R-4467
SWING SPAN
MINIMUM
TECHNICAL
REQUIREMENTS

July 18, 2017

PROJECT R-4467 **PERQUIMANS COUNTY**

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PURPOSE

This document is an extension of the Structures Scope of Work for the replacement of the existing swing span over the Perquimans River (Bridge No. 8) and shall be regarded with equal importance and status as all scopes of work, provisions, and all other documents comprising the RFP.

This document contains criteria and requirements that shall govern the Design-Build Team's general performance, efforts, and work products related to planning, design, construction, operation, and maintenance of the bridge, including all structural, mechanical, electrical, architectural, and safety-related devices, equipment, and systems related thereto.

The Design-Build Team shall be responsible for all calculations, plans, specifications, and other requirements of the Contract that are reasonably expected to be performed by the Designer (design consultant member(s) of the Design-Build Team) in the performance of similar design work. Information contained within this document is not intended to be, nor shall it be interpreted as, an acceptable substitute for any work product, the liability for which is typically borne by the Designer (e.g., signed-and-sealed Special Provisions), without the express written consent of the Department.

The requirements in this document shall be considered "minimum" levels of acceptability and shall not relieve the Design-Build Team, under any conditions, of its obligations to the Department and the general public to incorporate additional characteristics and features above and beyond those stated herein where it can reasonably be deemed necessary in executing the delivery of a safe and reliable bridge.

DESCRIPTION OF WORK

The Design-Build Team shall design, construct and put into permanent operation in accordance with all governing requirements a steel through-truss center-bearing swing span across the Perquimans River with complete control functions at the local site and remote operation capabilities from the Pasquotank County bascule bridge (Bridge No. 19) in Elizabeth City.

NAVIGATION CLEARANCES

Minimum vertical clearance to the lowest element of the swing span in the final condition shall be as required by the Structure Scope of Work elsewhere in the RFP. Minimum horizontal clearance in the final condition shall be 60'-0" for each channel, as measured between, and perpendicular to, the navigation faces of the fender systems. Minimum vertical clearance below the mean low water surface elevation shall be 9'-6" between the navigation faces of the fender

systems. When the swing span is open, unlimited vertical clearance above the water surface shall be provided between the navigational faces of the fender system. Dredging shall not be allowed to achieve the aforementioned 9'-6" vertical clearance.

Unless otherwise permitted by the U.S. Coast Guard, minimum vertical and horizontal navigation clearances during construction shall not be less than the existing bridge clearances, which shall be field-verified by the Design-Build Team.

DESIGN REQUIREMENTS

1.0 GENERAL

The Design-Build Team shall submit to the Department in accordance with established procedures final signed-and-sealed design calculations, plans, special provisions and other documentation prepared by the Design-Build Team during the development of the design of the swing span.

All design calculations, plans and provisions for the swing span are to be prepared in accordance with applicable AASHTO and Department documents cited in the Structures Scope of Work found elsewhere in this RFP and these Minimum Technical Requirements. For all proposed work that is not covered by the applicable codes, manuals, or other specifications, the Design-Build Team shall develop Special Provisions in accordance with the Structures Scope of Work elsewhere in the RFP and these Minimum Technical Requirements.

2.0 REFERENCE STANDARDS

Portions, or all, of certain recognized industry or association standards or specifications, referred to herein as being a requirement, shall be considered as binding as though reproduced in full herein unless supplemented and/or modified by more stringent requirements. Unless otherwise stated, the referenced standard or specification is that version which is current as of the date of the Technical Proposal. The following abbreviations shall be used to designate standard specifications for material 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 Society of Mechanical Engineers	ASME
G. ASTM International (formerly American Society for Testing and Materials)	ASTM
H. American Wire Gauge	AWG
I. American Welding Society	AWS

J. Environmental Protection Agency	EPA
K. Federal Communications Commission	FCC
L. Insulated Cable Engineer's Association	ICEA
M. Institute of Electrical and Electronics Engineers	IEEE
N. Illuminating Engineering Society	IES
O. Joint Industrial Council	JIC
P. Manual on Uniform Traffic Control Devices	MUTCD
Q. National Electrical Code of NFPA	NEC
R. National Electrical Manufacturers Association	NEMA
S. National Electrical Testing Association, Inc.	NETA
T. National Fire Protection Association	NFPA
U. National Lubricating Grease Institute	NLGI
V. Occupational Safety and Health Administration	OSHA
W. SAE International (formerly Society of Automotive Engineers)	SAE
X. Society for Protective Coatings (formerly Steel Structures Painting Council)	SSPC
Y. Underwriters' Laboratories, Inc.	UL

3.0 DESIGN CRITERIA

This section includes design criteria governing the general configuration, design approach, and structural considerations of the swing span. Design criteria included throughout other sections (e.g., mechanical, electrical, bridge tender's house) of these Minimum Technical Requirements shall be considered supplemental to these requirements.

