Laboratories (UL), American Gas Association (AGA), and American Refrigeration Institute (ARI), that use a label or listing as method of indicating compliance, proof of such conformance shall be submitted and approved. The label or listing of the specified organization will be acceptable evidence. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization adequately equipped and competent to perform such services and approved by the Engineer, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code.
11. Certified Test Reports: As used herein, certified test reports refer to reports of tests conducted on previously manufactured materials or equipment identical to that proposed for use.
12. Factory Tests: As used herein, factory tests refer to tests required to be performed on the actual materials or equipment proposed for use. Results of the tests shall be submitted in accordance with the provisions of this Contract for laboratory test results.
13. The Contractor shall submit the required shop drawings for machinery items to the Engineer for review within 120 days after the date of award of contract.
14. The Contractor shall submit to the Engineer for his approval all shop drawings. In case of correction or rejection, the Contractor shall resubmit until each drawing is approved. The Contractor shall bear all costs for damages, which may result from the ordering of any materials prior to the approval of the shop drawings; and no work shall be done until the shop drawings have been approved. After approval of the shop drawings, the Contractor shall supply the Engineer with copies of the approved shop drawings.

E. OPERATING AND MAINTENANCE MANUALS

1. Operating and maintenance manuals shall be provided by the Contractor as per Item (SPECIAL) “Operating and Maintenance Manuals”.

F. POSTED OPERATING INSTRUCTIONS

1. Operating instructions approved by the Engineer shall be provided for the system and each principal piece of equipment for the use of operation and maintenance personnel. The operating instructions shall include diagrams showing the complete layout of the entire system, and shall be framed under glass or in approved laminated plastic and posted where directed by the Engineer; printed or engraved operating instructions for each principal piece of equipment including proper adjustment, operating, lubrication, safety precautions, procedure in the event of equipment failure, and any other necessary items of instruction as recommended by the manufacturer of the unit shall be attached to or posted adjacent to the piece of equipment or as directed by the Engineer. Operating instructions exposed to the weather shall be made of weather-resisting materials or shall be suitably enclosed to be weather protected. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

G. QUALITY ASSURANCE

1. Standard Products. Materials and equipment shall be essentially the standard catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements. Materials and equipment shall essentially duplicate items that have been in satisfactory commercial or industrial use at least two years prior to bid opening. Where two units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer. Each major component of equipment shall have the manufacturer's name and address and the model and serial number on a nameplate, securely affixed in a conspicuous place. The name plate of the distributing agent will not be acceptable.
2. Manufacturer’s Recommendations. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material. The Contractor shall provide as part of the work all special machining and installation required by the component manufacturer.
3. Codes and Standards. Work under bridge machinery pay items shall comply with all applicable requirements of the latest edition of codes and standards issued by, but not limited to, the following organizations and publications, whose abbreviations used in this Specification shall be as shown:

    a. American Association of State Highway and Transportation Officials, AASHTO
    b. American Bearing Manufacturers Association, ABMA
    c. American Gear Manufacturers Association, AGMA
    d. American Iron and Steel Institute, AISI
    e. American National Standards Institute, ANSI

f. American Society for Testing and Materials, ASTM
g. American Welding Society, AWS
h. National Lubricating Grease Institute, NLGI
i. Society of Automotive Engineers, SAE
j. North Carolina DOT Standard Specifications for Roads and Structures

4. The work shall meet the requirements of all other codes and standards as specified elsewhere in these Specifications. Where codes and standards are mentioned for any pay item, it is intended to call particular attention to them, it is not intended that any other codes and standards be omitted if not mentioned.

H. QUALIFICATIONS, PERSONNEL AND FACILITIES

1. For the fabrication, installation, aligning, cleaning, lubricating, testing and all other work required by bridge machinery pay items, the Contractor shall use adequate numbers of skilled, trained, and experienced mechanics, millwrights and service personnel who are thoroughly familiar with the requirements and methods specified for the proper execution of work.
2. Mechanics, millwrights and service personnel shall be properly equipped with all necessary instruments to assure that related components have been provided within acceptable tolerances and to make all necessary adjustments for attaining the specified ratings.

I. RULES, REGULATIONS AND ORDINANCES

1. Work shall comply with all applicable Federal, State and Local rules, regulations, and ordinances.
2. In the event of a conflict between these Specifications and the above mentioned codes, standards, rules, regulations, and ordinances, the most stringent requirement shall apply.

J. MEASUREMENTS AND VERIFICATION

1. Dimensions indicated on the Plans are nominal and are intended for guidance only. All variations from the nominal dimensions on the Plans shall be noted on the shop drawings.

K. SUBSTITUTIONS

1. The terms "approved equal", "of equal quality" and "or equal" which appear on the Plans and in these Specifications are intended to allow the Contractor to substitute other manufacturers and model numbers of products of equal quality and rating for those specified.
2. Prior to the Contractor's ordering of any substitute product, the Engineer's approval of the equivalence of the substitute product shall be obtained in writing. The acceptance of the substitute products is at the sole discretion of the Engineer who will establish the basis for equivalence and will review the quality of the materials and products described in detail on the submitted shop drawings and product data.
3. The Engineer will "Approved" or "Revise and Resubmit" substitute material. Upon return of a shop drawing showing rejection, the Contractor shall resubmit the shop drawing showing the specified product. Rejection shall not in any way result in any extra cost.

4. Approval by the Engineer of any substitute products submitted by the Contractor shall not relieve the Contractor of responsibility for the proper operation, performance, or functioning of that product.
5. Where a manufacturer's name and catalog part number, in this Specification or on the Plans, specifies a particular product it is so specified to establish quality, configuration, and arrangement of parts. An equivalent product made by another manufacturer may be substituted for the specified product subject to the approval of the Engineer; however, all necessary changes required by the substitution in related machinery, structural, architectural and electrical parts, shall be made by the Contractor at no additional cost.
6. If any departures from the Plans or these Specifications are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted as soon as practicable for approval. No such departures shall be made without approval by the Engineer.

2.0 MATERIALS

A. CASTINGS AND FORGINGS

Before any work is started on castings and forgings, the manufacturer shall communicate with the Engineer to arrange for inspections and tests. The Engineer shall be notified not less than five (5) working days prior to the start of work so that a representative of the Engineer may be present.

All necessary precautions shall be taken to fabricate the castings true to pattern in form and dimensions, free of pouring faults, cracks, cold shuts, blow holes and other defects in positions affecting their strength and value for the service intended.

All castings shall be cleaned free of loose scale and sand; all fins, seams, gates, risers and other irregularities shall be removed. All unfinished edges of castings shall be neatly cast with rounded corners and all inside angles shall have ample fillets.

1. Required Testing:
   a. All castings shall be visually examined in accordance with ASTM A 802, meeting visual inspection acceptance criteria Level II. Castings that do not pass this test may be rejected. Test results, whether positive or negative, shall be submitted to the Engineer. Test records meeting Level III may be considered for weld repair, provided the manufacturer submits a procedure to the Engineer for review and approval.
   b. All castings that have solid sections 2-inches thick or greater in the as-cast condition and all fracture critical members shall be ultrasonically tested in accordance with ASTM A 609, Method A, meeting Quality Level 2. Castings that do not pass this test may be rejected. Test results, whether positive or negative, shall be submitted to the Engineer. Test records meeting Quality Level 3 may be considered for weld repair, provided the manufacturer submits a procedure to the Engineer for review and approval.

c. All casting surfaces shall be magnetic particle examined in accordance with ASTM E125, meeting the following acceptable levels of discontinuities:

i.	Type I	Cracks/Hot Tears	1/4 inch max
ii.	Type II	Shrinkage	Degree 3
iii.	Type III	Inclusions	Degree 3
iv.	Type IV	Chaplets	Degree 2
v.	Type V	Porosity	Degree 1

d. Test results, whether positive or negative, shall be submitted to the Engineer. All surface discontinuities may be considered for weld repair, provided the manufacturer submits a procedure to the Engineer for review and approval.

e. All repair procedures shall include details of the areas to be repaired and a means to qualify the repair method. Approved repair procedures shall be performed prior to final heat treatment, so that no weld repairs will be needed after final machining. In addition, all surface defects removed by rough machining shall be performed prior to final heat treatment.

f. All castings that fail to meet the established acceptance criteria and considered rejected shall be replaced, at the Contractors expense, with new castings.

g. All carbon and alloy steel forgings shall meet the requirements of AASHTO Specification M102 (ASTM A668) unless otherwise indicated or approved by NCDOT.

h. All forgings shall be reduced to size from a single bloom or ingot until homogeneity is secured. The blooms or ingots, from which shafts or pins are to be made, shall have a cross-sectional area at least three times that required after finishing. No forging shall be done at less than a red-heat.

i. All finish machined forging surfaces shall be magnetic particle examined in accordance with ASTM A 275. The maximum permissible indication on any surface shall be ¼ inch. Indications greater than ¼ inch may be cause for rejection. Test results, whether positive or negative, shall be submitted to the Engineer.

2. Independent Testing:

a. Independent inspection and testing, destructive and or non-destructive, may be performed by a representative of the Engineer and shall be paid for by the Owner. The tests would be in addition to and independent of tests being performed by the Contractor as per the plans and specifications.

b. The contractor shall furnish, i.e. make available for use, all facilities at the foundry, forge shop and or machine shop for independent inspection and testing, destructive and or non-destructive, required by the Engineer.

c. The previously noted acceptance criteria shall apply to any independent testing. In addition, the independent testing may include radiographic testing to help isolate areas, which in the opinion of the Engineer, may require further investigation. Acceptance or rejection will not depend solely on the radiographic test results but rather they will help define any flaws, which may be of concern to the Engineer.

B. BRONZE CASTINGS

1. All bronze castings shall meet the requirements of AASHTO Specification M107 (ASTM B22) and be Copper Alloy UNS No. C91100 unless otherwise indicated.

C. SHAFTING AND PINS

1. All shafts shall conform to tolerances in ASTM A29 unless otherwise indicated. Turned, ground and polished shafting straightness tolerances shall be 0.002 inch per foot for shafts up to and including 1 ½ inches in diameter and 0.003 inch per foot for shafts over 1 ½ inches in diameter.
2. All shafts and pins shall be accurately finished, round, smooth, and straight; and when turned to different diameters, they shall have rounded fillets at the shoulders. Each shaft or pin having a uniform diameter of more than 8 inches and each shaft or pin having several diameters, of which the smallest is more than 8 inches, shall be bored lengthwise through the center to a diameter approximately one-fifth the smallest body diameter.
3. Each end of all shafts, when finished to the required lengths, shall have a 60-degree lathe center, with clearance hole, at the exact center of the shaft. Shafts that have a hole bored lengthwise through their centers shall have the ends prepared for the attachment of a centering device equivalent to the lathe center. All such devices shall be furnished as part of the work.
4. Where it is required on the Plans that stepped shafts shall have fillets blended in smoothly to adjacent surfaces without tool marks or scratches, the surfaces shall have an ANSI maximum roughness of 63 micro inches, unless otherwise required herein or on the Plans to have a finer finish.
5. All cold-finished shafting shall be steel of the type and grade shown on the Plans and shall be tested for its mechanical properties, and a test certificate shall be furnished to the Engineer. Each cold-finished shaft shall be free from camber and shall run without vibration, noise, or chatter at all speeds up to and including the maximum rated speed.
6. All hubs mounted on the ends of cold-finished shafts shall have the fit specified herein or on the Plans. To obtain the required fit between hub and shaft, the Contractor may furnish the cold-finished shaft $^{1}/_{16}$ inch larger than the nominal diameter specified and shall turn the ends to the required dimension for the hub. The Contractor may, at his option, furnish any cold-finished shaft of one diameter end to end; but such shaft shall have tolerances selected from the normal manufacturing range, which will provide the specified fit. The selected tolerances shall be shown on the shop drawings.
7. Turned, ground, and polished commercial shafting of the grade specified shall be used where shown on the Plans.

D. FASTENERS

1. All bolts for connecting machinery parts to each other or to supporting members shall be as shown on the Plans or specified otherwise and conform to one of the following types:

   a. Finished body, high-strength bolts.
   b. Turned bolts, turned cap screws and turned studs.

c. High-strength turned bolts, turned cap screws and turned studs.
d. High-strength bolts.

2. All high-strength bolts shown on the machinery drawings shall be finished body, high- strength bolts unless otherwise noted.
3. Finished body high-strength bolts shall meet the requirements of ASTM A449. Finished body high-strength bolts shall have finished bodies and regular hexagonal heads. Clearance of not more than 0.010 inch larger than the actual diameter of individual bolts for that hole. The clearance shall be checked with a 0.011-inch wire. The hole shall be considered too large if the wire can be inserted in the hole together with the bolt.
4. Turned bolts, turned cap screws and turned studs shall have turned shanks and cut threads. Turned bolts shall have semi-finished, washer faced, hexagonal heads and nuts. Turned cap screws shall have finished, washer faced, hexagonal heads. All finished shanks of turned fasteners shall be 1/16 inch larger in diameter than the diameter of the threads, which shall determine the head and nut dimensions. The shank of all turned fasteners shall have a Class LC6 fit in the finished holes in accordance with ANSI Standard B4.1. The material used for machining turned shank fasteners shall meet the requirements of ASTM A307, Grade A. Turned fasteners shall be fully detailed on shop drawings.
5. High-strength turned bolts, turned cap screws and turned studs shall be detailed as specified above, except that the material shall meet the requirements of ASTM A449.
6. High-strength bolts shall meet the requirements of ASTM A325.
7. All elements connected by bolts shall be drilled or reamed assembled to assure accurate alignment of the hole and accurate clearance over the entire length of the bolt within the specified limit.
8. The dimensions of all bolt heads, nuts, castle nuts, and hexagonal head cap screws shall be in accordance with ANSI Standard B18.2, Square and Hexagon Bolts and Nuts.
9. Heads and nuts for turned bolts, screws and studs shall be heavy series.
10. The dimensions of socket-head cap screws, socket flathead cap screws, and socket-set screws shall conform to ANSI Standard B18.3. The screws shall be made of heat-treated alloy steel, cadmium-plated, and furnished with a self-locking nylon pellet embedded in the threaded section. Unless otherwise called for on the drawings or specified herein, set screws shall be of the headless safety type, shall have threads of coarse thread series, and shall have cup points. Set screws shall neither be used to transit torsion nor as the fastening or stop for any equipment that contributes to the stability or operation of the bridge.
11. Threads for bolts, nuts, and cap screws shall conform to the coarse thread series and shall have a Class 2 tolerance for bolts and nuts or Class 2A tolerance for bolts and Class 2B tolerance for nuts in accordance with the ANSI Standard B1.1, Unified Inch Screw Threads.
12. Bolt holes through unfinished surfaces shall be spot faced for the head and nut, square with the axis of the hole.
13. Unless otherwise called for, all bolts holes in machinery parts or connecting these parts to the supporting steel work shall be subdrilled at least 1/32-inch smaller in

diameter than the bolt diameter and shall be reamed assembled for the proper fit at assembly or at erection with the steel work after the parts are correctly assembled and aligned.

14. Holes in shims and fills for machinery parts shall be reamed or drilled to the same tolerances as the connected parts at final assembly.
15. Positive locks of an approved type shall be furnished for all nuts, except those on ASTM A449 bolts. If double nuts are used, they shall be used for all connections requiring occasional opening or adjustment. If lock washers are used for securing, they shall be made of tempered steel and shall conform to the SAE regular dimensions. The material shall meet the SAE tests for temper and toughness.
16. High-strength bolts shall be installed with a hardened plain washer meeting ASTM F436 at each end.
17. Wherever possible, high strength bolts connecting machinery parts to structural parts or other machinery parts shall be inserted through the thinner element into the thicker element.
18. All cotters shall conform to the SAE standard dimensions and shall be made of half-round stainless steel wire, ASTM A276, Type 316.
19. Anchor bolts connecting machinery parts to masonry shall be ASTM A307, Grade A material, hot-dipped galvanized per ASTM A153. Bolt locations shall be as shown on the shop drawings.
20. Anchor bolts for new construction shall be cast in place. When these fasteners connect a mechanical component directly to the concrete, there must be a filler material in the annular area between the bolt and the bolt hole in the machinery component. The filler material may be a non-shrink grout, babbitt metal or zinc.
21. All fasteners shall be of United States, manufacture and shall be clearly marked with the manufacturer's designation.

E. KEYS AND KEYWAYS

1. Keys and keyways shall conform to the dimensions and tolerances for square and rectangular keys of the ANSI Standard B17.1, Keys and Keyseats, unless otherwise specified. All keys shall be effectively held in place, preferably by setting them into closed-end keyways milled into the shaft. The ends of all such keys shall be rounded to a half circle equal to the width of the key. Keyways shall not extend into any bearing. If two keys are used in a hub, they shall be located 120 degrees apart and in line with wheel arms where practicable.
2. Unless otherwise specified herein or on the Plans, keys shall be machined from alloy-steel forgings, ASTM A 668 M, Class K.

F. BEARINGS AND BUSHINGS

1. All split bearings shall have one half fitted to the other half as shown on the Plans. The surface between the cap and base shall be accurately machined. All caps shall be securely bolted to the bases with turned bolts and double nuts. All caps and bases shall be provided with double-flanged bronze bushings securely held against changing position under load by hexagonal-head, steel cap screws, unless otherwise shown on the Plans. All bushings shall fit the inside bore and end faces of the base and cap, with an ANSI Class LC1 clearance and location fit, and shall fit the shaft

journals, with an ANSI Class RC6 running fit. All caps shall be provided with a tapped hole for lifting eyebolt, which shall be furnished for the purpose.

2. Bushings for split bearings shall be finished-bored with the caps in place and with ¼ inch thick rolled bronze or brass liners. At least $^{1}/_{8}$ inch of the liner thickness shall be of laminated construction capable of adjustment in increments of 0.003 of an inch. The edges of the liners toward the shaft journal shall be cut to fit the shaft shoulder fillets where they occur and shall be cut square and flush with the bushing flange if there is no change in shaft diameter. Except for a short distance from each end, the inside edges of the liners shall be cut back to form a grease groove along the shaft. All bolt holes shall be drilled through the liners.
3. For split bearings, each half bushing shall have machined double oval grease grooves connecting with the ends of the liner grooves and intersecting at the center of each half bushing, unless otherwise shown on the Plans. All grease grooves shall be precision machine-cut and smooth. The corners of all grooves shall be rounded to a radius of not more than half the width of the groove.
4. Anti-friction bearings shall be sized for a B-10 life of 40,000 hours as defined by ABMA for the ratings shown on the Plans.
5. Pillow block bearings shall be, adapter mounted, self-aligning expansion and non-expansion types as called for on the drawings. Housings shall be cast steel and capable of withstanding the design radial load in any direction, including uplift. Bases shall be cast without mounting holes. Mounting holes shall be drilled from the solid at assembly with the supporting steel work. Seals shall retain the lubricant and exclude water and debris. Cap bolts on pillow blocks shall be high-strength steel. The cap and cap bolts shall be capable of resisting the rated bearing load as an uplift force.

G. SHAFT JOURNALS

1. All journal bearing areas on shafts and pins shall be accurately turned, ground and polished with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. Burnishing of the shaft journal areas and adjoining shoulder fillets will be acceptable in lieu of grinding and polishing, provided the burnishing is done with a Stellite roller or equal which has been finished to a mirror surface. Journal diameters shall be finished to the limits of an ANSI Class RC6 running fit.

H. OPEN GEARING

1. Spur gears shall have 20-degree full-depth, involute cut teeth in accordance with the proportions of the ANSI/AGMA 201.02, Tooth Proportions for Coarse-Pitch Involute Spur Gears, unless otherwise specified herein or shown on the Plans.
2. The teeth of all gears shall be cut from solid rims or blanks. The sides and peripheries of all gears and pinions shall be finished, and the pitch circle shall be scribed on both sides not less than 0.02 inch deep with a V-pointed tool. The working surfaces of all gear teeth shall be true to the proper outline, accurately spaced on the true pitch circle, exceptionally smooth, and free from planing or milling-cutter ridges. Cutter burrs shall be removed from all edges of the teeth, and the top edges of all teeth shall be rounded to a $^{1}/_{32}$ inch radius.
3. Except as otherwise provided herein or on the Plans, all gears shall be cut and mounted to meet the requirements for accuracy of ANSI/AGMA Standard 2000-

A88, Gear Classification and Inspection Handbook. The AGMA quality number shall be stated on the applicable shop drawings. Open gearing shall conform to AGMA Quality No. 7 or higher.

4. Bevel gears shall have 20-degree full-depth, involute cut teeth in accordance with the proportions of the ANSI/AGMA 2005-B88, Design Manual for Bevel Gears.

I. ENCLOSED SPEED REDUCERS

1. Speed reducers shall be standard models from one manufacturer, with sizes, ratios and construction details as shown on the Plans.
2. Speed reducers shall be designed to meet all requirements of ANSI/AGMA Standard 6010, manufactured in accordance with the requirements of AGMA and given nameplates with the following information:

   a. Size
   b. Ratio
   c. Service Power Rating
   d. High Speed Shaft RPM
   e. Service Factor
   f. Lubrication Specification

3. Gear teeth shall be through hardened and conform to AGMA Quality No. 8 or higher. Casehardened gears shall not be used to drive bridge machinery.
4. Gears shall have spur, helical, herringbone or bevel teeth, bearings shall be antifriction type, and housings shall be steel castings or welded steel plate, which shall be stress relieved. The inside of the housings shall be sandblast cleaned prior to assembly and be protected from rusting. Exact ratios shall be furnished where specified.
5. Speed reducers shall be able to withstand a momentary overload equal to three (3) times the rated full load torque of the driving motor(s) without any component reaching 75 percent of its yield strength.
6. Lubrication of the gears and bearings shall be automatic when the unit is in operation.
7. It is preferable that a bath lubrication system be utilized. In a bath lubrication system, all components in the speed reducer, which require lubrication, are partially submerged in an oil bath.
8. When the configuration of gears and bearings prevent bath lubrication, a splash lubrication system should be used. Splash lubrication systems shall continuously lubricate all gears and bearings properly. Oil feed troughs may be used to supply oil to bearings and gears, which are above the bath. Splash lubrication systems shall be designed such that equal lubrication is supplied to each internal component for both directions of operation.
9. If a pressurized lubrication system is required for the reducer, a redundant secondary lubrication system shall be provided. The secondary system shall operate at all times when the primary system is functioning.
10. Inspection ports on reducers shall provide for inspection of all gears, bearings and other internal devices. The ports shall be located above the oil level, if practicable, so that oil draining is not required for inspection. The port shall be sized such that minor repairs could be made to reducers without requiring housing disassembly.

Ports shall be properly sealed with seals that do not require replacement when ports are opened.

11. Reducers shall be furnished with moisture trap breathers, oil fills, break proof glass oil level indicators, drains and inspection ports.
12. Moisture-trap breathers shall be located above maximum oil levels in all positions of the reducer during operation, and its piping shall enter the unit at the highest point possible. Breathers shall not be mounted in bearing caps.
13. Oil level indicators shall be mounted in locations that can be easily viewed by maintenance crews. On reducers in which the oil level varies by more than ½ inch per 50°F temperature change, the sight glass shall be graduated. The indicator shall be vented back to the case. Sight glasses shall be of rugged construction and protected against breakage.
14. Oil drains shall be located at the lowest point possible. The drain shall have a hand operated lever which can be locked in the closed position.
15. Oil sampling cocks shall be located in accessible positions on the reducers. There shall be two sampling cocks, one located at the lowest level of oil and one just below the upper oil level.
16. Speed reducers shall have provisions for oil expansion due to churning and temperature change.
17. Grease lubricated reducer bearings shall be furnished with separate fill and purge fittings, readily accessible after installation of reducer. Grease lubricated reducer bearings shall be furnished with internal seals between the bearing housing and reducer cavity, preventing grease and gear oil from interacting.
18. On shaft extensions, bearing shaft ring seals shall be mechanical type oil seals which compensate for wear. Dual lip spring loaded seals are preferred.
19. Shaft extensions for the various reducers shall be of the arrangement, lengths, and diameters shown on the Plans. Couplings shall be shrink fitted on the shafts in the shop.
20. On open-ended lower bearings of vertical shafts, extra precaution must be taken to prevent oil leakage. A dry-well arrangement in which the bearing is isolated from the oil bath is preferred. Grease lubrication of the lower bearing is required in these applications.
21. Pinions shall be proportioned so that the root diameter of the pinion is not smaller in diameter than the diameter of the journals for the pinion shaft.
22. Base plates for the reducers shall be large enough to give unobstructed access for drilling and reaming the mounting holes from above the unit.
23. Speed reducers driving bridge machinery and electrical controls shall be as shown on Plans or approved equal.
24. The manufacturer shall submit for approval by the Engineer a certified print of each speed reducer showing as a minimum the following:

    a. All external mounting dimensions including shaft sizes, bores, and keyways where required.
    b. Internal Plans showing each reducer component with part numbers.
    c. The ratings that will appear on the nameplate.
    d. Location of all lubricant connections and details of any external lubrication piping.

e. Lubrication recommendations.

25. The manufacturer shall submit for approval by the Engineer computerized calculations showing conformity to the requirements of the AGMA Standard Practice specified. The approved reducer prints and design calculations must be made available to NCDOT prior to construction of the unit.

J. HUBS AND BORES

1. The hubs of all gears, wheels, and couplings shall be finished on both faces and polished where the hub face performs the function of a collar to prevent shaft movement. The hubs shall be bored concentric with the rims of gears and wheels or with the outside of couplings. All hubs shall have an ANSI Class FN2 medium shrink fit on the shafts, unless otherwise specified.

K. SHIMS

1. Where shown on the Plans, all machinery shims required for leveling and alignment of equipment shall be stainless steel, neatly trimmed to the dimensions of the assembled parts and drilled for all bolts that pass through the shims.
2. Shims shall be Stainless Steel ASTM A240 Type 304 and furnished without bolt holes. Holes in shims shall be drilled and reamed to the same tolerance as the connected parts at final assembly. Shims greater than ½ inch shall include one solid plate of thickness equal to ½ inch less than total shim thickness.
3. Shims shall be shown and fully dimensioned as details on the shop drawings. Shims with open side or U-shaped holes for bolts will not be permitted. No shims shall have less than two holes for bolts. Bolt holes shall not be punched at machine shop to prevent distortion of the shims.
4. In general, sufficient thickness shall be furnished to secure 1/64 inch variations of the shim allowance plus one shim equal to the full allowance. The 1/2 inch nominal shim pack consists of the following thickness variations: one 1/4 inch, one 1/8 inch, one 1/16 inch, one 1/32 inch, and two 1/16 inch.

L. WELDING

1. Welding required for machinery shall be done in accordance with the Bridge Welding Code. ANSI/AASHTO/AWS D1.5 and all interim revisions published by AASHTO as of the bid opening date. Stress relieving will be required only when specified. All welds used to fabricate machinery shall be completely tested by ultrasonic inspection (ASTM E164-74) per AWS D1.5 for compression welds unless otherwise noted. All machining shall be performed after welding and stress relieving.
2. Welding joint sizes and details shall be shown on working drawings. Where multi-pass welds are required, welding procedures shall be submitted with shop drawings.
3. Distortion during fabrication shall be kept to a minimum by the use of welding fixtures and proper welding procedures.

M. MACHINERY GUARDS

1. Machinery guards shall be provided for all moving parts readily accessible to personnel and where otherwise required by OSHA or ANSI B15.1, Safety Standard

for Mechanical Power Transmission Apparatus, including but not restricted to the following:

a. Couplings
b. Open gears
c. Unused shaft extensions
d. Shafts at platform and roadway level
e. Brakes
f. Instrument drives and limit switches

2. Machinery guards shall not be required for the rack segments and pinions. Machinery guards shall be constructed to comply with the applicable requirements of ANSI B15.1, Safety Standard for Mechanical Power Transmission Apparatus.
3. Unless otherwise indicated or specified, all machinery guards shall be constructed of stainless steel having minimum thickness of No. 12 Gauge and shall have provision for removal without requiring disassembly of any machinery component.
4. Machinery guards shall be provided with removable hinged or bolted covers for access to lubrication fittings enclosed by the guard. Phenolic nameplates shall be provided on these covers with lubrication instructions.
5. Machinery guards shall be painted Safety Orange.

N. FLEXIBLE COUPLINGS

1. Couplings shall be of the type as shown on the Plans and shall include grid type, gear type, and others as needed.
2. Couplings shall, in general, be finish-bored and have keyways cut by the Coupling Manufacturer to dimensions and tolerances established on the shop drawings and then shipped to the manufacturers of the various components for shop installation on the shafts.
3. Grid-type, self-aligning, fully flexible, torsionally flexible couplings shall be used to connect electric motors to machinery components. The grid-type couplings shall have steel hubs, alloy steel grids, and steel or aluminum covers. Bolts in the covers shall be shrouded.
4. Gear-type, self-aligning, full-flexible couplings or semi-flexible couplings with floating shafts shall be used to connect all machinery components, except where other types of couplings are called for on the Plans. All couplings shall have shrouded bolts. The gear-type couplings shall be made of forged steel, have curved face teeth, and shall provide for at least a plus and minus ¾ degree misalignment per gear mesh.
5. Special couplings shall be as shown on the Plans.
6. Couplings shall be standard products of an established Manufacturer.

O. LUBRICATION

1. Lubrication Fittings: All bearings and surfaces requiring lubrication, other than gear teeth, shall be fitted for a pressure system of lubrication using NPS ¼ inch giant button head fittings, unless otherwise indicated on the Plans. The fittings for greasing bushed bearings shall be tapped into the housing or connected thereto by stainless steel seamless pipe, which shall be tapped into the housings so that grease will be discharged directly through the housing, shims, bushing, and into the grease

grooves for distribution. All grease fittings shall be conveniently located for greasing, and if necessary, shall be connected to the points requiring lubrication from convenient lubrication stations by NPS ¼ inch stainless steel seamless pipe – schedule 80 with stainless steel threaded pipe fittings – 3000 psi. All stainless steel pipe and fittings shall meet ASTM A312 and ASTM A182, respectively. All pipe extensions shall be kept as short as practical, shall be securely supported at fittings and intermediate points and located so that it shall be protected from injury. All lubricating equipment shall be installed in perfect condition.

2. Not more than two sizes of fittings shall be used. The large size shall be used wherever possible, and the smaller size shall be used for motor bearings and other small devices. Pressure fittings shall be rated at a minimum of 10,000 psi. Fittings shall contain a steel check valve that will receive grease and close against back pressure.
3. Immediately after the completion of fabrication, all fitting locations shall be plugged until components are installed and regular lubrication is started. The plugs shall then be replaced with the proper grease fittings. During installation, the Contractor shall lubricate all rotating and sliding parts of the machinery and fill all gear reducers, bearing housings and flexible couplings with lubricants indicated on approved lubrication charts.
4. Lubrication Charts: The Contractor shall furnish three (3) copies on mylar of lubrication charts showing the location of all lubricating fittings and other points of the mechanical and electrical equipment which require lubrication of any kind, and shall show the kind of lubricant to be used at each point and the frequency of lubrication. The charts shall be framed under glass in neat wooden frames and shall be placed as directed by the Engineer.
5. Maintenance and lubrication literature for each machinery component shall be kept in the Control House in a heavy bound binder.

P. TOOLS AND EQUIPMENT

1. The following tools and lubrication equipment shall be provided:

   a. One 4 ft x 2.5 ft x 8 ft heavy duty steel tool storage cabinet with four shelves, hinged doors and a heavy duty padlock. All steel shall be a minimum of ¼ inch thick.
   b. One set of box and open-end combination wrenches made of high-grade, drop-forged steel, with chrome plated over nickel finish, to fit bolt heads, nuts, and cap screws from ¼ inch to 1 ¼ inch, inclusive. GGG-W-636E, Type III.
   c. One set of single-end, angle wrenches of high-grade, drop-forged steel to fit all bolt heads and nuts larger than 1 ¼ inch size actually used on the job. GGG-W-636E, Type V.
   d. One set of socket wrenches to supplement the wrenches in Items 2 and 3, and for dismantling flexible couplings. GGG-W-641E.
   e. One 12-inch adjustable wrench. GGG-W-631b, Type 1, Class 1.
   f. One set of alloy-steel wrenches for all socket-head screws. GGG-W-652, Type 1, Class A.
   g. One 8-inch and 10-inch screw driver with solid, hardened steel; square shanks; and insulated composition handles. GGG-S-121E, Type 1, Class 4.

h. One 2-pound ball peen hammer. GGG-H-86C, Type II, Class 1, Style A.
i. Two hand lubrication guns, screw type, 12-ounce capacity, for each size lube fitting used.
j. One loader pump for 25-pound capacity pail for each type gun furnished.
k. One grease transfer pump complete with hose and fittings for 120-pound drum.
l. One 1-Ton hoist with a minimum standard lift of 15 feet equal to Coffing Mfr's. Model LHH-1B15 as manufactured by Duff-Norton, Charlotte, NC.
m. One of any other special size wrench and special tools or special lubrication equipment necessary to service machinery components actually installed in the bridge, which are not otherwise specified.

Q. SPARE PARTS

1. The Contractor shall provide a complete list of each and every shaft and coupling seal used at the job, including current part number and manufacturing of each seal furnished plus sufficient generic description and dimensions to order seals in the future when current models/manufacturers may no longer be identifiable.
2. In addition to the spare parts described under other items the following spare parts shall be provided:

   a. One grid of each grid-type coupling.
   b. One complete set of gaskets for every flexible coupling.

3. Five lubrication fittings of each different type and size used.

3.0 CONSTRUCTION METHODS

A. SHOP FABRICATION

1. The Contractor shall give no less than ten (10) working days notice to the Engineer of the beginning of work at foundries, forge, and machine shops so that inspection may be provided. No materials shall be cast, forged, or machined before the Engineer has been notified where the orders have been placed.
2. The Contractor shall furnish all facilities for the inspection of material and workmanship in the foundries, forge, and machine shops and the Inspector designated by the Engineer shall be allowed free access to necessary parts of the premises. Work done while the Inspector has been refused access or presented in a manner that prevents adequate inspection will automatically be rejected.
3. The Inspector shall have the authority to reject materials or workmanship, which do not fulfill the requirements of these Specifications.
4. Inspection at the foundries, forge, and machine shops is intended as a means of facilitating the work and avoiding errors. It is expressly understood that inspection will not relieve the Contractor from any responsibility in regard to imperfect material or workmanship and the necessity for replacing defective materials or workmanship, which are delivered to the job site.
5. The Contractor shall furnish the Engineer with a copy of all orders covering work performed by subcontractors or suppliers.
6. Unless otherwise provided, the Contractor shall furnish without additional charge test specimens as required, and all labor, testing machines, tools, and equipment necessary to prepare the specimens and to make the physical tests and chemical

analyses required by material specifications. A copy of all test reports and chemical analyses shall be furnished to the Engineer.

7. The acceptance of any material or finished parts by the Engineer shall not be a bar to their subsequent rejection if found defective. Rejected material and workmanship shall be replaced or made acceptable by the Contractor at no additional cost.

B. SHOP INSPECTION AND TESTING

1. Machinery components shall be shop assembled to verify their correct fit prior to shipment. Measurements required for each assembly are shown on the Plans and/or described in the individual pay items.
2. The speed reducer manufacturer shall shop test the reducers. The Contractor shall submit a testing procedure that will show how the test is to be performed, layout of the apparatus to be used, equipment to be used as well as forms that will be filled out to record the test. This procedure is to be reviewed and approved by the Engineer prior to testing being performed.
3. With the exception of instrument drive reducers, testing shall be performed on all reducers.
4. Before the start of the test, the following measurements shall be taken and documented. All documentation shall be submitted with the certificate of compliance:

    a. Temperature of ambient air.
    b. Temperature of oil near bottom of crankcase shall preferably not rise more than 40°F from ambient during the test. Oil temperature exceeding 150°F shall not be acceptable.
    c. Surface temperature of each shaft extension adjacent to shaft seal shall preferably not rise more than 50°F from ambient during the test. Temperature above the rating of the seals or bearings is unacceptable.
    d. Sound level at point above and 3 feet distant from the edge of housing of unit shall not exceed 90dbA.

5. All reducer testing shall orient in the same mounting position as installed on the bridge.
6. Each reducer shall be first tested by running at no load and at 100% rated motor RPM for at least 2 hours in each direction (4 hours total continuous operation). Readings of measurement 1 through 4 above shall be taken at 30 minute intervals for the full duration of the test.
7. Each reducer shall then be tested by running at 150% rated full load motor torque and at 100% rated motor RPM for ½ hour in each direction (1 hour total continuous operation). Readings of measurement 1 through 4 shall be taken at 15 minute intervals for the full duration of the test.
8. The tests shall be performed with the reducer filled to the dip-stick mark, with new oil of the type the manufacturer recommends on the lubrication chart for normal operation.
9. The reducer shall be checked for the following during both the load and no load testing:

a. Any excessive or unusual noise
b. Excessive bearing clearance
c. Excessive vibration
d. Excessive temperature rise

10. The proper lubrication of the oil system shall be demonstrated during the shop test.
11. Gear teeth shall be checked for proper distribution of load. This can be measured with the help of tooth contract tape applied to each gear. These tapes will be preserved in the records to be submitted with the Certificate of Compliance.
12. Bluing dye can be used as an alternate so long as all teeth are coated and digital photographs taken before and after the tests are included with the report.
13. No testing shall be performed on the reducer without a representative of the Owner being present. Any testing not witnessed by the Engineer or the Owner's representative shall not be acceptable.
14. If any condition in 9a through 9d is observed, the Manufacturer shall be put on notice by the Engineer of the observation. The Manufacturer shall then determine the cause and corrective action necessary to correct the condition and submit a report to the Engineer for review and acceptance. A retest of the reducer will be required to show that the repair has corrected the condition and the Engineer or Owner's representative will determine if the reducer is acceptable.
15. The NCDOT reserves the right to reject the reducer at any time for any nonconformance that is determined to be detrimental to the proper function and operation of the reducer. Repairs to be performed on the reducer shall be reviewed and accepted by the Engineer prior to the work being performed.
16. The Contractor is responsible for furnishing all materials required for the test including, but not limited to motor, test stand, and oil.
17. Additional testing of speed reducers may be specified under individual pay item sections.