A. Design the swing span in accordance with AASHTO *LRFD Movable Highway Bridge Design Specifications, 2nd Edition,* with interims through 2015 (herein referred to as "AASHTO *Movable*") and other references as listed in the Structures Scope of Work found elsewhere in this RFP.

B. Design the structural, mechanical and electrical systems of the swing to open counterclockwise and close clockwise. See additional Bridge Operation requirements elsewhere in these Minimum Technical Requirements.

C. Corrosion-protection measures on the swing span shall adhere to the requirements for a highly corrosive bridge as outlined in Section 12-12 of the *Structure Management Unit Manual* with the exceptions as noted in the Structures Scope of Work and Special Provisions elsewhere in the RFP. Where not specifically noted in these Minimum Technical Requirements or elsewhere it the RFP, the Design-Build Team shall specify and provide materials, products and systems that are generally regarded and/or explicitly rated for long-term outdoor use in a marine environment.

D. The swing span truss shall be a through truss. A partial through, or "pony", truss without upper bracing is permissible. If a pony truss is used, the floor system shall be at the bottom of the structure such that the main trusses are prominently visible above the roadway deck, emulating the through truss configuration of the existing bridge.

E. Design the floor system as a floorbeam-stringer system with at least four lines of longitudinal stringers supported by transverse floorbeams spanning between, and supported by, the trusses at the lower chord panel points.

F. Design the swing span such that there are at least four accessible jacking locations at the center pier. Jacking locations shall be arranged symmetrically about longitudinal and transverse axes through the center pivot and designed to support the full dead load of the structure.

G. Provide at least two accessible jacking locations at each rest pier, arranged symmetric with respect to the longitudinal axis through the center pivot. The design load(s) and jacking condition(s) for the jacking locations at the rest piers shall be clearly noted in the design calculations and on the plans.

H. Design the deck as a full-depth cast-in-place reinforced concrete slab for the full width of the roadway and sidewalk. Sand lightweight concrete is permissible. Stay-in-place forms are prohibited. Deck thickness and concrete cover at the top mat of reinforcing shall take into consideration bridge deck grooving and grinding requirements. Where required to facilitate manual operation of machinery, deck penetrations shall be provided with access hatches. Access hatches shall be fully sealed to prevent moisture intrusion, be designed for full live load, have machined contact surfaces for skid resistance, and the top surface elevation shall not deviate more than 1/8" from the adjacent deck riding surface.

I. Design deck drainage in accordance with the Hydraulics Scope of Work elsewhere in the RFP. Direct discharge onto structural steel, mechanical and electrical elements is not permitted.

J. Design the swing span truss assuming non-composite behavior at the strength limit state. Composite behavior may be assumed, where appropriate, for design of the truss at all other limit states, as well as for the floor system at all limit states.

K. Design the deck joints at the ends of the swing span for live load impact of 100%. These shall be detailed with sufficient clearance between the swing span and approach spans to allow for free operation of the span without interference throughout the design temperature range. The riding surface of roadway joints shall be detailed to safely accommodate bicycle traffic. Sidewalk joints shall be ADA-compliant. Joint assemblies shall be detailed for vertical and horizontal adjustability, and in the final condition, with the span closed and all wedges driven, the following joint alignment criteria shall be satisfied at each end of the swing span:

    a. The horizontal joint width shall not vary more than 1/8 inch along the full width of the roadway and sidewalk.

b. The relative vertical difference across the joint (between approach span and swing span) shall not exceed 1/8 inch along the full width of the roadway and sidewalk.

L. Set elevations of the substructure that support mechanical and electrical components such that mechanical and electrical components shall not be less than 1 foot and 2 feet, respectively, above the 100-year flood elevation.

M. Vessel collision is not required for design of the substructure. See Fender System elsewhere in these Minimum Technical Requirements.

N. Use concrete for the rest piers and pivot pier. The concrete shall meet the requirements in the Structures Scope of Work elsewhere in the RFP.

O. Design the swing span foundations in accordance with Design-Build Team recommendations that have been approved by the Geotechnical Engineering and Structures Management Units.

P. Provide access to the pivot and rest piers from the east side of the bridge, accessible from the sidewalk with locking/security features to prevent unauthorized access. Platforms, stairs, and ladders shall be fiberglass-reinforced plastic, configured to satisfy OSHA safety requirements, where applicable. Access to the machinery shall not require operation of the span. See also Access System and Fiberglass-Reinforced Plastic Elements elsewhere in these Minimum Technical Requirements.

Q. Develop details for bridge rail joints at the ends of the swing span that are compatible and consistent with the standard details for 42-inch Oregon Rail, as required by the Structures Scope of Work elsewhere in the RFP, to emulate the visual and safety characteristics of the railing and minimize the appearance of a discontinuity. The details shall be included in the plans and, at a minimum, they shall address joint width, post placement, and treatment at the exposed ends of the rails. Provide a minimum width joint in the rails capable of accommodating the range of thermal movement anticipated at both ends of the swing span. Locate bridge rail end supports as close as practical to the ends of the rails on both sides of each deck joint.

R. In the final condition under dead load (in the absence of wind), the swing span superstructure shall be balanced about longitudinal and transverse axes through the center pivot at all points of rotation. This final imbalance moment about the transverse or longitudinal axis shall not exceed the design assumptions stated in the design of the balance wheels. Counterweights, if applicable, shall be located below the bridge deck and shall include accessible pockets with removable steel weights for horizontal or longitudinal adjustment of the swing span center of gravity. Balance weights or blocks shall not weigh more than 75 lbs., shall be stackable, and shall be configured with integral lifting handles.

S. Where proposed in the design, all substructure elements requiring Mass Concrete shall be identified in the plans.

T. Where cofferdams are required, the seal shall be designed to remain watertight using the maximum differential water elevation in the fully dewatered condition. Design criteria,

including design water elevations and calculations for sheet piles and seals shall be included in the Preliminary and Final design submittals, as defined in these Minimum Technical Requirements.

SUBMITTAL REQUIREMENTS

1.0 GENERAL

All design and post-design (construction) submittals shall be made in accordance with the Project Special Provisions, Design-Build Submittal Guidelines, and these Minimum Technical Requirements. All design and post-design submittals shall be identified on the Critical Path Method (CPM) schedule.

2.0 DESIGN SUBMITTALS

Design submittals for all components of the swing span, including all items covered under these Minimum Technical Requirements, shall be submitted as described herein:

A. Preliminary Design Calculations

B. Preliminary Plans

C. Preliminary Special Provisions

D. Final Design Calculations

E. Final Plans

F. Final Special Provisions

G. RFC Plans

H. RFC Special Provisions

Note that Design Calculations are not required to accompany the RFC documents. All comments pertaining to the Design Calculations (Preliminary and Final) shall be resolved to the Department's satisfaction prior to submission of the RFC Plans and Special Provisions.

For each submittal milestone (Preliminary, Final and RFC), the total number of documents required and distribution shall be as follows:

Total Number Required: 2 Full-size, 8 Half-size, 6 sets SP's, 6 sets calculations

Resident Engineer: 2 Full-size, 1 set SP's, calculations

- Sent directly by Design-Build Team

Design-Build Unit: 1 set PDF, 2 Half-size, 1 set SP's, calculations

Structure Management Unit: 2 Half-size, 1 set SP's, calculations

State Bridge Construction Engineer:	1 Half-size, 1 set SP's, calculations
Area Bridge Construction Engineer: • Sent directly by Design-Build Team	1 Half-size, 1 set SP's, calculations
ITS Section (Electrical Plans only):	2 Half-size, 1 set SP's, calculations

2.1. Design Calculations

Design calculations shall demonstrate design compliance of all elements to the requirements of all applicable specifications including these Minimum Technical Requirements. Design Calculations shall be submitted prior to, or concurrently with, Plans of the same level. Preliminary Design Calculations shall be commensurate with the level of design development presented in the Preliminary Plans and Preliminary Special Provisions. Preliminary Structural Design Calculations shall include, at a minimum, all design loads necessary for preliminary machinery sizing and power requirements. Final Design Calculations shall be prepared, signed and sealed by a Professional Engineer registered in the State of North Carolina.

2.2. Plans

Preliminary, Final and RFC Plans shall conform to these Minimum Technical Requirements. RFC Plans shall be signed and sealed by a Professional Engineer registered in the State of North Carolina.