C. DEFECTIVE MATERIAL AND WORKMANSHIP

1. All machinery rejected during inspection and testing that is not made acceptable shall be removed from the work site and replaced without additional cost.
2. Delays resulting from the rejection of material, equipment or work shall not be the basis of any claim.
3. All defects found during the guarantee period resulting from faulty material, components, workmanship, or installation shall be corrected by the Contractor without cost. In the event that the Contractor does not make the corrections in a timely manner, NCDOT reserves the right to make necessary corrections with its own forces and charge the resulting costs to the Contractor.

D. DELIVERY AND STORAGE

1. Protection for Shipment:
   a. Machinery parts shall be cleaned of dirt, chips, grit, and all other injurious materials prior to shipping and shall be given a coat of corrosion-inhibiting preservative.
   b. Finished metal surfaces and unpainted metal surfaces that would be damaged by corrosion shall be coated as soon as practicable after finishing with a rust-

inhibiting preservative. Excepting unfinished metal surfaces inside of gear reducers, this coating shall be removed prior to operation and from all surfaces prior to painting after erection.

c. Any interface between stainless steel or aluminum and Structural Steel shall receive an Engineer approval coat of zinc-chromate primer prior to assembly.
d. Machinery parts shall be completely protected from weather, dirt, and all other injurious conditions during manufacture, shipment, and storage.
e. Shaft journals that are shipped disassembled from their bearings shall be protected during shipment and before erection by a packing of oil-soaked rags secured in place by burlap and covered with heavy metal thimbles or heavy timber lagging securely attached. Every precaution shall be taken to ensure that the bearing surfaces are not damaged and that all parts arrive at their destination in satisfactory condition.
f. Pillow blocks with anti-friction bearings that are shop mounted on shafts shall be supported independently of the shaft support to prevent false brinelling during shipment.
g. Assembled units shall be mounted on skids or otherwise crated for protection during handling and shipment.

2. Packaging and Delivery of Spare Parts:
   a. Spare parts shall be protected for shipment and prolonged storage by coating, wrapping, and boxing.
   b. All spare parts shall be durably tagged or marked with a clear identification showing the designation used on the approved shop drawing.
   c. Boxes for spare parts shall be clearly marked on the outside to show their contents. Spare parts shall be delivered to a location designated by Bridge Maintenance.
3. Guarantee and Warranties:
   a. Manufacturer's warranties or guarantees on equipment, materials or products purchased for use on the Contract which are consistent with those provided as customary trade practice, shall be obtained by the Contractor and, upon acceptance of the Contract, the Contractor shall assign to NCDOT, all manufacturer's warranties or guarantees on all such equipment, material or products furnished for or installed as part of the Work.
   b. The Contractor shall warrant the satisfactory in-service operation of the mechanical equipment, material, products, and related components. This warranty shall extend for a period of one year following the date of final acceptance of the Project.

E. ERECTION

1. General:
   a. For each stage of construction, the Contractor shall submit calculations, drawings and procedures detailing his intended scheme for installing all machinery. Machinery installation shall be done in a coordinated manner to ensure all the machinery components fit the adjacent material furnished under other items.
2. Alignment and Bolting:

a. The order of assembly and alignment of bridge machinery shall start at the final driven components and worked back to the prime mover. The Contractor shall limit the finality of some staged machinery installations so that proper alignment of mating components is met prior to final reaming and fastening.
b. All open gearing shall be aligned such that backlash is within tolerance and at least the center 50% of the effective face width of each pair of meshing teeth is in contact. The cross mesh shall not exceed 0.01 inch per 6 inches of face width. All open gear measurements shall be submitted to the Engineer for review and approval. The measurements shall include backlash, cross-mesh alignment, tooth valley gap and face contact. The type of bluing or lubricant used for face contact measurements shall be submitted to the Engineer for approval prior to any measurements. The measurements shall be performed at a minimum of 8 equally spaced span positions ranging from fully open to fully closed.
c. All parts of the machinery shall be match marked for proper assembly and correct orientation. Before final drilling or reaming, all parts shall be adjusted to exact alignment by means of shims. If required, tapered shims shall be provided at no additional cost. Installation, alignment and shimming of the electric motors, and devices such as limit switches and encoders, shall be included with the machinery for such erection. After final alignment and bolting, all parts shall operate smoothly.
d. The span shall not be operated by the bridge machinery until all components are installed, in final alignment and bolted as approved by the Engineer.
e. Bolt holes in structural steel for connecting machinery shall, in general, be drilled from the solid after final alignment of the machinery. Sufficient erection holes, subdrilled ¼ inch undersize for undersized temporary bolts, may be used for erection and alignment of the machinery. When the machinery is aligned in its final position, the temporary bolts shall be removed one bolt at a time, full-size holes for the remaining bolts shall be drilled or subdrilled and reamed, and the full size bolts installed.
f. Bolt holes in structural steel, shims and machinery components shall be drilled and reamed assembled to assure accurate alignment of the hole and accurate clearance over the entire length of the bolt within the specified limit. Hand held reamers are not considered accurate enough and the Contractor shall assume that a reaming jig shall be used to keep the bolt hole cylindrical. This jig shall be of structural steel, fixed to the drill and secured to the work preventing the reamer shaft from deviating. Holes shall be checked with a bolt hole micrometer to assure uniform diameter.
g. ASTM A449 bolts shall be torqued to the same tension required for ASTM A 325 bolts specified in the Standard Specifications.
h. Torques for other classes of bolts shall be proportioned to their strength and shall be indicated on the erection drawings.

3. Coatings:
   a. Threads for turned bolts shall be coated with anti-seize compound before assembly with nuts to prevent corrosion or galling and to facilitate future removal if necessary.

4. Edges and corners:
   a. All edges and corners of machinery parts, sheet metal work, bed plates, and fabricated supports that are exposed in the finished work shall be rounded or chamfered. All burrs or other surface defects that could be injurious to workers erecting or maintaining the bridge machinery shall be removed.
5. Personnel and Facilities:
   a. The machinery shall be erected and adjusted by competent millwrights skilled in the type of work involved. They shall be provided with all necessary measuring and leveling instruments as may be required.

F. PAINTING

1. General:
   a. Cleaning and painting of all unfinished surfaces of machinery shall comply with requirements of the NCDOT Standards Provisions, Section 442 – Painting Steel Structures. The Contractor shall submit for review with the working Plans an outline of painting materials and methods.
2. Shop Painting:
   a. All unfinished machinery external surfaces shall be cleaned with final surface preparation, prior to painting, done by blast cleaning to meet the requirements of SSPC-SP6 "Commercial Blast Cleaning" with the following exceptions:
      i. Flexible couplings
      ii. Reducers
      iii. Sleeve bearings with bushings in place
      iv. Electric motors
      v. Brakes
      vi. Limit switches
      vii. Other equipment with shaft seals
      viii. The equipment excepted by the Engineer
   b. The excepted machinery or equipment shall be cleaned with solvent and hand tools to meet the requirements of SSPC-SP2, Hand Tool Cleaning as depicted in SSPC VIS 1.
   c. After proper surface preparation, all unfinished machinery surfaces except for the interior of gear housings, flexible couplings and pillow blocks shall be given one shop coat of primer by hand brushing. The modified aluminum epoxy mastic primer, Carbomastic 15 or approved equal, shall be compatible with the paints selected for subsequent coats. Interiors of gear housings shall be protected with special oil-resistant crankcase paint or approved equal.
3. Field Painting:
   a. After erection is complete, all machinery surfaces remaining exposed, except machine finished surfaces in sliding contact, shall be thoroughly cleaned with an approved high-flash solvent and given an intermediate field coat. The epoxy polyamide intermediate, Carboguard 888 or approved equal, shall be compatible with the finish coat. The intermediate coat shall be applied by hand brushing, and shall be resistant to weathering (marine environment) and abrasion and free of lead.

b. After field testing is complete but prior to final acceptance of machinery, all machinery surfaces remaining exposed, except machine finished surfaces in sliding contact, shall be re-cleaned with an approved high-flash solvent and given a finish field coat. The aliphatic acrylic-polyester polyurethane, Carbothane 133 LH or approved equal, shall be compatible with the previous coats. The finish coat shall be applied by hand brushing, which shall color code the machinery to distinguish between fixed and moving parts. The following colors shall be used:

c. Federal Safety Orange: Except for machine finished surfaces in sliding contact, for all moving parts of the machinery such as shafting, couplings, and the side of gears and brake wheels.

d. Federal Safety Green: For all stationary parts of the machinery. Machinery component fasteners mating with machinery supports shall be painted the same color as the structural steel.

e. Paint for the finish coat shall be high-gloss, resistant to weathering and abrasion and conform to OSHA color requirements of the Safety Color Code for Marking Physical Hazards, ANSI Z53.1. The brand and colors shall be submitted to the Engineer for approval. The color for each component shall be indicated on the assembly shop drawings or separate paint drawings.

f. The Contractor shall place cautionary signs in the Turning Machinery area and Control House, which shall explain the color code. Details of the signs giving text, dimensions and materials shall be placed on a shop drawing.

g. The Contractor shall take special care to avoid painting of machinery surfaces, which are in normal rubbing contact. All nameplates, legend plates, and escutcheons mounted on machinery shall be masked for protection from paint. Lubrication fittings shall be kept clog-free.

G. CONTRACTOR'S INSPECTION

1. After erection is completed, the Contractor shall make a thorough inspection to insure that all gears are clean and free of obstruction, that all parts are properly aligned and adjusted as closely as practicable without actual operation, that all bolts are properly tightened and that the span is properly balanced.
2. Inspection of tightened fasteners shall be in accordance with the NCDOT Standard Specifications for Roads and Structures. The Contractor's inspection shall verify that field painting has been performed as specified herein. Touch-up painting shall be performed to correct all painting defects found during this inspection.
3. The Contractor's inspection shall verify that all enclosed gear housings are filled to the proper level, and all rotating and sliding parts are supplied with lubricants as recommended by the Manufacturers of the units. Typical products for the various locations are as follows:

   a. Sleeve Bearings and Pillow Blocks:
   NLGI #2 Grease

   b. Open Gears:
   Open Gear Lubricant (Mobiltac 375 NC)

Specific Gravity, 72°F (22°C)	0.96
SUS @ 100°F	25,000

(cSt @ 40° C	5,000)
SUS @ 210°F	5,000
(cSt @ 100°C	1,100)

c. Enclosed Gear Reducers:
Refer to AGMA Standard 9005.D94
"Lubrication of Industrial Enclosed Gear Drives"

d. Gear Couplings:
NLGI #0 Grease

e. Grid Couplings:
NLGI #2 Grease

4. The Contractor shall be accompanied by the Engineer during his final inspection before field testing. On the basis of the results of this inspection, the Engineer shall determine whether the bridge is ready for field testing.

H. FIELD TESTING

1. When the machinery and electrical equipment is ready for field testing, the Contractor shall meet with the Engineer to arrange a test schedule and shall keep available a complete crew of mechanics for a minimum of four working days in order to provide operation of the swing span for all tests and to make all adjustments and corrections which shall be required to complete the tests.
2. The Contractor shall prepare a field testing procedure, which shall be approved by the Engineer. The testing procedure shall be coordinated with the tests required for the electrical equipment and shall include measurements of power and current draw by the motors when operating under load as required hereinafter.
3. The testing procedure shall include but not be limited to the verification of proper installation, alignment, fastening and operation and/or final adjustment of the following:

a. Stabilizing Machinery
b. Turning Machinery
c. End Wedge Machinery
d. Center Wedge Machinery
e. Centering Device Machinery
f. Auxiliary Operating System

4. When the machinery is ready for field testing, the bridge machinery shall be driven by the main electrical system through at least ten complete cycles.
5. Three phase kilowatts, single phase amperes, span position and motor RPM for the span and wedge motors shall be recorded on a computerized data acquisition system. The recordings shall be for a complete span opening and closing cycle, with at least three cycles of data for each motor. The data acquisition system shall have 16 bit resolution and shall sample at a rate of 10 Hz. minimum. Data shall be imported into Microsoft Excel format, and graphs shall be printed out on 11 x 17 paper. Time of day shall be on the X axis, and primary and secondary Y axis shall be chosen to best present the data. In addition, a CD shall be provided with all the raw data and all the Excel files.

6. During the test runs, each machinery assembly shall be inspected in its entirety to determine whether everything is in proper working order and fully meets the requirements of these Specifications, Plans and manufacturer's recommended tolerances. All test runs shall be performed in the presence of the Engineer. The temperature rise of all machinery components shall not exceed design ratings. If any tests show that any components are defective or inadequate, or function improperly, the Contractor shall make all corrections, adjustments, or replacements required before the final acceptance at no additional cost.

I. TRAINING

1. Training shall be provided by the Contractor as per Item (SPECIAL) Operations & Maintenance Manuals, Training and As Built Documents.

4.0 MEASUREMENT AND PAYMENT

No measurement or payment will be made for *General Machinery*. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be included in the bid price for the various bridge machinery pay items.

STABILIZING MACHINERY (SPECIAL)

1.0 DESCRIPTION

The work included under this item shall consist of rehabilitating, fabricating, erecting, testing, adjusting, and painting the Stabilizing Machinery. The components include but are not limited to:

A. CENTER PIVOT BEARING ASSEMBLY (1)

B. BALANCE WHEEL ASSEMBLIES (8)

C. TRACK RAIL (1)

Details and arrangements of all systems are shown on the Plans.

The work shall be in accordance with the requirements specified in "General Machinery".

The Contractor shall coordinate the rehabilitation of the Stabilizing Machinery with all other bridge machinery items, electrical work and structural work, as well as navigational and vehicular traffic closures and restrictions.

2.0 MATERIALS

A. GENERAL

The materials used to fabricate the machinery components shall be as shown on the Plans and in accordance with the requirements specified in "General Machinery".

B. CENTER PIVOT BEARING

The Contractor shall survey the rack, balance wheel track rail and center pivot in order to determine their center relationship with each other. Survey results shall be submitted to the Engineer for review.

The swing span shall be adjusted in elevation at the center pivot by jacking and shimming. The object of jacking and shimming at the pivot bearing is to account for the proper deflection of the cantilevered swing span. The swing span shall be shimmed such that the free ends of the cantilevered girders produce a 12.0 kip end load reaction at each end wedge location with the end wedges driven.

In order to determine the center pivot shim thickness the following procedure is suggested:

1. With the swing span in the closed position, withdraw the end wedges and center wedges.
2. Place shims or wedges between the balance wheels and track rails so that all balance wheels are in hard contact with the balance rail.
3. Place one calibrated jack and one dial indicator at each corner of the end floor beams of the swing span.
4. Using the dial indicator for travel measurement, deflect the end of the swing span one inch using the jacks.
5. Convert pressure to force and with the distance travel of one inch, the spring constant at each of the four jack locations is determined.
6. Determine the average of the four spring constants and consider this the span spring constant.
7. Using the span spring constant determine the distance required to apply the end load reaction of 12.0 kips/wedge. This is the end load distance.
8. Measure the vertical distance between the deflected swing span roadway surface and the approach roadway surface at each corner of the swing span.
9. Determine the average vertical distance at these locations.
10. Subtract the end load distance found in line 7 from the average vertical distance found in line 9. The result is the required shim thickness adjustment at the center pivot.

The Contractor shall submit a proposed jacking procedure prepared by a professional engineer to the department for approval. It shall detail all equipment and steps of operation. The professional engineer shall oversee the complete jacking and shimming operation.

When the shimming of the center pivot bearing is complete all jacking materials are to be removed including any temporary concrete jacking pads, fill, spacers and bearing plates. Open holes in the steel structure are to be filled in with ASTM A325 bolts with washers under head and nut.

See the Plans for further information and requirements.

3.0 CONSTRUCTION METHODS

A. SHOP INSPECTION AND TESTING

1. Suggested Rehabilitation of Center Pivot Assembly
   a. The Contractor shall plan to temporarily remove the center pivot's oil box from the assembly to expose the upper and lower bearing discs. This effort may be coordinated with the Contractor's efforts to jack the swing span for introduction or removal of the corrective shim between the center pivot top and pivot girder. The upper and lower bearing discs shall be inspected to confirm they remain in like-new condition.
   b. The existing center pivot assembly shall be cleaned prior to reinstalling the oil box. The oil box shall be installed with a new gasket and all new hardware. As part of the assembly effort, all non-gasketed joints shall be sealed with a permatex non-hardening compound as recommended by the Contractor and approved by the Engineer. The exterior of the center pivot assembly shall then be painted. As soon as practical, the bearing cavity shall be filled with the proper quantity and type of lubricant. See the Plans for details.
   c. During and after center pivot assembly rehabilitation, all precautions shall be made to protect its components.
2. Track Rail
   a. As part of the center pivot assembly rehabilitation, the Contractor shall measure, survey and locate the positions of the new track rail. The Contractor shall submit the results to the Engineer for review. Upon approval, the Contractor shall remove and replace the existing track rail and rail anchorage hardware. Prior to installing the new track rail, the Contractor shall confirm that existing embedded support plates remain in satisfactory condition as noted in the Plans. The new track rail shall be positioned with a centerline concentricity tolerance of 1/16 inch with respect to the swing span center of rotation.
3. Positioning of Span on Center Pivot Assembly
   a. Positioning of the swing span onto the center pivot assembly shall take place after the bearing cavity is filled with the proper lubrication.
   b. With the swing span positioned above the center pivot assembly on temporary supports or jacks, the swing span shall be adjusted to its final vertical position by shimming between the pivot girder and the center pivot.
   c. Permanent fasteners connecting the pivot top plate to the pivot girder shall be as indicated on the Plans. Fastener holes shall be drilled and reamed through the assembled pivot girder, shims, fill plate and pivot to provide an LC6 fit between the body of the fastener and the hole.
   d. At this stage, the center pivot assembly shall be used to support dead load only. All unbalanced loads due to wind, equipment, personnel, etc. shall be supported at jacking points located on either end of the swing span and in each corner. The Contractor shall submit his proposed means for temporarily supporting the unbalanced loads for approval by the Engineer. These temporary supports shall remain intact until the balance wheels are shimmed to achieve a 0.050 inch clearance with the track.
4. Balance Wheels

a. The balance wheel assemblies shall be rehabilitated as detailed on the Plans.
b. With the swing span permanently fastened to the center pivot assembly, and the span unbalanced loads temporarily supported at jacking points located on either end of the swing span and in each corner, the center wedges pulled and end wedges pulled, the clearance between all balance wheels and track shall be 0.050 inch.
c. Upon approval of alignment, by the Engineer, the balance wheel shims shall be drilled and reamed assembled as shown on the Plans.