2.3. Special Provisions

Preliminary, Final and RFC Special Provisions shall conform to these Minimum Technical Requirements. RFC Special Provisions shall be signed and sealed by a Professional Engineer registered in the State of North Carolina.

3.0 POST-DESIGN SUBMITTALS

Post-design submittals shall generally conform to the document, prerequisite, and distribution requirements of the NCDOT Structure Management Unit *Submittal of Working Drawings* Project Special Provision. Requirements in this section generally describe the types of submittals anticipated for the various materials, components and systems of a movable bridge. Additional detailed post-design submittal requirements are included throughout other sections of these Minimum Technical Requirements.

Prior to submitting to the Department, each submittal shall be reviewed for compliance with the Contract requirements by the Design-Build Team as evidenced by signature and date of review and stamp or annotation to this effect on each page or sheet of the submittal.

3.1. Manufacturer's Certificates

A. When required, the Design-Build Team shall submit manufacturer' certificates for review. Certificates may be recent or previous test results on material or product, but shall be acceptable to the Engineer.

B. The Design-Build Team shall indicate that material or product conforms to or exceeds specified requirements and submit supporting reference data, affidavits, and certifications as appropriate.

3.2. Manufacturer's Instructions

A. When specified in the Contract Documents, the Design-Build Team shall submit manufacturer instructions for review.

B. The Design-Build Team shall identify conflicts between manufacturer instructions and the Contract Documents and submit resolution for review and approval.

3.3. Shop Drawings/Working Drawings

A. Shop drawings for components or elements of a system or assembly shall be grouped as a single submittal.

B. The Design-Build Team shall provide in the title block of all shop drawings the Project Number, the Bridge Name, and Bridge Number.

C. The Design-Build Team shall submit electronic drawings in PDF format and full size drawings for those items requiring construction from such drawings. The Design-Build Team shall provide descriptive leaflets for standard catalog items that are mass-produced. Minimum acceptable drawing size is 11 by 17 inches.

D. Before preparation of shop drawings for new components that must mate with the existing structure at the Remote Control Station, the Design-Build Team shall obtain all necessary field dimensions to provide proper fit of the new components.

E. The Design-Build Team shall clearly identify all dimensions shown on the shop drawings which were obtained by field measurements.

F. The Design-Build Team shall include manufacturer test data, certified by the manufacturer, and identify the application for which they are proposed.

G. The Design-Build Team shall mark standard drawings showing more than one model or size, to indicate the model or size proposed.

H. The Design-Build Team shall submit shop drawings of cabinets containing electrical equipment and include outside dimensions, areas for conduit penetrations, one-line and three-line diagrams, wiring diagrams, schematic and interconnection diagrams, terminal block arrangements and numbers (if such terminal blocks are intended for connection in the field) and operating instructions.

I. The Design-Build Team shall provide layout drawings and geographic diagrams for the complete electrical systems.

J. The Design-Build Team shall submit shop drawings when installation and mounting details of switches, fixtures, and devices are different from or not specifically detailed on the RFC Plans.

K. The Design-Build Team shall submit field/factory test procedures and reports for electrical and mechanical equipment for the Engineer's review and approval.

3.4. Samples

A. The Design-Build Team shall submit for inspection, where specified in the RFC Special Provisions and in these Minimum Technical Requirements, or if requested by the Engineer, at no cost to the Department, samples and support data of the proposed items and substitutions.

B. The Department will not be liable for any materials purchased or work done or any delay incurred prior to their review.

C. Failure of the Engineer to note unsatisfactory materials as received is not a relief from responsibility.

3.5. Product Data

Product data shall be clearly marked to identify applicable products, models, options, and other data. Supplement manufacturers' standard data with information unique to this project. Product data shall be referenced to the applicable Special Provision(s) clearly identified.

3.6. As-Built Plans

A complete set of As-Built Plans shall be submitted representing the As-Built project and identifying all modifications from the RFC Plans. As-Built Plans shall be produced and submitted in the same format as RFC Plans, documenting all modifications as revisions annotated on applicable Plan sheets. All As-Built Plan sheets shall contain a stamp indicating "As-Built" regardless if revisions were made to the Plan sheet.