5. Span balance
   a. In order to compensate for any span imbalance the Contractor shall balance the bridge so that any imbalance moment about the center pivot shall be less than the frictional moment about the center pivot. The Contractor shall demonstrate that the span is balanced to the Engineer. On a day where the wind is less than 5 miles per hour, no balance wheels are to be in contact with the track rail. If any balance wheel is in hard contact with the track rail a jack shall be placed at a location close to and outboard of the balance wheel in hard contact. The jack location shall be agreed to by the Engineer. The span shall then be jacked so that the balance wheel in hard contact is no longer in hard contact. The jack shall then be lowered. If that balance wheel does not return to its hard contact position the swing span is considered balanced. If that wheel does come back into hard contact, the swing span must be balanced by adding weight to an agreed to location by the Engineer in order to counterbalance the imbalance moment. The balance test must then be repeated until the span balance requirement is met and to the satisfaction of the Engineer.

B. FIELD TESTING

When the machinery is final installed, permanently fastened and ready for field testing, the Contractor shall submit to the Engineer a testing procedure and schedule in accordance with the requirements specified in the "General Machinery". Upon final location, the Contractor shall submit the final location of each of the work items herein.

4.0 MEASUREMENT AND PAYMENT

Stabilizing Machinery will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Stabilizing Machinery* item.

Payment will be made under:

Pay Item	**Pay Unit**
Stabilizing Machinery	Lump Sum

TURNING MACHINERY **(SPECIAL)**

1.0 DESCRIPTION

The work included under this item shall consist of removing the existing Turning Machinery and replacing/rehabilitating the machinery as shown on the Plans. This includes but is not limited to furnishing, fabricating, erecting, testing, adjusting and painting the Turning Machinery. The components include but are not limited to:

A. RACK SECTIONS (12)

B. PINION SHAFT ASSEMBLIES (2)

C. RIGHT ANGLE BEVEL GEAR SET-BEVEL GEAR ON TOP (1)

D. RIGHT ANGLE BEVEL GEAR SET-BEVEL GEAR ON BOTTOM (1)

E. FLOATING DRIVE SHAFTS (2)

F. SUPPORTED DRIVE SHAFTS (1)

G. DIFFERENTIAL REDUCER – R1 (1)

H. MOTOR BRAKE (1)

I. MACHINERY BRAKE (2)

Details and arrangements of all systems are shown on the Plans.

The work shall also include installing and aligning the drive motors and brakes, as well as control instrumentation that is to be supplied under the Bridge Electrical Work item. The work shall be in accordance with the requirements specified in "General Machinery".

The Contractor shall coordinate the installation of the Turning Machinery with all other bridge machinery items, electrical work and structural work, as well as navigational and vehicular traffic closures and restrictions.

2.0 MATERIALS

A. GENERAL

The materials used to fabricate the machinery components shall be as shown on the Plans and in accordance with the requirements specified in "General Machinery".

B. ENCLOSED GEAR REDUCERS

1. The speed reducer for the Turning Machinery shall be a special model, with ratings, ratios, dimensions, and construction details as shown on the Plans. Ratings shall be based on a service factor of 1.5 unless otherwise indicated on the Plans.
2. The Speed reducer for the Turning Machinery shall have mounting holes located such that final field drilling and reaming for permanent fasteners is feasible.
3. Manufacturers (or approved equal by the Engineer) for the speed reducers for the Turning Machinery include:
   a. Earle Gear by Steward Machine Co., Birmingham, AL.

b. Nuttall Gear, Niagara Falls, NY.
c. Prager, Inc., New Orleans, LA

C. LUBRICATION

1. Upon approval, the Contractor shall provide the following quantities of additional lubricants for the Turning Machinery, which shall be stored at the site:
   a. Gear Reducer Oil 55 gal
   b. Open Gear Grease 50 lbs.
   c. Bearing Grease 50 lbs.
   d. Grid Coupling Lubricant 25 lbs.
   e. Gear Coupling Lubricant 25 lbs.

D. SPARE PARTS

1. The Contractor shall provide the following spare parts for the Turning Machinery, which shall be stored at the site:
   a. One rack pinion with keys and keeper plate in accordance with the Plans.

3.0 CONSTRUCTION METHODS

A. SHOP FABRICATION, INSPECTION AND TESTING

1. All Turning Machinery components shall be assembled to assure proper fits and verify tolerances specified on the Plans. Assemblies requiring disassembly shall be match marked and documented so that the machinery can be reassembled at the construction area.
2. Each speed reducer will have a 'no load' test per the General Machinery special provision.
3. The speed reducer for the Turning Machinery shall be tested by running at 150% rated full load motor torque and at 100% rated RPM for ½ hour in each direction (1 hour total continuous operation). The Contractor shall supply testing equipment, which shall include test motors. The tests shall be performed in the presence of the Engineer.

B. TURNING MACHINERY INSTALLATION, INSPECTION AND TESTING

1. Turning Machinery components to be mounted on the pivot pier shall be transported from the shop to the on-site construction area. During the approved stage, the machinery components shall be assembled and installed on the center pier as detailed on the Plans.
2. With the track segments aligned and permanently fastened to the center pier in accordance with the requirements specified in "Stabilizing Machinery", the rack sections shall be installed, adjusted, final aligned and permanently fastened to the center pier. Replacement rack sections shall be installed such that their ends fully mate, they form a concentric circle around the existing center pivot, their tooth faces remain vertical, their top surfaces level and their elevations consistent. The fully assembled rack shall be installed with a concentricity tolerance of 1/32 inch with respect to the center pivots bottom disc. The fully assembled rack shall be set and secured at an elevation that complements the final elevation of the swing span and mating rack pinions.

3. Turning Machinery components to be mounted on the swing span shall be transported from the shop to the on-site construction area. During the approved stage, the machinery components shall be assembled and installed as detailed on the Plans.
4. With the swing span permanently fastened to the center pivot assembly, the balance wheels permanently fastened to the machinery supports and temporarily shimmed to secure the position of span, the center and end wedges pulled, the rack pinion bearings shall be final aligned to meet the rack and pinion alignment requirements stated in the "General Machinery" special provision. Upon approval of alignment, by the Engineer, the assemblies shall be sub-drilled assembled with the machinery supports and secured with temporary fasteners.
5. Turning Machinery components from the bevel gear sets up to but not including the reducer-R1 shall then be final aligned. Upon approval of alignment, by the Engineer, the components shall be sub-drilled assembled with the swing span and machinery supports and secured with temporary fasteners.
6. Turning Machinery components from reducer-R1 to the span motors shall then be final aligned. Upon approval of alignment, by the Engineer, the components shall be drilled and reamed assembled with the machinery supports and secured with permanent fasteners.
7. Using the Auxiliary Operating System, verify the alignment of the Turning Machinery open gearing. With all components properly lubricated and the motor and machinery brakes manually released, use the Auxiliary Operating System to test the Turning Machinery under no additional load. During the initial test run, confirm proper and consistent alignment between rack and rack pinions as well as bevel gear and bevel pinions throughout their travel range. It is suggested that six (6) equally spaced check points be used to confirm proper alignment. Once proper alignment is confirmed, use the Auxiliary Operating System to test general performance repeatability by operating the Turning Machinery through 5 full openings and closings of the swing span. During the test run, the Turning Machinery components shall be inspected in their entirety to determine whether everything is in proper working order and fully meets the requirements of the Plans. If the test shows that any Turning Machinery components are defective or inadequate, or function improperly, the Contractor shall make all corrections, adjustments or replacements required before repeating the test run. The Contractor shall not be permitted to operate the swing span using the main drive until the test run is successfully completed and all components are permanently fastened to their respective supports as stated herein.
8. With the alignment of the rack and rack pinions confirmed, permanent fasteners connecting each rack pinion bearing assembly to the machinery supports shall be installed as shown on the Plans. Fastener holes shall be drilled and reamed through the bearing assembly, shims and machinery support to provide an LC6 fit between the body of the fastener and the hole.
9. With the alignment of the bevel gear and bevel pinions confirmed, permanent fasteners connecting each bearing-B1 assembly to the machinery supports shall be installed as shown on the Plans. Fastener holes shall be drilled and reamed through the bearing mounting feet, shims and machinery support to provide an LC6 fit

between the body of the fastener and hole. Holes in the machinery supports beyond the first flange shall be 1/16 in larger than the fastener body diameter.

10. With the alignment of the collar bearings, reducer-R1, motor brake and span motor confirmed, permanent fasteners connecting each of these assemblies to the machinery supports shall be installed as shown on the Plans.

C. FIELD TESTING

1. When the machinery is final installed, permanently fastened and ready for field testing, the Contractor shall submit to the Engineer a testing procedure and schedule in accordance with the requirements specified in the "General Machinery".

4.0 MEASUREMENT AND PAYMENT

Turning Machinery will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Turning Machinery*.

Payment will be made under:

Pay Item	**Pay Unit**
Turning Machinery	Lump Sum

END WEDGE MACHINERY (SPECIAL)

1.0 DESCRIPTION

The work included in this item shall consist of removing the existing End Wedge Machinery and replacing/rehabilitating the machinery as shown on the Plans. This includes but is not limited to furnishing, fabricating, erecting, testing, adjusting and painting the new and rehabilitated End Wedge Machinery. The components include but are not limited to:

1. Turnbuckles (12)
2. Supported Drive Shafts (4)
3. Worm Gear Reducers (2)
4. End Wedge (4)
5. Wedge Guides (4)
6. Wedge Seats (4)
7. Bearing Bushings

Details and arrangements of all systems are shown on the Plans or specified herein.

The work shall include installing and aligning the end wedge machinery from the end worm gear reducer to the end wedges, as well as control instrumentation that is to be supplied under the Bridge Electrical Work item. The work shall be in accordance with the requirements specified in "General Machinery".

The Contractor shall coordinate the End Wedge Machinery installation with all other bridge machinery items, electrical work and structural work, as well as navigational and vehicular traffic closures and restrictions.

The Contractor is required maintain the end wedge in a condition which will allow the swing span to operate while the end wedge machinery is being rehabilitated. The Contractor shall prepare a plan to permit live load to be reacted by the end wedges as required by AASHTO during the end wedge rehabilitation period. It is suggested that the Contractor rotate the swing span to the closed position and extend the wedges so that the end of the swing span is raised to the proper elevation and approved by the engineer. Shoring should be installed per an approved plan prepared by the Contractor. Shoring should have screw jacks or hydraulic jacks so that the swing span can be preloaded before existing end wedges are retracted. Shoring should be such that it can be readily removed so that the swing span can open and close.

2.0 MATERIALS

A. GENERAL

1. The materials used to fabricate and rehabilitate the End Wedge Machinery components shall be as shown on the Plans and in accordance with the requirements specified in “General Machinery”.

B. JACK ASSEMBLIES

1. The Contractor shall supply four (4) jack assemblies. The jacks may be mechanical screw jacks or hydraulic jacks.

3.0 CONSTRUCTION METHODS

A. SHOP FABRICATION, INSPECTION AND TESTING

1. All End Wedge Machinery components including but not limited to worm gear reducers and turnbuckles shall be assembled to assure proper fits and verify tolerances specified on the Plans. Assemblies requiring disassembly shall be match-marked and documented so that the machinery can be reassembled at the construction area.

B. END WEDGE INSTALLATION, INSPECTION AND TESTING

1. Replace end wedge bearing bushings as shown on the Plans. Field measure mating component to insure accurate fit up.
2. Rehabilitate end wedges, guides and seats as shown the Plans.
3. Install new turnbuckles and adjust to proper length.
4. In their final position, all End Wedge Machinery components shall be aligned such that the swing span ends align with the approach roadway elevations when engaged. Upon approval of alignment, by the Engineer, the components shall be sub-drilled assembled with the machinery supports and secured with temporary fasteners.
5. Upon approval of the End Wedge Machinery installation, by the Engineer, the End Wedge Machinery shall be functionally tested. With all End Wedge Machinery components properly lubricated, the components shall be operated through a minimum of 5 cycles under a no load condition and inspected. Crank operation shall be performed manually by hand and motor operation shall be performed electrically by use of a Contractor supplied power source

6. Upon approval of alignment by the Engineer, the components shall be drilled and reamed assembled with the machinery supports and secured with permanent fasteners.

C. FIELD TESTING

1. When the machinery is final installed, permanently fastened and ready for field testing, the Contractor shall submit to the Engineer a testing procedure and schedule in accordance with the requirements specified in the "General Machinery".

4.0 MEASUREMENT AND PAYMENT

End Wedge Machinery will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *End Wedge Machinery*.

Payment will be made under:

Pay Item	**Pay Unit**
End Wedge Machinery	Lump Sum

CENTER WEDGE MACHINERY (SPECIAL)

1.0 DESCRIPTION

The work included under this item shall consist of removing the existing Center Wedge Machinery and replacing/rehabilitating the machinery as shown on the Plans. This includes but is not limited to furnishing, fabricating, erecting, testing, adjusting and painting the new and rehabilitated Center Wedge Machinery. The components include but are not limited to:

1. Center Wedges (2)
2. Crank Assemblies (2)
3. Turnbuckles (4)
4. Wedge Guides (2)
5. Wedge Seats (2)
6. Worm Gear Reducer (1)

Details and arrangements of all systems are shown on the Plans.

The work shall also include installing and aligning the drive motor as well as control instrumentation that is supplied under the Bridge Electrical Work item. The work shall be in accordance with the requirements specified in "General Machinery".

The Contractor is required to maintain the Center Wedges in a condition which will allow the Swing Span to operate while the Center Wedge machinery is being rehabilitated. The Contractor shall prepare a plan to permit live load to be carried by the Center Wedges as required by AASHTO during the Center Wedge rehabilitation period. It is suggested that the Contractor rotate the Swing Span to the closed position and extend the Center Wedges using the existing machinery. Install shoring adjacent to the Center Wedges per an approved plan prepared by the Contractor. Shoring should have either screw jacks or hydraulic jacks so that

it can be preloaded before existing Center Wedges are withdrawn. Shoring should be such that it can be readily removed so that the Swing Span can open and close.

The Contractor shall coordinate the installation of the Center Wedge Machinery will all other bridge machinery items, electrical work and structural work, as well as navigational and vehicular traffic closures and restrictions.

2.0 MATERIALS

The materials used to fabricate and rehabilitate the Center Wedge Machinery components shall be as shown on the Plans and in accordance with the requirements specified in "General Machinery".

3.0 CONSTRUCTION METHODS

A. SHOP FABRICATION, INSPECTION AND TESTING

1. All Center Wedge Machinery components including but not limited to the Worm Gear Reducer and Turnbuckles shall be assembled to assure proper fits and verify tolerances specified on the Plans. Assemblies requiring disassembly shall be match-marked and documented so that the machinery can be reassembled at the construction area.

B. SWING SPAN INSPECTION AND TESTING

1. During the approved stage, the machinery components shall be assembled and installed on the swing span as detailed on the Plans.
2. Replace Center Wedge Machinery bearing bushings as shown on the plans. Field measure mating component to insure accurate fit up. Rehabilitate Center Wedges, Guides and Seats as shown on the Plans. Install new Turnbuckles and adjust to proper length.
3. The Center Wedge Machinery components to be mounted on the swing span shall be final aligned. Upon approval of alignment, by the Engineer, the components shall be drilled and reamed assembled with the machinery supports and secured with permanent fasteners.
4. Upon approval of the Center Wedge Machinery installation, by the Engineer, the Center Wedge Machinery shall be functionally tested. With all Center Wedge Machinery components properly lubricated, the components shall be operated through a minimum of (5) cycles under a no load condition and inspected. Crank operation shall be performed manually by hand and motor operation shall be performed electrically by use of a Contractor supplied power source.
5. The Center Wedge Machinery components shall be mounted on the pivot pier supports during the approved stage. The machinery components shall be assembled and installed on the center pier as detailed on the Plans.
6. With the swing span aligned and permanently fastened to the center pivot assembly and the end wedge machinery permanently fastened and raised, install the Center Wedge Seat.
7. The Contractor shall rehabilitate the Center Wedge Seat and related machinery as shown on the Plans, securing the seat to the pivot pier. Alignment shall be set relative to the position of the center wedge.

8. Upon approval of alignment, by the Engineer, the wedge seat shall be secured with the existing anchor bolts and new non-shrink grout.

C. FIELD TESTING

1. When the machinery is final installed, permanently fastened and ready for field testing, the Contractor shall submit to the Engineer a testing procedure and schedule in accordance with the requirements specified in the "General Machinery".

4.0 MEASUREMENT AND PAYMENT

Center Wedge Machinery will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Center Wedge Machinery*.

Payment will be made under:

Pay Item	**Pay Unit**
Center Wedge Machinery	Lump Sum

CENTERING DEVICE MACHINERY (SPECIAL)

1.0 DESCRIPTION

The work included under this item shall consist of removing the existing Centering Device Machinery and replacing/rehabilitating the machinery as Shown on the Plans. This includes but is not limited to fabricating, erecting, testing, adjusting and painting the new Centering Device Machinery. The components include but are not limited to the following:

1. Latch Bar (2)
2. Crank and Shaft Assembly (2)
3. Latch Roller (2)
4. Latch Trip Lever (2)
5. Latch Pocket (2)
6. Bearings

Details and arrangements of all systems are shown on the Plans.

The work shall also include aligning the control instrumentation that is supplied under the Bridge Electrical Work item. The work shall be in accordance with the requirements specified in "General Machinery".

The Contractor shall coordinate the installation of the Centering Device Machinery with all other bridge machinery items, electrical work and structural work, as well as navigational and vehicular traffic closures and restrictions.

2.0 MATERIALS

A. GENERAL

1. The materials used to fabricate the machinery components shall be as shown on the Plans and in accordance with the requirements specified in "General Machinery".

3.0 CONSTRUCTION METHODS

A. SHOP FABRICATION, INSPECTION AND TESTING

1. All Centering Device Machinery components shall be assembled to assure proper fits and verify tolerances specified on the Plans. Assemblies requiring disassembly shall be match-marked and documented so that the machinery can be reassembled at the construction area.