WARRANTY

The Design-Build Team shall guarantee the complete mechanical and electrical installation and performance (including all associated items, devices, equipment and systems) to be free of defects in material and workmanship for a minimum period of five (5) years from the date of Final Acceptance. Final Acceptance shall be in accordance to the requirements of the 2012 NCDOT *Standard Specifications for Roads and Structures*. Any defect within this period shall be repaired or replaced by the Design-Build Team, including labor, parts, and transportation at no additional cost to the Department. The Design-Build Team shall provide letters to the suppliers with copies to the Department, identifying the scheduled date of Final Acceptance of the bridge and, therefore, the date the warranty period shall begin. If the date of final acceptance is extended or if beyond the normal warranty, it shall be the Design-Build Team's responsibility to extend the commencement of the warranties from the suppliers at no cost to the Department. The Design-Build Team shall assign to the Department, all manufacturer's warranties or

guarantees on all such equipment, material or products furnished for, or installed as, part of the work.

For all fiberglass-reinforced plastic components, the Design-Build Team shall provide a limited manufacturer's warranty against defects in material and workmanship for a period of at least five (5) years following Final Acceptance.

Architectural and building materials utilized in the construction of the Bridge Tender's House shall be warranted by the Design Build Team for a period of one (1) year against failure due to defects in materials and workmanship following Final Acceptance. All materials shall be provided with a manufacturer's warranty for a period of at least twenty (20) years against defects in materials following Final Acceptance, and said warranties shall be assigned to the Department. Standards of performance and conditions representing failure of all items, groups of items, and systems to be used shall be clearly and explicitly indicated The Design-Build Team shall be responsible for ensuring that means and methods of handling, storage, installation and protection do not violate the terms of, nullify, or otherwise compromise in any way, the manufacturer's warranty of any item, group of items or system, For each item, group of items, or system, the Design-Build Team shall assume responsibility for fulfilling the manufacturer's obligations for the manufacture-specified period if any action of the Design Build Team during construction and within the one-year warranty period following Final Acceptance noted in this paragraph relieves the manufacturer of obligations to repair or replace under the terms and conditions of the manufacturer's warranty for that item, group of items, or system.

CONCRETE STRUCTURES

Revise the 2012 NCDOT *Standard Specifications for Roads and Structures* as follows:

Page 4-25, Article 420-2 Materials, add the following to the list of materials:

Item	**Section**
Sand Lightweight Concrete	See Special Provision for Sand Lightweight Concrete
Mass Concrete	See Special Provision for Mass Concrete

STEEL STRUCTURES

The Design-Build Team shall prepare and submit to the Engineer for review and approval a detailed erection plan. This plan shall include all procedures and activities for the complete fabrication and erection of the swing span, and it shall be coordinated with the 2012 NCDOT *Standard Specifications for Roads and Structures* and the Machinery Installation Procedure elsewhere in these Minimum Technical Requirements. The purpose shall be to illustrate, in a comprehensive manner, the Design-Build Team's plan for establishing and maintaining critical dimensions to ensure that the structural steel and machinery systems will function properly and within tolerances upon erection and installation.

The plan shall include and clearly identify fabrication and erection tolerances for structural elements and/or assemblies that are more stringent than those permitted by ASTM A6, AWS D1.5, and the 2012 NCDOT *Standard Specifications for Roads and Structures* for compatibility with machinery systems and/or to satisfy requirements for structure alignment.

Revise the 2012 NCDOT *Standard Specifications for Roads and Structures* as follows:

Page 4-57, Article 440-8(C)(1) Bolt Tensions:

Tighten each fastener to provide at least the minimum bolt tension shown in Table 440-1. Tighten fasteners using the turn-of-nut method. See Special Provision for Turn-of-Nut Tightening.

DRAW BRIDGE ADVANCE WARNING SIGNS

1.0 DESCRIPTION

Provide permanent traffic control signs with supplemental warning beacons that read "DRAW BRIDGE AHEAD" in advance of the swing span signals and gates at each bridge approach, in accordance with the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD), the 2012 NCDOT *Standard Specifications for Roads and Structures*, and the requirements herein. The warning beacons shall be interconnected with the local and remote bridge control systems. The locations of these signs shall be clearly noted on the plans developed by the Design-Build Team.

2.0 MATERIALS

Each sign shall be diamond-shaped, 36 inches by 36 inches, with a flashing yellow warning beacon consisting of 12-inch signal head with visor. Signs shall be furnished, fabricated and erected in accordance with the MUTCD and NCDOT standard drawings and the 2012 NCDOT *Standard Specifications for Roads and Structures* for Type "E" signs.

3.0 CONSTRUCTION

Each sign and beacon assembly shall be mounted in the locations shown on the plans developed by the Design-Build Team. The Design-Build Team shall demonstrate interconnectivity with the bridge control systems prior to final acceptance of the swing span.