B. SWING SPAN INSPECTION AND TESTING

1. The Centering Device Machinery components to be rehabilitated shall be transported to and from the shop to the on-site construction area. During the approved stage, the machinery components shall be assembled and installed on the rest piers as detailed on the Plans.
2. With the swing span aligned and permanently fastened to the center pivot assembly, the swing span centered, the end wedge machinery permanently fastened and raised and the center wedge machinery permanently fastened and driven, the suggested installation procedure for each latch pocket is as follows:
3. After preparing the rest pier, the Contractor shall install (4) anchor bolts as shown on the Plans (placement to match latch pocket provisions) to be used for positioning, leveling, aligning and securing of the latch pocket to the rest pier. Alignment shall be set relative to the position of the centering bar.
4. Installation of the latch pocket shall provide, with the span in the closed position and centered, ¼ inch clearance between the latch roller and the sides of the latch pocket. Upon approval of alignment, by the Engineer, the latch pocket shall be secured with the remaining anchor bolts and non-shrink grout.
5. The disengagement of the center latch bar from its engaged position is accomplished in unison with the withdrawal of the end wedges. The latch trip lever which engages the latch pawl and the latch pawl itself shall be in line with their respective hinge pins when the end wedges are fully withdrawn. They are thus collinear and toggled. In this position the center latch bar is now raised to its highest vertical position prior to operating the swing span. As the span begins to rotate to the open position, the latch trip lever will disengage from the latch pawl while the latch roller contacts the inner ramp of the latch pocket. This allows the latch bar to ride up the inner ramp and down the outer ramp of the latch pocket as the span rotates to its open position. The latch pawl swings down by gravity to its initial position and the latch bar is now lowered to its initial vertical elevation. When the swing span rotates to its closed position, the latch roller will contact the outer ramp of the latch pocket and ride up and over the latch pocket, allowing the latch bar to drop in the latch pocket thereby centering the swing span. All linkages and limit switches must be adjusted so that the preceding sequence can take place.

C. FIELD TESTING

1. When the machinery is final installed, permanently fastened and ready for field testing, the Contractor shall submit to the Engineer a testing procedure and schedule in accordance with the requirements specified in the “General Machinery”

4.0 MEASUREMENT AND PAYMENT

Centering Device Machinery will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Centering Device Machinery*.

Payment will be made under:

Pay Item	**Pay Unit**
Centering Device Machinery	Lump Sum

AUXILIARY OPERATING SYSTEM (SPECIAL)

1.0 DESCRIPTION

A. GENERAL

1. The Contractor shall prepare and implement a plan to safely operate all mechanical and electrical systems necessary to operate the movable span for the duration of construction. This system shall be independent of the existing or new normal operating means. This plan shall be submitted to the Engineer for approval and shall include all necessary calculations (stamped by NC PE), drawings (stamped by NC PE), scheduling, and any information necessary to demonstrate a complete and safe system of accommodating span operations throughout construction. Under this item, the Contractor shall furnish all labor, materials, plant and equipment; and shall do all work necessary to install, test, and place in satisfactory operating condition, an auxiliary operating system for opening and closing the swing span. The Contractor shall warranty the in-service performance of the auxiliary operating system during all the construction phases of its intended use.
2. This plan shall address the following needs:
   a. Safely control vehicular traffic before, during and after swing span operations.
   b. Maintain navigation lighting and communications.
   c. Safely operate live load supports at each end of the swing span, and beneath the pivot girder.
   d. Safely control all aspects of swing span turning operations including acceleration, deceleration, and braking while not exceeding the specified time of operation.
   e. Evolving system that can be modified as the reconstruction progresses; including modifications to conduit, wire, equipment location, etc.
3. For purposes of accommodating span turning operations, a concept design is provided herein for the contractor's reference and bidding purposes. The contractor shall fully develop a plan (stamped by NC PE), for implementation that is fully compatible with the rehabilitation work shown elsewhere in the contract documents. The Department will not require professional liability insurance for after the Department takes ownership of the system. The equipment to be utilized for turning the swing span shall be designed to achieve safe and reliable operations for the duration of construction. At the conclusion of construction, the turning machinery system shall remain in place and be used as the auxiliary system. The concept

design provided herein, as well as associated details provided elsewhere in the contract documents, includes provisions for integration of this auxiliary system into the permanent equipment. Any proposed turning machinery system developed by the Contractor shall be compatible with the requirements of these provisions.

2.0 MATERIALS

A. CONFORMANCE

1. All equipment and its installation shall conform to the requirements of the 1988 Standard Specifications for Movable Highway Bridges of the American Association of State Highway and Transportation Officials, 1992 and 1993 revisions except as may be otherwise provided herein.
2. Materials and construction shall conform to the requirements of any applicable local, state and federal rules and ordinances. The Contractor shall obtain any required permits and approvals of all Departments or Agencies having jurisdiction. All work shall be in conformance with the requirements of the United States Coast Guard and local governing authorities.

B. MATERIAL REQUIREMENTS

The following are general material requirements for equipment used as part of the final auxiliary system that is to be left in place. The contractor's plan must meet or exceed these requirements.

1. All equipment shall be outdoor rated and corrosion resistant.
2. Electrical equipment shall be installed in NEMA 4X stainless steel enclosures with enclosure heaters. The enclosure heaters shall be connected to the new lighting and distribution panelboard in the Control House once the new panelboard is available.
3. The control station and equipment shall be located and mounted to move with the span including accommodation for the Operator to safely move with the span.
4. The auxiliary system shall be provided with a means to be powered by both an independent power supply as well as the bridge normal and stand-by power sources. Sources such as a portable generator shall be sized and provided by the Contractor and its location shall be positioned at the discretion of the Contractor and with the approval of the Engineer.
5. The portable power source shall be connected to the auxiliary system using a receptacle and cord set. A permanent method of transferring between the two power sources shall be provided.
6. Any motor or incoming power source shall be provided with a local disconnecting means capable of being locked in the open position.
7. The power used for the auxiliary system shall be 3 phase, 480 Volts AC. Control voltage shall be 120 Volts AC.
8. A method shall be provided to disconnect the auxiliary system both electrically and mechanically when the normal operating system is being used.
9. An interlocking limit switch shall be provided that will prevent operation of the main motor while in the auxiliary mode of operation. The limit switch shall meet the general requirements for limit switches specified elsewhere and be connected to the PLC.

C. EQUIPMENT FOR CONCEPT DESIGN FOR AUXILIARY OPERATING SYSTEM

1. The following describes a concept design to operate the swing span and ancillary equipment.
   a. Pinion, with shaft and bearings similar to the main pinion assembly currently in use, that will mesh with the rack
   b. Bevel gear set to drive the pinion
   c. Speed reducer with cut-out coupling and safety interlocks
   d. Electric motor with an internal brake and shaft extension for manual operation
   e. Assembly mounted to the swing span structural steel
   f. Pendent push-button station capable of operating the swing span from the center pivot pier
   g. A method to operate, or provide equivalent operation of, the traffic signals, warning gates, barrier gates and live load supports

D. BRIDGE OPERATION UNDER AUXILIARY OPERATING SYSTEM

1. During construction, the auxiliary operating system shall be operated by qualified personnel provided by the Contractor who have been fully trained with use of the auxiliary operating system.
2. The bridge is required to operate on-demand 24 hours a day, 7 days a week. The Contractor will be required to provide qualified personnel to maintain this 24/7 schedule in accordance with USCG requirements.

3.0 CONSTRUCTION METHODS

A. GENERAL

1. The Contractor shall be fully responsible for performing field inspections and surveys to determine the location of all equipment.

B. SUBMISSION OF PROPOSED METHOD OF INSTALLATION

1. The Contractor shall submit, in detail, his proposed method for installing and operating the auxiliary operating system, and shall obtain the approval of the Engineer before any work is started.
2. The Contractor shall be fully responsible for providing an auxiliary operating system for the span to allow safe operation of the bridge and all equipment.
3. All operations shall be complete in less than 20 minutes (from traffic stopped to traffic released).
4. The Contractor shall field verify a normal bridge operation and provide all functions to match the normal operation within his Auxiliary Operation Plan.
   a. Advance Warning Flashing Lights, Gongs and Roadway Red-Yellow-Green Traffic Signals: These shall operate prior to and during a span operation. Flaggers, battery powered lights, hand held air horn, or temporary power may be provided to perform these operations.
   b. Warning and Barrier Gates: These shall operate as normal during an operation. Crash vehicles, temporary power, or manual operation may be provided to perform these operations.

c. Wedge Operations: The Contractor shall provide method of jacking the span and pulling/driving all (6) of the wedges to allow span operation.
d. Span Operation: The Contractor shall provide an auxiliary operating system during construction to operate the swing span independent of the normal operating equipment. The equipment shall meet the intent of the concept design specified herein.
e. Navigation Siren: The siren shall operate as normal during an operation. Provide a battery powered siren, hand held air horn, or temporary power and control to the existing siren until the new siren is installed and fully functional.
f. Marine Radio: The marine radio shall operate as normal during an operation. Provide a battery powered marine radio or temporary power and control to the existing marine radio to remain.

5. All auxiliary equipment shall conform to the requirements of the Contracting Agency and the Coast Guard. The equipment shall be submitted to the Engineer for review and approval, and any equipment deemed by the Engineer to not be satisfactory shall be replaced with acceptable materials and equipment.
6. In order to compensate for any imbalance caused by the installation of the auxiliary drive system, the Contractor shall balance the bridge so that any imbalance moment about the center pivot shall be less than the frictional moment about the center pivot. The Contractor shall demonstrate that the span is balanced to the Engineer. On a day where the wind is less than 5 miles per hour, with the span in the closed position but all wedges are pulled, no balance wheels are to be in hard contact with the track rail. If any balance wheel is in hard contact with the track rail a jack shall be placed at a location close to and outboard of the balance wheel in hard contact. The jack location shall be agreed to by the Engineer. The span shall then be jacked so that the balance wheel in hard contact is no longer in hard contact. The jack shall then be lowered. If that balance wheel does not return to its hard contact position, and no other wheels are in contact with the rail, the swing span is considered balanced. If that wheel, or any other wheel, does come back into hard contact the swing span must be balanced by adding weight to a location agreed to by the Engineer, in order to counterbalance the imbalance moment. The balance test must then be repeated until the span balance requirement is met and to the satisfaction of the Engineer.

C. WORKING DRAWINGS

The Contractor shall prepare and submit to the Engineer for review and comment the following working drawings (stamped by NC PE) executed in accordance with the provisions of the Contract. These drawings shall be reviewed by the Engineer and all comments resolved to the Engineer’s satisfaction prior to placing an order with any manufacturer.

1. A drawing to scale showing the location and layout of all mechanical, electrical and structural components required to accommodate and install the auxiliary drive system.
2. All calculations shall be stamped by a NC PE.
3. Manufacturer's construction drawings of mechanical and electrical components.

4. Schematic wiring diagrams of all equipment to be used as part of the auxiliary drive and temporary systems.
5. Detail drawings showing the construction of any necessary equipment and components mounted therein.
6. The Contractor shall submit for inspection and test, if directed by the Engineer, samples of any apparatus or device which he proposes to use as a part of the auxiliary operating system.

D. AUXILIARY OPERATING SYSTEM INSTALLATION

1. The Contractor shall provide proper tools, equipment for transporting and installing the mechanical, electrical and structural components of the auxiliary systems. He shall exercise proper care so as not to overstress, score, or damage the new and existing equipment.

E. TESTING

1. Factory Inspection and Testing
   a. The components of the auxiliary operating system shall be subjected to shop inspection and testing to demonstrate compliance with all specified requirements. The inspection is intended as a means of facilitating the work and avoiding errors. It is expressly understood that it will not relieve the Contractor of responsibility for imperfect material or workmanship.
   b. Special testing shall include complete verification, adjustment, and testing of the mechanical and electrical loading required to open and close the swing span.
   c. All tests shall be witnessed by the Engineer or his authorized representative, and no equipment shall be shipped from the factory until it has been released for shipment by the Engineer. The Contractor shall provide notification in advance of the date (2 weeks minimum) of the tests so that arrangements can be made for the Engineer to be present at the tests.
   d. During the witnessed inspection, nameplate legends, instrument scales, and all other details of construction shall be checked for conformity with the Contractor’s approved plan.
2. Manufacturer's Field Start-Up Service
   a. A representative of the manufacturer shall be present at field start-up time to facilitate proper adjustment, if necessary, so as to achieve satisfactory functioning of their component of the auxiliary operating system.
   b. The manufacturer's field service engineering personnel shall be experienced in the installation and adjustment of their particular mechanical and electrical equipment. The personnel shall be capable of locating and correcting faults or defects and/or of obtaining from the manufacturer, without delay, new parts or replacements for apparatus that, in the opinion of the Engineer, does not perform satisfactorily.
3. Field Testing
   a. The Contractor shall arrange for and provide all the necessary field tests, as directed by the Engineer, to demonstrate that the entire auxiliary operating system is in proper working order and in accordance with the Plans and Specifications. The tests shall include, but not be limited to opening and closing the swing span to the satisfaction of the Engineer.

b. Should the tests show that any piece of equipment, in the judgment of the Engineer, is defective or functions improperly, adjustments and/or replacements shall be made by the Contractor, at no extra cost, as to make the operation satisfactory to the Engineer.

F. LOCK OUT AND TAG OUT

a. The Contractor shall develop, document and follow all safety precautions necessary to ensure safe operation of the bridge at all times.
b. Proper lock-out and tag-out of the normal and auxiliary operating systems will be required during construction.
c. All personnel on-site shall be properly trained in lock-out and tag-out procedure to be followed by the contractor.

G. BRIDGE OPERATOR AND TRAINING

1. The Contractor shall provide persons to operate the auxiliary operating system of the bridge during all required stages of construction.
2. The Contractor shall also ensure that the auxiliary operating system of the bridge is in operable condition at all times.
3. The Contractor shall also provide training on safe use of the auxiliary system to NCDOT following project completion. Training shall include witnessing two complete test openings using the auxiliary system in addition to four hours of training.

4.0 MEASUREMENT AND PAYMENT

Auxiliary Operating System will not be measured for payment. All costs associated with furnishing and installing materials, labor, tools and incidentals necessary to complete the work shall be incidental to the Lump Sum price bid for the *Auxiliary Operating System*.

Payment will be made under:

Pay Item	**Pay Unit**
Auxiliary Operating System	Lump Sum

Project Special Provisions

Pivot Pile Repairs

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Samuel Cullum
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10/31/2016

CONCRETE RESTORATION

Description:

Replace deteriorated concrete by placing polymer/latex modified concrete.

In addition to the locations of spalls shown in the Plans, the Contractor shall perform a sounding survey of the bridge center pivot pier substructure and identify all locations in need of concrete repair. The survey shall be performed in the presence of the Engineer prior to commencing any work.

No concrete removal shall be performed without the Engineer's approval.

Materials:

Mortar/concrete shall be a polymer/latex modified-silica fume enhanced mortar/concrete unless otherwise required in the Contract Documents. The selected material shall achieve a minimum compressive strength of 4,500 psi in seven days and 5,500 psi in 28 days.

For horizontal or vertical spalls with a minimum depth of 1 inch, use repair mortar that includes an aggregate in accordance with the manufacturer's recommendations. For spalls near the water that may be submerged during cure, add anti-washout admixture. For horizontal or vertical spalls less than 1 inch deep, hand-apply repair mortar in accordance with manufacturer's recommendations.

Provide proposed repair material and method of application, including manufacturer's technical specifications and formulation. Do not place patch materials in lifts. Place the material using form and pour methods unless otherwise approved by the Engineer based on specific condition of deficiencies.

Materials must be applied in accordance with this Project Special Provision and manufacturer's recommendations.

Surface Preparation:

Remove deteriorated concrete to sound material (or limits described in plans) by scarification or by chipping with light duty pneumatic or electric concrete chippers (30 LB or less in general, 15 LB or less adjacent to strand, reinforcing steel, and structural limits of construction). Remove concrete that is contaminated with grease or oil.

Blast clean all reinforcing bars exposed after concrete removal in accordance with SSPC SP10 near white metal surface. Replace bars that have lost 25 percent or more of their original diameter with new bars spliced in place within the original cover, lapping rebar to develop the full strength of the bar as detailed in the plans and, if necessary, providing additional chipping. Dual bars of equivalent or greater section may be used. Where the bond between existing concrete and reinforcing steel has been destroyed, or where the steel is exposed, remove the concrete adjacent to the bar to a depth that will permit modified concrete to bond to the entire periphery of the exposed bar. A clearance of ¾" to 1" behind the bar is required for this purpose. Prevent cutting, stretching or damaging of exposed reinforcing steel.

Blast clean existing concrete surfaces that will be in contact with freshly placed repair material and clean to remove loose material and dust immediately prior to application of repair material.

Mixing:

Provide a Mix Plan for quantities of bag mix in excess of 1.0 cubic yards at a single location for the Engineer's approval including: manufacturer's specifications, method of mixing, means of application, and placement procedure to provide a homogenous pour free of cold joints.

Use clean mixers and accurately proportioned ingredients. Mix the materials at the site. Ensure that the material, as discharged from the mixer, is uniform in composition and consistency.

Placing and Finishing:

Typical spall repair: A concrete bonding agent, compatible with the repair material and approved by the Engineer, shall be applied to the exposed reinforcing steel prior to the placement of new repair material, and, if recommended by the material manufacturer, to the existing concrete. The compound shall be applied and cured in accordance with approved manufacturer's instructions. The bonding agent shall contain corrosion inhibitors. Provide measures for dewatering areas near the waterline, or provide alternate suitable repair materials for use underwater.

Repair areas of unsound concrete with the following modifications for spalls greater than 1 inch deep. Cut the upper perimeter of sound concrete to an angle sloping slightly upward to avoid entrapping air and water. Form area to be repaired to original neat lines. Form must withstand the anticipated head pressure of the repair material and a minimum pressure of 10 psi. Apply form release agent, compatible to the repair material, to the interior surfaces of form. Pump material into forms with proper venting to ensure complete filling of voids, starting with a port at the bottom of the form. Perform external form vibration as necessary to insure proper consolidation. Cap vents when steady flow of material is ensured then fill until an immediate increase of 3 to 5 psi is detected. See plans for additional details. At the Engineer's discretion, gravity fed pours may be allowed in some cases for uniform deficiency shapes where quality control can be assured after trial installations.

Quality Control:

Include the work under this Project Special Provision in the Contractor Quality Control General requirements set forth in NCDOT Specifications.

A quality control/quality assurance (QC/QA) plan that shall govern all work shall be submitted by the Contractor to the Engineer for approval prior to commencing the installation work for the concrete restoration. Cost of the quality control and other technical services shall be included as incidental to the concrete restoration. No additional payments will be allowed for technical services.

As a minimum, include in the QC/QA Plan means and methods and equipment for removing the deficient concrete and cleaning the reinforcing steel, repair materials, and forming and placement methods. Also include frequency of intended QA visits and time to discuss QC and method of construction with Contractor's and the Engineer.

Limitations:

Make 4 to 6 extra test cylinders or cubes (as requested by the Engineer) and test for compressive strength gain determinations. The Engineer will determine the time of testing. Cure test cylinders in air for the full curing period required before testing. Do not place repair material at ambient temperatures below 45°F, or above 85°F, or more stringent temperature ranges provided by the manufacturer unless adequate protection is provided against adverse effects of extreme temperature conditions.

Coarse aggregate to extend repair material (when bagged mix is used) shall be maintained at a clean, dry, location where protected from the elements to avoid material contamination. Amount of aggregate for grout extension shall be as recommended by material manufacturer. Use either prepackaged coarse aggregate (included within the repair material bag mix) or from an NCDOT approved source.

Method of Measurement

The quantity to be paid for will be the volume in cubic feet of concrete repair material authorized, complete, in place and accepted. The method utilized in determining the volume will be the surface area in square feet multiplied by the average depth of such areas.

Basis of Payment

Price and payment will be full compensation for all work specified in this Project Special Provision including all removals, surface preparations, bonding agents, concrete placement, dewatering, forming, materials, equipment, tools, scaffolds, labor and other materials necessary to complete the work in accordance with the contract documents. Measures for dewatering areas near the waterline and any quality control and other technical services shall be incidental to the concrete restoration work.

Pay Item Restore Spalled Areas (Epoxy) (CF)

BPP-5

B-5936 Tyrrell County

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PILE STRENGTHENING USING CFRP WRAP

General.

Submittals:

(1) Submit product data indicating product standards, physical and chemical characteristics, technical specifications, limitations, installation instructions, maintenance instructions, and general recommendations regarding each material in accordance with Department Specifications.

(2) The Epoxy/Composite Supplier shall provide a five-year proven record of performance of concrete member strengthening with carbon fiber materials, confirmed by actual field tests, and a minimum of 25 successful installations. Include certification that the Manufacturer is ISO 9001 compliant by current audit.

(3) Submit for record a qualification statement listing completed Carbon Fiber Reinforced Polymer (CFRP) projects similar in size and scope, including: location, owner, engineer/architect, and contact numbers. Include a certified letter stating that the Contractor is currently qualified to install the Manufacturer's CFRP.

(4) Submit Health and Safety Sheets and Safety Data Sheets (SDS) of each product used on site and certification that the materials conform to local, state, and federal environmental and workers' safety laws and regulations.

(5) Prepare and submit, for approval, the Quality Assurance/Quality Control (QA/QC) plan, including the shop drawings and the work plan for the installation of the CFRP system in accordance with Department Specifications. The shop drawings and work plan shall contain all the details of the CFRP wrap, CFRP anchor, surface preparation, crack and concrete repair materials, joint and end details, lap details, and all other information required for the proper installation of the system. The work plan will describe the testing and inspection requirements and testing equipment to be used.

Quality Assurance:

Carbon Wrap Manufacturer/Supplier Qualification: The Carbon System Manufacturer/Supplier shall specialize in the manufacturing of the products specified in these Specifications, with documented experience. The Manufacturer shall have been in existence for a minimum of 5 years. The Manufacturer/Supplier shall have a minimum of 25 documented successful field installations.

Carbon Fiber Contractor Qualifications: The Contractor shall have successfully completed a minimum of five projects of similar size and scope. In addition, the Contractor shall be experienced in the installation of the specified carbon wrap product, and provide a notarized certification letter from the Carbon Manufacturer, attesting the contractor is currently qualified to install the materials.

Inspection: Inspect all materials prior to application to assure that they meet specifications and have arrived at the job site undamaged. The CFRP reinforcement shall be completely inspected by the Contractor during, and immediately following, application of the composite materials. Conformance with the design drawings, proper alignment of fibers, and quality workmanship shall be assured. Entrapped air shall be released or rolled out before the epoxy sets. Defects shall be noted in the Daily Construction Log, kept by the Field Representative. After CFRP reinforcement has cured, inspect all the work to check for voids

and/or debonding. Repairs shall be made, and noted in the Daily Construction Log.

Job Site Conditions: Environmental conditions shall be examined before and during installation of the CFRP system to ensure conformity to the contract documents and Manufacturer's recommendations. Do not apply primers, putty, saturating resins or adhesives on damp, or wet surfaces. Ambient and concrete surface temperatures shall be within 50°-95°F, unless specified by the Manufacturer. Moisture level on all contact surfaces shall be less than 10% at the time of installation of the CFRP system, as evaluated according to ACI 503R-93. Moisture restrictions may be waived for resins that have been formulated for wet applications.

Do not apply CFRP reinforcement materials if rain, or dew condensation is expected. The ambient temperature and temperature of the epoxy components shall be between 50° and 80° F at the time of mixing.

Storage, Handling and Disposal:

Storage Requirements: All components of the CFRP system shall be delivered and stored in the original factory-sealed unopened packaging or containers, with proper labels identifying the manufacturer, brand name, system identification number, and date. Store catalysts and initiators separately. All components shall be protected from dust, moisture, chemicals, direct sunlight, physical damage, fire, and temperatures outside the range specified in the system data sheets. Any component that has been stored in a condition different from that stated above shall be disposed of as specified in this specification. All components of the CFRP system, especially resins and adhesives, that have been stored longer than the shelf life specified on the system data sheet, shall not be used, and shall be disposed of, as specified herein

Handling: All components of the CFRP system, especially fiber sheets and anchors, shall be handled with care according to the Manufacturer recommendations to protect them from damage, and to avoid misalignment or breakage of the fibers by pulling, separating, or wrinkling them, or by folding the sheets. After cutting, sheets shall be either stacked dry with separators, or rolled gently at a radius no tighter than 12 inches or as recommended by the manufacturer.

Safety Hazards: All components of the CFRP system, especially resins and adhesives, shall be handled with care to avoid safety hazards, including but not limited to, skin irritation and sensitization, breathing vapors, and dusts. Mixing resins shall be monitored to avoid fuming and inflammable vapors, fire hazards, or violent boiling. The Contractor is responsible to ensure that all components of the CFRP system at all stages of work conform to the local, state, and federal environmental and worker's safety laws and regulations.

SDS for all components of the CFRP system shall be accessible to all at the project site. Specific handling hazards and disposal instructions shall be specified in the SDS.

The Contractor is responsible for providing proper means of protection for safety of the personnel and the work place. Inform the personnel of the dangers of inhaling fumes of primer, putty or resin, and shall take all necessary precautions against injury to personnel. The resin mixing area shall be well vented to the outside.

The Contractor is responsible for the clean-up of the equipment and the project site from hazardous and aesthetically undesirable CFRP components using appropriate solvents, as recommended in the SDS.

Disposal: Any component of the CFRP system that has exceeded its shelf life or pot life, or has not been properly stored or handled, and any unused or excess material that is deemed waste, shall be disposed of in a manner amiable to the protection of the environment and consistent with the SDS.

CFRP System Properties.

Fiber Properties and Data: CFRP fabric properties vary depending on the manufacturer. The number of layers utilized in the application should be determined to satisfy the requirements specified in the following table for each layer (total number of layers provided from plans. The maximum number of layers utilized shall not exceed three layers, not including anchors.

Dry Laminate Property	
Property	Minimum Requirement
Ultimate tensile strength	500,000 psi
Tensile modulus	33 x 10^6 psi
Elongation	1.33%
Primary fiber direction	Bidirectional

Cured Laminate Properties	
Tensile strength	60,000 psi
Modulus of elasticity	5.5 x 10^6 psi
Elongation at break	1.00%
Thickness	No Minimum
Minimum strength per inch width	500 lbs

Fiber Anchor Properties: CFRP anchor fiber properties shall be comprised of a CFRP anchor rod set using a high strength structural epoxy. The cross-sectional area of the CFRP anchor rod shall be a minimum of 0.1 square inches. The epoxy shall match the material requirements of the saturant. Alternate anchorage systems compatible with the CFRP wrap system may be submitted to the Engineer for approval. Anchor submittals shall meet the requirements of these Special Provisions.

Surface Primer: Surface Primer shall be a two component, 100% solids, moisture tolerant epoxy.

Surface primer shall meet the following minimum requirements:

Property	Requirement	ASTM Test
Tensile strength, 7 Day	2,500 psi	D638
Tensile modulus, 7 Day	105 ksi	D638
Elongation at break, 7 day	1.0%	D638
Flexural strength, 14 Day	3,500 psi	D790
Heat deflection temp. (HDT)	118°F	D648

Saturant: Saturant resin shall be two component, 100% solids, moisture tolerant, high strength, high-modulus epoxy.

Saturant shall meet the following minimum requirements:

Property	Requirement	ASTM Test
Tensile strength	6,000 psi	D638
Tensile modulus	440 ksi	D638
Elongation at break	1.5%	D638
Flexural strength	10,000 psi	D732
Flexural modulus	400 ksi	D790
Heat deflection temp. (HDT)	120°F	D648

Procedure for CFRP Application.

Concrete Section Preparation: The work under this section consists of restoring delaminated concrete on selected bridge components using polymer/latex modified concrete. Surfaces where the CFRP system is to be applied shall be sound. Concrete spalls and delaminations shall be repaired according to procedures ACI 546R-96 and ICRI No. 03730, as follows:

Concrete restoration shall include the removal of all delaminated concrete from the area to be restored. Any loose concrete remaining in the damaged region shall be removed, leaving the member with sound concrete. The perimeter of the spall shall be identified and saw cut to a minimum depth of ¾ inch to prevent feathered edges. The resulting shape shall be uniform with no pointed corners. No concrete removal shall be performed without consultation and approval of the Engineer.

Cracks within solid concrete with widths greater than 0.016 (1/64) inches shall be stabilized using epoxy injection methods in accordance with these specifications. Surface depressions shall be filled and cured in advance with epoxy filler per Manufacturer's instructions. CFRP system shall be installed no earlier than 24 hours after crack injection. Any surface roughness caused by injection shall be removed.

Any existing chips or spalls shall be sandblasted clean before patching. Concrete restoration shall be performed using an approved polymer/latex-modified mortar/concrete. The selected material shall achieve a minimum compressive strength of 4,500 and 5,500 psi in seven and 28 days, respectively. Proposed material and method of application including Manufacturer's technical specifications and formulation, if applicable, shall be submitted to the Engineer for approval prior to commencing work.

The restored concrete surface shall be smooth, uniform and shall match the concrete component's original profile. Remove form lines and sharp edges by grinding or filling with putty. Ridges greater than 0.2 inch may need to be ground down per the Engineer's direction.

All inside and outside corners and sharp edges shall be rounded or chamfered to a minimum radius of ½ inch. Ridges, form lines, and sharp or roughened edges greater than ¼ inch shall be ground down or filled with putty. Filler material, where required, shall be an epoxy. Obstructions and embedded objects shall be removed before installing the CFRP system, if required by the Engineer.

Substrate concrete and finished surface of concrete shall be cleaned to the approval of the Engineer. All concrete surfaces shall be dry and free of surface moisture prior to applying the carbon wrap system.

Final approval of the surface prior to concrete surface preparation shall be received from the Engineer prior to proceeding with the work.

Concrete Surface Preparation: Work performed under this section consists of roughening and cleaning the concrete surface prior to the application of CFRP. Work to be performed shall include abrasive blasting, air blowing, vacuuming, and any other technique required to remove dust, grit, coatings, chalk marks, paints, curing compounds, laitance, and other substances which would inhibit bonding of the CFRP to the concrete surface.

The surface preparation technicians and supervisors shall be certified before abrasive blasting is started. Abrasive blasting at each location shall not begin before necessary concrete repairs at that location are completed and the environmental measures are in place. Before abrasive blasting commences at each location, the concrete patch material shall be allowed to cure as recommended by the Manufacturer or otherwise specified in the Contract Documents.

Perform no work on this item until written approval is received from the Engineer and all supervisors and technicians have been certified for work.

Equipment and Materials Requirements: The following are equipment and material requirements for this item of work:

(a) Abrasive Blasting Equipment – Abrasive blasting equipment shall be conventional, air pressure-type blasters. A minimum pressure of 100 psi shall be maintained at the blast nozzle.

(b) Abrasives – The abrasive material shall be clean and dry silica sand or other suitable material. The blast material shall be plant packaged and maintained in a clean and dry condition at all times. Material stored in the sand blaster pot overnight shall not be used. A copy of the SDS shall be provided to the Engineer prior to sandblasting. Spent abrasives shall not be reused.

(c) Compressed Air – Compressed air used for abrasive blasting shall be clean, oil free, and dry, per ASTM D4285. Air line filters and moisture separators shall be installed upstream from the blasting equipment. These shall be inspected daily for cleanliness and correct operation. Any indication of malfunctioning equipment shall be corrected immediately.

(d) Submit detailed descriptions of all materials to be used to the Engineer for approval. This information shall provide all relevant constituents and properties of each material and the specifications to which each complies. Data published by the manufacturers will be acceptable except where certifications of materials characteristics are required.

Abrasive Blasting Technician Certification: Abrasive Blasting Technicians, who are certified by the Contractor, shall perform all abrasive blasting under this item of work. The testing proposal shall be submitted a minimum of 30 working days prior to the proposed test date, but not before the Contractor has received the Engineer's approvals for all equipment, materials, and procedures to be used for this work. Technicians who demonstrate their abilities to prepare concrete surfaces to the standards specified in the section through safe use of the required equipment shall be certified by the Contractor as "Abrasive Blasting Technicians" for this project after approval by the Engineer, who will witness certification testing. The Department shall be allowed to stop work due to poor workmanship at any time without consequence to the Department.

Abrasive Blasting and Cleaning Requirements: The following are performance requirements for this item of work:

(a) Contractor shall comply with all OSHA requirements during the sandblasting operation.

(b) All abrasive blast operators shall wear NIOSH (National Institute of

Occupational Safety and Health) approved, air-fed helmets or hood.

(c) Soil, cement spatter, and other foreign matter (other than grease and oil) shall be removed by scraping, chipping, brushing with stiff fiber or wire brushes, or needle gun. Oil or grease shall be removed by cleaning with detergents or emulsifying agents. The surface shall then be flushed with potable water to remove detrimental residue. Cleaning shall remove any dust, laitance, grease, oil, curing compounds, wax, impregnations, stains, paint coatings, surface lubricants, foreign particles, weathered layers or any other bond-inhibiting material.

(d) After completing activity (c), the concrete surfaces shall be abrasive blasted with nonmetallic grit. Abrasive blasting shall remove all loose and weak materials. Abrasive blasting shall remove laitance, efflorescence and other non-oil contaminants. It shall open up pore “bug” holes below the surface and shall leave a clean, rough surface, which has the appearance of medium grit sandpaper. In areas of sound concrete, large aggregate shall generally not be exposed. Abrasive blasting shall be performed so that no damage is done to completed portions of the work. All abrasive blasted surfaces shall be thoroughly cleaned by minimum 50 psi air blasting to remove all traces of abrasive blasting residue. The abrasive blasted surface shall be examined for traces of oil, grease, and other adhering contaminants. If present, they shall be removed by the techniques specified above, and that portion of the surface shall be re-blasted. Relatively small contaminated areas may be cleaned by needle guns rather than re-blasting. Workers shall assure that cleaned surfaces do not become re-contaminated from any source until CFRP repair is applied, including bare hands.

(e) Collect and safely dispose of all project wastes. The facilities for confining and safely disposing of these wastes shall be provided and operated by the Contractor. Wastes include demolition debris, concrete, and concrete dust, and blasting materials. Any damage to property shall be the responsibility of the Contractor.

Mixing Primer and Saturant: All resin components, including main agent and hardener, shall be mixed at proper temperature, using appropriate weight ratio, and for a duration specified by the manufacturer, until thorough mixing with uniform color and consistency is achieved. Resins shall not be diluted with any organic solvents, such as thinner. Manual stirring and small electrically powered mixing blades are allowed.

Resin shall be mixed in quantities sufficiently small to ensure that it can be used within its pot life. Any mixed resin that exceeds its pot life, or begins to generate heat or show signs of increased viscosity, shall not be used.

Mixing of some resins may be accompanied by noxious fumes. Precautions shall be taken, as specified by the manufacturer, regarding their impact on the environment, including emission of volatile organic compounds and toxicology.

Primer and Saturant Application: Apply primer in accordance with Manufacturer’s recommendations. Primer/ saturant may be applied with a brush or roller. The first coat of resin, shall be uniformly applied as an undercoat to all locations on the concrete surface where the CFRP system is to be installed. The primer/saturant shall have sufficiently low viscosity to ensure full impregnation of the fiber sheets prior to curing. Apply second coat as necessary after first coat has penetrated into concrete.

To maintain proper viscosity of the saturant, the ambient and concrete surface temperatures shall be within the range specified herein. Any mixed saturant that exceeds its pot life shall not be used, and shall be disposed of, in accordance with these Special Provisions.

Follow Manufacturer's recommendations pertaining to time between priming and application of CFRP reinforcement.

Primer shall be covered with fiber within 24 hours of application. If 24-hour window is exceeded due to unforeseen circumstances, the primed surfaces shall be solvent-wiped with a fast-flashing solvent, or roughened with sandpaper to break the amine blush.

Surface irregularities caused by the primer application shall be ground and removed by disc sanding.

CFRP Reinforcement Application (Wet Lay-Up Method): Apply CFRP Reinforcement in accordance with Manufacturer's recommendations. Follow Manufacturer's recommendations regarding primer open times.

CFRP reinforcement sheets shall be cut beforehand into prescribed lengths.

Upon uniformly applying the first layer of saturant as an undercoat, the fiber sheet previously cut to the length specified in the contract documents, shall be installed in place and gently pressed onto the wet saturant. Any entrapped air between fiber sheet and concrete surface shall be released or rolled across the sheet in the direction parallel to the fibers, while allowing the resin to impregnate the fibers and achieve intimate contact with the substrate.

Sufficient saturant shall be applied on top of the fiber sheet, as an overcoat, to ensure full saturation of the fibers. The undercoat, fiber sheets, and the overcoat shall be applied with no interruption.

To ensure complete bonding between layers, any successive layer of fabric shall be placed before the onset of complete gelation of the previous layer of epoxy.

The number of plies that can be applied in a single day shall be determined based on the Manufacturer's recommendation and the approval of the Engineer.

The cured composite shall have uniform thickness and density, bond between layers, and lack of porosity. Undulations in the completed wrap surface shall not exceed 0.25 inch per foot in any direction.

Fibers of the wrap fabric shall not deviate from a horizontal or a vertical line by more than 0.50 inch per foot.

Protect finished installation of CFRP system from rain, sand, dust, etc., using protective sheeting or other barriers. Do not allow protective sheeting to come in contact with finished application.

The CFRP system shall be allowed to cure, as recommended by the Manufacturer. Field modification of resin chemistry for rapid curing is not allowed.

Curing of finished application shall be a minimum of 24 hours prior to application of protective coating.

Repair of Defects.

Upon completion of the curing process, the installed system shall be checked for areas where saturant has not penetrated or where saturant has not completely cured. Such areas shall be epoxy injected to reestablish bond, subject to the approval of the Engineer.

Repair procedures shall be performed in accordance with Manufacturer's recommendations and as specified by the Engineer. All repairs shall be subject to the same application, curing, and quality control specifications as the original work.

Small delaminations, less than 2 square inches each, do not require corrective action, as long as the total delaminated area is less than 5% of the applied surface area.

Large delaminations, greater than 25 square inches each, shall be repaired by selectively

cutting away the affected sheet, reapplying primer and resin layers, and applying an overlapping CFRP patch of equivalent plies and fiber orientation. Allow for 6 inches overlap in all directions.

Moderate delaminations, less than 25 square inches each, shall be repaired by filling the delaminations using low-pressure injection of the saturant, or by the previous procedure specified for large delaminations.

Repair procedures for conditions that are not specifically addressed in this specification shall be submitted and approved by the Engineer prior to proceeding with the work.

Inspection, Testing, and Sampling.

All inspections in this section shall be performed by a trained inspector, acting on behalf of the Department for quality assurance of the project, in the presence of the Contractor and the Engineer. The Contractor may have its own inspector for quality control.

Inspection and Quality Assurance: Manufacturer's certifications for all delivered and stored CFRP components will be inspected for conformity to the Project Special Provisions (PSPs) before starting the CFRP repair.

Materials testing shall be conducted on samples of pre-cured witness panels. Any material that does not meet the requirements of the contract documents will be rejected.

Daily inspection will include:

Date and time of repair
Ambient and concrete surface temperatures
Relative humidity and general weather conditions
Surface dryness per ACI 503.4
Surface preparation and surface profile using ICRI surface-profile-chips
Qualitative description of surface cleanliness
Widths of cracks not injected with epoxy
Fiber laminate batch numbers and their locations in structure
Batch numbers, mixture ratios, mixing times, and qualitative descriptions of the appearance of all mixed resins, primers, putties, saturants, adhesives, and coatings
Observations of progress of cure of resins
Conformance with installation procedures
Adhesion test result including bond strength, failure mode, and location
CFRP properties from tests of field sample panels
Location and size of any delaminations or air voids
General progress of work

Fiber or ply orientation, fiber kinks, and waviness will be examined by visual inspection for conformity to the conditions specified in the PSPs. Non-conforming CFRP area will be removed, and repaired as per Repair of Defects Section, at the Contractor's expense.

After at least 24 hours for the initial cure of the resin, a visual inspection of the surface will be performed for any swelling, bubbles, voids, or delaminations. If an air pocket is suspected, an acoustic tap test will be carried out in accordance with these provisions

Testing: For Testing Requirements see Section CFRP System Properties.

Sampling: Record lot number of fiber used for wrapping. Six samples shall be prepared randomly throughout the duration of the project. The Engineer shall select the time and location of these samples. Samples shall consist of two 12 inch by 12 inch layers of fiber (flat).

Mix samples of epoxy resin according to Manufacturer's recommendations. All materials used for the samples shall be from the same products (lot number) being used at the site on a daily basis. On a smooth, flat, level surface covered with polyethylene sheets, prepare a sample by placing two layers of the composite oriented in the same direction. Cover with polyethylene sheets and squeeze out all bubbles. The prepared, identified samples shall be tested. All testing shall be at the Contractor's expense, by an independent laboratory, in accordance with ASTM 3039. Two copies of the test results are to be submitted to the Engineer within five days of testing. As a minimum the testing shall consist of:

Ultimate tensile strength
Tensile modulus
Percent elongation

Method of Measurement.

Carbon wraps will be computed for payment in place, per linear foot along pile, as shown on the plans.

Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including cleaning, surface preparation, carbon and epoxy materials, UV coating materials, labor, tools, equipment, specified testing, and incidentals necessary to complete the work.

No additional compensation will be made for areas which shall be reapplied due to Contractor's error.

Payment will be made under:

Pay Item Pile Wrap - per linear foot

ALTERNATE PILE STRENGTHENING

PART 1 – GENERAL

1.1 SUMMARY

A. This Section specifies the minimum requirements for restoring deteriorated piles using Fiber-Reinforced Polymer (FRP) Laminate encasement or jacket (these terms are interchangeable). The work shall consist of using a fiber–reinforced laminate to create a jacket around the pile to be restored, and filling the annulus between the jacket and the pile with fill material, see Section 2.3.

B. Contractor shall provide all labor, materials, tools, and equipment required for the completion of the Work, as shown on the Contract Documents and specified herein:

1. Prepare existing areas, as defined by these specifications and related Contract Drawings, designated to receive pile restoration
2. Design, furnish, fabricate, and install all jackets, shores, and bracing
3. Prepare installation and placement shop drawings
4. Prepare design drawings for shores, and bracing if required
5. Furnish all submittals required by this Section of the Specifications
6. Coordinate all work with other trades on site.

1.2 REFERENCES

A. The latest edition and addenda of the following publications in effect on the date of Contract Award are part of this Specification and, where referred to by title or basic designation only, are applicable to the extent indicated by the specific reference:

1. SSPC SP-2, Hand Tool Cleaning
2. SSPC-SP 6/NACE No. 3, Commercial Blast Cleaning
3. SSPC SP-12 WJ-2 Surface Preparation and Cleaning of Metals by Water Jetting
4. SSPC-SP 13/NACE No. 6, “Surface Preparation of Concrete”
5. SSPC-SP 15 Commercial Grade Power Tool Cleaning
6. ASTM F-2207 Standard Specification for Cured-in-Place Pipe Lining System for Rehabilitation of Metallic Gas Pipe; used to establish the confinement capacity of the FRP.

1.3 SUBMITTALS

A. Comply with pertinent provisions of the Master Project Specification, Submittals.

1. Product Data:

1. Fiber-Reinforced Laminate product data sheets showing material properties and strength.
2. Fill resin product data sheets showing material properties and strength.
3. Adhesive resin product data sheets showing material properties and strength.
4. Fill and Adhesive Resin SDS sheets.
5. Miscellaneous fasteners, anchors, straps, spacers, etc. product data sheets showing material properties.

B. Design and Shop Drawings:

The following information must be provided and sealed by a professional civil engineer:

1. Calculations showing the confining pressure provided by the jacket being used.
2. Details shall be carried out in accordance with the local building codes, and as shown on plans.
3. Shop drawings showing the FRP jacket installation steps, spacer sizes, overlap details, and the filler material to be placed in the annular space.

C. Certifications

1. ASTM F-2207 test report showing the jacket provides a minimum confining pressure given in Section 2.1.C, below.
2. Summary of full-scale structural test reports for strengthening steel, concrete and timber piles. List of and results of full-scale tests.
3. Product approval by the US Army Corps of Engineers and FEMA
4. Material certification for FRP laminates to show date of fabrication.
5. Material certification for fill and adhesive resin to show date of manufacture.

D. Quality Assurance Documents

1. Daily installation reports showing air and water temperatures
2. Daily installation reports showing lot numbers of FRP laminates and resins used on each pile

PART 2 – PRODUCTS

2.1 FIBER-REINFORCED POLYMER (FRP) LAMINATES

A. The laminate shall be a high-strength Fiber Reinforced Polymer (FRP) laminate constructed with bidirectional carbon or glass fabrics that provides strength in both longitudinal and transverse directions.

B. The FRP laminates shall have the minimum properties listed in the table below.

FRP Laminate Properties			
Property	**Standard**	**Glass**	**Carbon**
Longitudinal Direction			
Tensile Strength, ksi	ASTM D3039	60	100
Modulus of Elasticity, ksi	ASTM D3039	3,500	7,000
Ultimate Elongation, %	ASTM D3039	1.31	0.85
Transverse Direction			
Tensile Strength, ksi	ASTM D3039	60	64
Modulus of Elasticity, ksi	ASTM D3039	3,650	2,940
Ultimate Elongation, %	ASTM D3039	1.06	1.42
Other Properties			
Barcol Hardness	ASTM D2583	50	45
Max. Water Absorption, %	ASTM D 570	0.8	0.7
Laminate Thickness, in.		0.026	0.026

C. The FRP Laminate must provide the nominal structural values listed in the table below.

Pile Jacket Dia. (in.)	**Glass FRP**		**Carbon FRP**	
	Confining Pressure* (psi)	Long. Steel Equivalent spacing, in.**	Confining Pressure* (psi)	Long. Steel Equivalent spacing, in.**
10	645	19	1050	12
12	535	22	875	14
15	430	28	700	17
18	355	34	580	21
24	265	45	435	28
36	180	66	290	41

48	130	91	220	54
60	107	111	175	68

*Assuming a 2-ply jacket

**Equivalent number of #4 Gr. 60 steel reinforcement distributed around the circumference of the pile

2.2 ADHESIVE RESIN

A. The adhesive resin shall be a two-component high-strength structural epoxy designed for underwater applications. It shall have an immediate high tack consistency both in air and water and shall trowel easily.

B. The adhesive resin shall be a 100% solids formulation with low toxicity and low odor during cure.

C. The adhesive resin must be NSF-61 Certified for potable water application.

D. The adhesive resin shall meet the properties listed in the table below.

Adhesive Resin Properties		
Property	**Standard**	**Value**
Tensile Strength, psi	ASTM D-638	4,360
Compressive Strength, psi	ASTM D-695	11, 700
Flexural Strength, psi	ASTM D-790	8,900
Tensile Elongation, Max. %	- - -	5%

2.3 FILL MATERIAL

A. LOW VISCOSITY RESIN (See Section 3.2.D for Application Instructions)

1. The fill resin shall be a two-component, high-strength, low-viscosity structural epoxy. The resin shall cure underwater and shall provide excellent durability and chemical resistance. The resin shall be a 100% solids formulation with low toxicity and low odor during cure. Low Viscosity Resin (recommended for round timber, concrete or steel piles where the annular space is minimal (smaller than 1/4 inch) and it is desired to fill the cracks and voids with resin in timber and concrete piles)
2. The fill resin must have a low viscosity of 780 cps at 77 F to ensure that it will fill small cracks and voids in the pile.
3. The resin must be heavier than water, with a density greater than 1.10 to flow to the bottom of the annular space and displace the water.
4. The fill resin must be so that its color would show through the glass laminate.
5. The fill resins shall meet the properties listed in the table below.

Fill Resin Properties		
Property	**Standard**	**Value**
Viscosity @ T=77° F, cps	ASTM D-1290	780
Tensile Strength, psi	ASTM D-638	7,900

Compressive Strength, psi	ASTM D-695	11,200
Density	- - -	1.10
Tensile Elongation, Max. %	ASTM D-638	5%
Hardness, Min. Shore D	ASTM D-2240	86

B. EPOXY GROUT (See Section 3.2.E for Application Instructions)

1. The epoxy grout shall be a two-component 100% solids epoxy grout specifically designed for underwater concrete and masonry applications.
2. The epoxy grout resin must have a mixed viscosity of 750-1250 cps at 77 F to ensure easy flow.
3. The epoxy grout resin shall meet the properties listed in the table below.
4. The epoxy grout must be so that its color would show through the glass laminate.
5. Epoxy grout will require placement by incorporating ports in the jacket at 180 degree alternating positions and filling the resin from bottom until it comes out of the next top one; then sealing the first port and connecting to the next top one and continuing thus.

Epoxy Grout Resin Properties		
Property	**Standard**	**Value**
Viscosity @ T=77° F, cps	ASTM D-1290	750-1250
Tensile Strength, psi	ASTM D-638	5,100
Compressive Strength, psi	ASTM D-695	8,500
Tensile Elongation, Max. %	ASTM D-638	4-8%
Hardness, Min. Shore D	ASTM D-2240	85-90

C. UNDERWATER GROUT (See Section 3.2.E for Application Instructions)

1. The fill material shall be a pumpable underwater cement-based non-shrink grout.
2. The grout shall meet the US Army Corps of Engineers CRD-C-621 specifications for plastic/flowable conditions.
3. The grout shall have minimum compressive strength of 2500 psi (1 day), 8050 psi (7 days) and 9100 psi (28 days).
4. Underwater grout will require placement by incorporating ports in the jacket at 180 degree alternating positions and filling the resin from bottom until it comes out of the next top one; then sealing the first port and connecting to the next top one and continuing thus.

2.4 SPACERS

Spacers used to create an annulus around the pile shall be of the non-reactive type.

2.5 REINFORING MATERIAL

A. Carbon FRP Strips

1. The reinforcing material shall be a non-reactive and fully cured carbon FRP strips with a thickness of 0.47 inch and width of 4 inches.
2. The laminate shall have a tensile strength of 400 ksi and a tensile modulus of elasticity of 24,000 ksi.

B. Reinforcing Steel

1. The reinforcing material shall be Grade 60 steel conforming to ASTM A615.
2. The reinforcing steel shall be epoxy coated and conform to ASTM A775.
3. Prior to installation in the field, all reinforcing steel shall be inspected to ensure the epoxy coating is free of any damage. Epoxy coat the ends of rebar that has been cut in the field.

2.6 ALTERNATIVE MATERIALS

Any alternative materials proposed as a substitute for the materials specified in this specification shall be submitted for review and approval to the Project Engineer at least 15 days prior to the bid date.

PART 3 – EXECUTION

3.1 PREPARATION

A. Concrete Piles

1. All loose and deteriorated concrete shall be removed using hydraulic or pneumatic hand tools.
2. Contractor shall take precautions not to damage non-spalled or cracked concrete at location of scheduled repair.
3. After loose concrete is chipped away, all concrete surfaces scheduled to receive encasements shall be cleaned using high pressure water-jetting with rating of 5000 psi. The purpose of this preparation is to remove all marine growth and any soft surface layer that may have accumulated on the piles.
4. The elapsed time between the cleaning of the concrete surface and the installation of the FRP encasement shall not exceed 72 hours. If this time frame is exceeded contractor shall re-clean the pile prior to encasement.
5. Irrespective of paragraph 3.1.B.4, above, Contractor shall remove any marine growth that has accumulated on the concrete surface prior to encasement.

3.2 APPLICATION

A. Epoxy Paste

1. The epoxy paste shall be appropriate for underwater installations or for dry installations, as applicable. Adhere strictly to Manufacturer's Recommendations.
2. The epoxy shall be mixed in small batches at the point of installation.
3. Great care shall be given to application of the epoxy paste to the laminate. Thoroughly clean the laminate surface per manufacturer's recommendation prior to the application of the epoxy paste. Air, water and laminate surface temperature shall be between 45 and 90 degrees F.
4. Do not begin application if air, water or laminate surface temperature is below 45 or expected to fall below 45 F within 12 hours of application.

5. Do not begin application if the dew point is within 5 F of the temperature.

6. All epoxy components shall be conditioned to a temperature between 65 and 85 F prior to the time of mixing.

B. FRP Laminate Jacket (Encasement)

1. Cut the required length of the 4-ft (1200-mm) wide laminate jacket in the field. Note that the jacket must wrap a minimum of twice around the pile (720 degrees) plus an 8-inch (200-mm) overlap.

2. Thoroughly mix the epoxy paste.

3. Apply a 30-mil thick film of the epoxy paste to the overlapping portion of the laminate. A notched trowel can be used to ensure uniform epoxy thickness.

4. Tubes or Spacers and Ports.

    a. Tubes are used with Low Viscosity Resin; see Section 2.3.A. Secure a minimum of three injection tubes at 120 degrees apart along the height of the pile to be repaired. Grooves may be cut into the pile to place the tubes flush with the face of the pile.

    b. Spacers are used with Fill Material; see Section 2.3.B and 2.3.C. Install two injection ports in the laminate jacket, one near the bottom of the jacket and the second near the top of the jacket and 180 degrees opposite to the lower jacket. Install the Spacers around the perimeter of the pile at the same elevation to form a "ring". Install one "ring" of Spacers near the bottom of the laminate jacket and install a second "ring" near the top of the laminate jacket.

5. Wrap the laminate around the pile ensuring the second layer is in full contact with the first layer. Adjust the diameter of the jacket as necessary.

6. Use ratchet straps or shrink wrap as temporary means to keep the FRP diameter in the desired size.

7. When necessary, additional 4-ft (1200-mm) sections of laminate can be installed similarly. Apply epoxy paste over the overlapping portion of the first laminate to create a longer jacket.

8. At the contractor's discretion Steps 3 through 7 can be performed on a portion of the pile above water and the assembly lowered below the waterline.

9. Seal the bottom of the annular space.

C. Fill Resin Placement Equipment

1. Contact the FRP Manufacturer for recommended mixing equipment.

2. For small projects the resin may be proportioned and mixed separately before placing the mixed resin in a dispensing pump.

3. For larger projects, an automatic measuring, mixing and dispensing pump must be used.

D. Mixing and Placing Low Viscosity Resin Described in Section 2.3.A above

1. Mix the resin at the point of installation. Adhere strictly to Manufacturer's Recommendations.

2. Minimum application temperature shall be 45 F.

3. All epoxy components shall be conditioned to a temperature between 65 and 85 F prior to the time of mixing.

4. Introduce resin at the bottom of the annular space using tubes of the appropriate size. At a minimum, use 3 tubes located at 120 degrees.

5. Fill the lower 6 inch (150 mm) of the annular space with resin. Allow sufficient time for this resin to set and penetrate into the pile, creating a horizontal seal layer at the bottom of the FRP jacket.

6. Fill the remaining height of the annular space with resin. Fill resin placement shall begin from the bottom of the laminate jacket until it reaches the top of the jacket. The density of the fill resin is heavier than water and will push the water to the top of the annular space.

7. Allow fill resin to overtop the jacket until all water has been removed from the inside of the jacket.

E. Placing of the Fill Material Described in Sections 2.3.B and 2.3.C above

1. Fill the lower 6 inch (150 mm) of the annular space with fill material. Allow sufficient time for this material to set, creating a horizontal seal layer at the bottom of the FRP jacket.

2. Fill material placement shall begin from the bottom of the laminate jacket using pre-installed ports that are positioned at alternating 180 degrees. Start filling the annular space from bottom until the fill material comes out of the next top port; then seal the first port and connect hose to the next top port and continue thus.

3. Allow the fill material to overtop the jacket until all water and any debris has been removed from the inside of the jacket.

4. Seal the top ½ inch height of the annular space with low viscosity resin.

3.3 INSPECTION

A. The Work to be provided in accordance with this Section of the Specification shall be subject to inspection by Owner at any time(s) during the progress of the Work. Contractor shall provide access and any labor, materials, tools, and equipment required by Owner to complete inspection of the Work as specified herein.

B. Completed installations shall be visually inspected to confirm the integrity of the laminate encasement and the resin fill. Any deficiencies shall be corrected at the Contractor's expense. The Contractor shall propose a repair method and submit it to the Engineer for approval prior to implementing said repair.

C. Acceptance of structure shall be contingent on the Work meeting all of the requirements of the Contract Documents as indicated by the results of all testing, inspection, and other quality assurance procedures required by Owner.

3.4 METHOD OF MEASURENT

Pile strengthening will be computed for payment in place, per linear foot along pile, as shown on the plans.

3.4 BASIS OF PAYMENT

Prices and payments will be full compensation for all work specified in this Section, including cleaning, surface preparation, carbon, glass, and epoxy materials, UV Coating materials, labor, tools, equipment, specified testing, and incidentals necessary to complete the work.

No additional compensation will be made for areas which shall be reapplied due to Contractor's error.

Payment will be made under:

Pay Item Pile Wrap – per linear foot

END OF SECTION

CARBON FIBER REINFORCED POLYMER TESTING REQUIREMENTS

General.

The Engineer shall observe all aspects of on-site field-testing.

Quality Assurance.

All tests shall comply with requirements of ASTM A370, ASTM C802, ASTM C1021, ASTM E329, ASTM E543, ASTM E548, ASTM E699, and ACI 440.2R-01.

Calibrate testing equipment before proceeding with each set of tests using devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.

Contractor Submittals.

Prior to starting work, submit to the Engineer for approval, a proposed Quality Assurance and Testing plan and work schedule.

Carbon Wrap Testing Requirements.

Inspection for voids/delaminations:

After allowing at least 24 hours for initial resin cure to occur, perform a visual and acoustic tap test of the layered surface, in accordance with ACI 440.2R-01 (Part 3, Chapter 6 (6.2.3)). The acoustic tap test coverage will be, at a minimum, one sounding tool strike per square foot of area coated with the Carbon Fiber Reinforced Polymer (CFRP). Additional testing shall be performed if an area is deemed to be suspect.

Other methods for detecting voids must be submitted by the Contractor and approved by the Engineer prior to proceeding.

Bond Testing (CFRP fabric):

All tests under this section are to be performed by the Contractor in the presence of the Engineer.

Conduct direct pull-off testing per ASTM D 4541-89, or approved equal. Documentation – ASTM, ACI, logbooks, and Manufacturer's data should be readily available.

Conduct direct pull-off tests under the following test conditions:

Prior to the first CFRP installation, conduct a pull-off test on an installed sample of the CRFP (12"x12") to verify the tensile bond between the CRFP and the existing concrete substrate. This sample shall conform to the number of CFRP layers to be used in the repair. The location of the pull-off tests shall be representative of the general conditions and performed on a flat surface. Allow the CFRP system to cure a minimum of 24 hours before execution of the direct pull-off test. After testing, inspect the failure surface of the coupon specimen. Failure at the bond line at tensile stresses below 200 psi is unacceptable. If the results are unacceptable, consult the Manufacturer, make necessary modifications, and repeat the tests until acceptable results are obtained. The Engineer has the discretion to order the Contractor to substitute a different carbon wrap system if the results from the repeated tests prove unacceptable.

During CFRP installation, conduct pull-off tests to verify the tensile bond between the CFRP and the existing concrete substrate. Test location to be prescribed by the Engineer. Allow the CFRP system to cure a minimum of 24 hours and a maximum of 48 hours

before execution of the direct pull-off test. After testing, inspect the failure surface of the coupon specimen. Failure at the bond line at tensile stresses below 200 psi is unacceptable. The Engineer has the discretion to order the Contractor to remove the unacceptable materials and repeat the process.

Testing Frequency:

Conduct direct pull-off testing at the following frequency:

One initial CFRP pull-off test sample (12”x12”) is required. The Engineer will select the location where this initial testing will be performed.

Test the installed CFRP prior to the application of the protective coating. Perform a minimum of 20 direct pull-off tests at randomly selected locations throughout the project. Allow the CFRP system to cure a minimum of 24 hours (maximum 48 hours) before execution of the direct pull-off test. The Engineer will select the locations where the testing will be performed. Patch all test areas with an equivalent CFRP material prior to the application of the protective coating.

Conditions of Acceptance (CFRP fabric):

1. The failure mode must be cohesive failure within the concrete for tests on the CFRP.
2. The tensile bond strength must be in excess of 200 psi.
3. If required, repair the tested area in accordance with Repair of Defect of these Project Special Provision for Pile Strengthening using CFRP Wrap.

Verify compliance of materials and mixes with requirements of Contract Documents. Promptly notify the Engineer of observed irregularities or non-conformance of work or products.

Perform additional tests required by the Engineer. If re-testing is required due to nonconformance to specified requirements, perform the required repair as well as the new testing at no additional cost to the Department.

Take a minimum of five samples for quality control testing of epoxy injection material, CFRP sheets, bonding resins, and topping products. Provide these samples at no additional cost to the Department.

Test Report.

After each test, promptly submit one copy of the test report to the Engineer. Include with each test report: Date issued Project title

Name of inspector
Date and time of inspection and testing
Identification of product and specifications section (including batch numbers)
Location of tests in the Project
Type of inspection or test
Results of tests
Conformance with Contract Documents and Specifications

Method of Measurement.

Per test.

Basis of Payment.

Payment will be made under:

Pay Item Pile Wrap – per linear foot

EPOXY INJECTION OF CRACKS

Description.

Inject epoxy into cracks in portland cement concrete.

Materials.

Use Type "E" compound epoxy for injection to repair cracks in old structures. Use Type "F-1" compound epoxy (non-sagging gel) for sealing crack surfaces in preparation for injection. Epoxies shall contain no volatile solvent. Epoxies shall be basically pure reactive material with ash content of 2% maximum. The Contractor shall submit to the Engineer certification from the manufacturer of the epoxy, confirming that the requirements of this Section are met.

Specific Requirements for Type B Compounds.

Mixing and Application: Type B epoxy compounds (for bonding fresh concrete to hardened concrete or bonding precast concrete parts) shall be mixed, applied, and cured in accordance with the manufacturer's directions, or as might be directed otherwise by the Engineer. Epoxy compounds shall be used only under conditions which are compatible with the material being applied in accordance with the specific directions of the manufacturer.

Performance Tests:

1. Epoxy Bonding Compounds: Epoxy Bonding Compounds shall be prepared and tested in accordance with FM 3-C882. The ratio of the compressive strength of the composite cylinder to the compressive strength of the weaker concrete shall not be less than 0.90
2. Epoxy Mortars: Epoxy mortar shall be prepared and tested in accordance with FM 3-C882. The average compressive strength of the three test specimens shall be at least 5,000 psi.

Specific Requirements for Type E Compounds.

Epoxies for crack injection shall meet the Specification for Type B compound with these additional requirements:
Viscosity five minutes after mixing 300 to 600 cps at 77 deg. F by ASTM D 2393
Wet bond strength to concrete, minimum 250 psi at seven days by FM 5-518

Specific Requirements for Type F Compounds.

Repairing Spalled Areas: Epoxies for repairing spalled areas shall meet the requirements in this Section.

Subtype F-1: Subtype F-1 is used for repairing vertical and other surfaces and shall be a trowelable low modulus, non-sagging gel epoxy compound capable of bonding to wet surfaces with these properties:

Color	Shall match gray color No. 36622 of FED-STD-595
Viscosity	Gel
Maximum sand loading	2.25 parts sand to one part mixed epoxy by volume
Elongation in tension minimum	10% by ASTM D 638, seven day cure
Wet bond to Steel and Concrete minimum	250 psi by Florida Test Method FM 5-518

All materials must be submitted by Contractor and approved by Engineer prior to use.

Equipment.

For the equipment used to inject the epoxy, meet the recommendations of the epoxy injection material manufacturer and the following requirements:

1. Use equipment that has the capacity to automatically proportion the material components within the mix ratio tolerances set by the epoxy materials manufacturer.

2. Use equipment that has the capacity to automatically mix the epoxy component materials within the pump and injection apparatus. The Engineer will not allow batch mixing.

3. Use equipment that has the capacity to inject the epoxy resin under controlled variable pressures up to 200 psi, with a pressure gauge mounted at or near the nozzle to indicate the actual working pressure.

Injection Personnel Qualifications.

Employ personnel trained in performing injection work similar to that required for the project to carry out the epoxy injection of cracks in concrete. Provide an on-site supervisor for the epoxy injection work who is qualified by one of the following methods: 1. Certified by the manufacturer of the epoxy injection material as having the necessary competence to accomplish the epoxy injection work in a satisfactory and safe manner in compliance with these Specifications. 2. They can furnish documented evidence that they have a minimum of three years experience of on-site supervision of similar epoxy injection work and a list of five contracts in which similar epoxy injection was acceptably completed. Ensure that the listed experience in on-site supervision and completed contracts contains the project name and location, names of contracting parties, the owner's name, brief description of the work, and dates of completion of the epoxy injection work. Submit written evidence showing personnel training and the on-site supervisor's qualification to the Department prior to beginning any epoxy injection work.

Crack Surface Preparation and Cleaning Requirements.

Clean the area surrounding the cracks of all deteriorated concrete, efflorescence and other contaminants detrimental to the adhesion of the surface sealing epoxy compound. Clean the interiors of the cracks with air under sufficient pressure to remove loose materials entrapped within the crack including efflorescence.

Sealing Cracks for Epoxy Injection.

After cleaning, drill injection port holes using a swivel drill chuck and hollow drill bits, including a vacuum attachment which will remove dust and debris generated during drilling. Determine the spacing of the injection port holes by the size of the crack and the depth of the crack in the concrete substrate. Generally, space the injection ports from 4 to 8 inches apart. Determine the actual spacing of injection ports by field trials. Drill the holes to a minimum depth of 5/8 inch, exercising care in aligning the hole along the plane of the crack so that the hole follows the crack for the full 5/8 inch depth. Insert the injection ports in the drilled holes approximately 1/2 inch, allowing for a small reservoir below the injection port. After cleaning the cracks and drilling the injection port holes, seal the crack surface and the injection ports with suitable epoxy.

Epoxy Injection.

Inject the epoxy in accordance with the epoxy manufacturer's instructions. Determine the actual injection procedures and pressures in field trials, based on crack widths and depth into the substrate and sufficiency of the results.

Cleaning After Epoxy Injection.

Clean concrete surface areas of excess epoxy materials and injection ports after completing the epoxy injection work. Clean in a manner which will not damage the concrete by scraping, light sand blasting, grinding, use of solvents, or any other appropriate method approved by the Engineer. Clean excess materials so that no epoxy material or injection ports extend beyond the plane surface of the concrete.

Acceptance.

Drill three cores located in each day's work as directed by the Engineer. Take drilled core samples containing representative crack sizes. The Engineer will accept the epoxy injection work represented by the core samples when the core samples indicate that 90% of the crack void greater than 0.006 inch wide is filled with epoxy resin and the concrete of the core sample is bonded through the crack into a unit. Reinject epoxy injection work which does not satisfy the acceptance criteria, and correct it as necessary at no expense to the Department. Install additional injection ports as required to achieve satisfactory reinjection of epoxy resin. After the epoxy injection work is completed and accepted, fill the core holes with an epoxy mortar consisting of one part by volume epoxy injection resin and four parts by volume clean, dry sand. Supply the sand in moisture proof bags. Do not use previously opened bags of sand for making epoxy mortar. The Contractor may use one part by volume epoxy material for sealing with one part by volume clean, dry sand in lieu of the above.

Method of Measurement.

Epoxy Material:

The quantity to be paid will be the volume, in gallons, authorized, injected, and accepted.

Inject and Seal Crack:

The quantity to be paid will be the length, in feet, authorized and accepted, measured along the approximate centerline of the sealed crack.

Basis of Payment.

Epoxy Material:

Price and payment will be full compensation for all work specified in this Section, including furnishing the epoxy material, and miscellaneous related costs, storage, handling, etc.

Inject and Seal Crack:

Price and payment will constitute full compensation for furnishing all labor, equipment, incidentals and materials (except epoxy), for cleaning and sealing the crack, and all labor and equipment for injecting the crack.

Payment Items:

Payment will be made under the following pay items:

Epoxy Material – per gallon.

Inject and Seal Crack – per foot.

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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	1330000000-E	607	INCIDENTAL MILLING	267 SY		
0003	1519000000-E	610	ASPHALT CONC SURFACE COURSE, TYPE S9.5B	22.5 TON		
0004	1575000000-E	620	ASPHALT BINDER FOR PLANT MIX	1.5 TON		
0005	4400000000-E	1110	WORK ZONE SIGNS (STATIONARY)	604 SF		
0006	4405000000-E	1110	WORK ZONE SIGNS (PORTABLE)	96 SF		
0007	4410000000-E	1110	WORK ZONE SIGNS (BARRICADE MOUNTED)	104 SF		
0008	4415000000-N	1115	FLASHING ARROW BOARD	2 EA		
0009	4430000000-N	1130	DRUMS	177 EA		
0010	4445000000-E	1145	BARRICADES (TYPE III)	116 LF		
0011	4450000000-N	1150	FLAGGER	800 HR		
0012	4480000000-N	1165	TMA	2 EA		
0013	4685000000-E	1205	THERMOPLASTIC PAVEMENT MARKING LINES (4", 90 MILS)	400 LF		
0014	4686000000-E	1205	THERMOPLASTIC PAVEMENT MARKING LINES (4", 120 MILS)	400 LF		
0015	4847000000-E	1205	POLYUREA PAVEMENT MARKING LINES (4", **********) (HIGHLY REFLECTIVE ELEMENTS)	59,706 LF		
0016	4900000000-N	1251	PERMANENT RAISED PAVEMENT MARKERS	188 EA		

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
			STRUCTURE ITEMS			
0017	0000990000-E	SP	GENERIC MISCELLANEOUS ITEM EPOXY MATERIAL	42 GAL		
0018	8217000000-E	425	REINFORCING STEEL (BRIDGE)	10 LB		
0019	8664000000-E	SP	SHOTCRETE REPAIRS	938 CF		
0020	8678000000-E	SP	EPOXY RESIN INJECTION	98.1 LF		
0021	8860000000-N	SP	GENERIC STRUCTURE ITEM AUXILIARY OPERATING SYSTEM	Lump Sum	L.S.	
0022	8860000000-N	SP	GENERIC STRUCTURE ITEM BRIDGE CONTROL SYSTEM	Lump Sum	L.S.	
0023	8860000000-N	SP	GENERIC STRUCTURE ITEM CENTER WEDGE MACHINERY	Lump Sum	L.S.	
0024	8860000000-N	SP	GENERIC STRUCTURE ITEM CENTERING DEVICE MACHINERY	Lump Sum	L.S.	
0025	8860000000-N	SP	GENERIC STRUCTURE ITEM CONTROL HOUSE RENOVATIONS	Lump Sum	L.S.	
0026	8860000000-N	SP	GENERIC STRUCTURE ITEM DISCONNECT SWITCHES	Lump Sum	L.S.	
0027	8860000000-N	SP	GENERIC STRUCTURE ITEM DRY TYPE TRANSFORMER	Lump Sum	L.S.	
0028	8860000000-N	SP	GENERIC STRUCTURE ITEM ELECTRICAL DEMOLITION	Lump Sum	L.S.	
0029	8860000000-N	SP	GENERIC STRUCTURE ITEM ELECTRICAL REFURBISHING	Lump Sum	L.S.	
0030	8860000000-N	SP	GENERIC STRUCTURE ITEM END WEDGE MACHINERY	Lump Sum	L.S.	
0031	8860000000-N	SP	GENERIC STRUCTURE ITEM FIELD MEASURING	Lump Sum	L.S.	
0032	8860000000-N	SP	GENERIC STRUCTURE ITEM GROUNDING	Lump Sum	L.S.	
0033	8860000000-N	SP	GENERIC STRUCTURE ITEM HVAC UNIT	Lump Sum	L.S.	

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0034	8860000000-N	SP	GENERIC STRUCTURE ITEM JUNCTION AND PULL BOXES	Lump Sum	L.S.	
0035	8860000000-N	SP	GENERIC STRUCTURE ITEM LIGHTING	Lump Sum	L.S.	
0036	8860000000-N	SP	GENERIC STRUCTURE ITEM MOTOR CONTROL CENTER	Lump Sum	L.S.	
0037	8860000000-N	SP	GENERIC STRUCTURE ITEM MOTORS	Lump Sum	L.S.	
0038	8860000000-N	SP	GENERIC STRUCTURE ITEM OPERATION & MAINT MANUALS, TRAINING & AS-BUILT DOCUMENTA-TION	Lump Sum	L.S.	
0039	8860000000-N	SP	GENERIC STRUCTURE ITEM PANELBOARD	Lump Sum	L.S.	
0040	8860000000-N	SP	GENERIC STRUCTURE ITEM RACEWAY	Lump Sum	L.S.	
0041	8860000000-N	SP	GENERIC STRUCTURE ITEM SIREN	Lump Sum	L.S.	
0042	8860000000-N	SP	GENERIC STRUCTURE ITEM STABILIZING MACHINERY	Lump Sum	L.S.	
0043	8860000000-N	SP	GENERIC STRUCTURE ITEM START UP & COMMISSIONING	Lump Sum	L.S.	
0044	8860000000-N	SP	GENERIC STRUCTURE ITEM SUBMARINE CABLE	Lump Sum	L.S.	
0045	8860000000-N	SP	GENERIC STRUCTURE ITEM SWITCHES AND RECEPTACLES	Lump Sum	L.S.	
0046	8860000000-N	SP	GENERIC STRUCTURE ITEM TURNING MACHINERY	Lump Sum	L.S.	
0047	8860000000-N	SP	GENERIC STRUCTURE ITEM UTIL SER, MED VOLT EQUIP, AUTO TRANSFER SWITCH & GENERATOR	Lump Sum	L.S.	
0048	8860000000-N	SP	GENERIC STRUCTURE ITEM WIRE AND CABLE	Lump Sum	L.S.	
0049	8867000000-E	SP	GENERIC STRUCTURE ITEM BRIDGE JOINT REMOVAL	9,429 LF		

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Line #	Item Number	Sec #	Description	Quantity	Unit Cost	Amount
0050	8867000000-E	SP	GENERIC STRUCTURE ITEM INJECT AND SEAL CRACK	420 LF		
0051	8867000000-E	SP	GENERIC STRUCTURE ITEM PILE JACKETS	7,013.5 LF		
0052	8867000000-E	SP	GENERIC STRUCTURE ITEM PILE WRAP	280 LF		
0053	8867000000-E	SP	GENERIC STRUCTURE ITEM REJACKETS	438 LF		
0054	8867000000-E	SP	GENERIC STRUCTURE ITEM SILICONE JOINT SEALANT	9,489 LF		
0055	8882000000-E	SP	GENERIC STRUCTURE ITEM RESTORE SPALLED AREA - EPOXY	80.4 CF		
0056	8892000000-E	SP	GENERIC STRUCTURE ITEM CONCRETE DECK REPAIR FOR EPOXY OVERLAY	473 SF		
0057	8892000000-E	SP	GENERIC STRUCTURE ITEM EPOXY OVERLAY SYSTEM - MECHANICALLY DISTRIBUTED	387,507 SF		
0058	8860000000-N	SP	GENERIC STRUCTURE ITEM PAINTING CONTAINMENT FOR BRIDGE NO 7	Lump Sum	L.S.	
0059	8882000000-E	SP	GENERIC STRUCTURE ITEM EPOXY MORTAR REPAIR	279 CF		
0060	8897000000-N	SP	GENERIC STRUCTURE ITEM CLEANING & PAINTING EXISTING BEARINGS WITH HRCSA BRIDGE NO 7	2,198 EA		