MAINTENANCE OF WATER TRAFFIC

The Design-Build Team shall 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 Design-Build Team 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

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.

** Note ** Deleted text regarding permit acquisition. Covered elsewhere in the RFP.

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, and / or facilities shall be provided and maintained by the Design-Build Team on temporary and permanent construction, and vessels until such facilities are no longer needed as determined by the Engineer and / or permitting agency.

The Design-Build Team shall immediately notify the appropriate authorities and take corrective measures as needed when any situation occurs that imposes a threat to the public. The Design-Build Team shall also immediately correct any acts or occurrences that contradict or violate any requirements in the (1) plans developed by the Design-Build Team and accepted by the Department, (2) RFP, and / or (3) permits when corrective measures can be performed in a safe manner. The Design-Build Team shall notify the appropriate authorities when such corrective measures cannot be performed in a safe manner.

The Department will not allow any contract time extension or additional compensation to comply with the above requirements.

VERTICAL CLEARANCE GAUGES

The Design-Build Team shall furnish and install clearance gauges in accordance 33 CFR 118 and as required by the USCG within thirty (30) days prior to acceptance of the bridge for local or remote operation.

NAVIGATIONAL CLEARANCE VERIFICATION AND WATERWAY INSPECTION

The Design-Build Team is responsible for the following:

Upon removal of all temporary work bridges, inspect the waterway bottom to ensure that all construction waste materials have been completely removed. Remove any bridge-related debris discovered during this survey. Provide a certification to the Engineer, in writing, by a licensed engineer or licensed surveyor in the State of North Carolina that the waterway has not been impaired and all construction related debris has been cleared from it. The certification shall include the actual method used to conduct the inspection.

Upon completion of the proposed bridge, verify as-built clearances for the navigational channel and provide a certification to the Engineer, in writing, by a licensed surveyor or registered professional engineer in the State of North Carolina attesting to the correctness of the clearances.

FENDER SYSTEM

1.0 DESCRIPTION

Design, detail, furnish and install a structural plastic fender system, including fiberglass-reinforced plastic lumber, fiberglass-reinforced plastic piles, and all miscellaneous hardware required to execute the work, in accordance with these Minimum Technical Requirements, RFC Plans, and RFC Special Provisions.

2.0 DESIGN REQUIREMENTS

Design and detail a fender system to protect all piers adjacent to navigation channels and the swing span to resist a 25-kip vessel collision force at 6 feet above mean high water surface elevation. The bottom of the lowest rail shall not be higher than 1 foot above mean low water surface elevation. The top of the uppermost rail shall not be lower than 8 feet above mean high water. The fender system shall be configured and sufficiently offset from the bridge to prevent vessel and fender system contact with the bridge throughout the tidal range when the span is in the open or closed position. The substructure and foundations shall not participate in absorbing the impact energy. Include the effects of scour (no reduction) combined with vessel collision in the design of the fender system.

All hardware shall be recessed.

Equip all fenders with walkways and handrails as part of the Access System that do not project beyond the face of the fender into the navigation channel for access to lights and other aids to navigation. At the pivot pier fender, the fender and walkway shall provide clear passage for a person walking upright around the perimeter of the swing span in the open position.

3.0 MATERIALS

The Department prefers that the Design-Build Team use low-, medium- or high-density polyethylene (or a combination thereof) made from post-consumer or post-industrial thermoplastics for elements of the fender system (piles, wales, spacer blocks), but other materials may be used. Mix the polyethylene with appropriate colorants, UV inhibitors, hindered amine light stabilizers, antioxidants, and chopped fiberglass reinforcement (15% minimum by weight) so that the resulting product at least meets the requirements specified in Table 1. Structural plastic products must not corrode, rot, warp, splinter or crack. The outer skin must be smooth and gray in color.

Use Type 316 fastening hardware and wire ropes, as required by the design.

Table 1 Material Properties for Plastic Structural Shapes		
Property	Test Method	Requirement
Density	ASTM D792	50-65 pcf
Water Absorption	ASTM D570	2 hrs: < 1.0% weight increase 24 hrs: < 3.0% weight increase
Brittleness	ASTM D746	No break at minus 40°F
Impact Resistance	ASTM D256 Method A (Izod)	> 4 ft·lbs/inch
Hardness	ASTM D2240	44-75 (Shore D)
Ultraviolet	ASTM D4329 (UVA)	500 hours < 10% change in Shore D Durometer Hardness
Chemical Resistance	ASTM D543	Sea water: < 1.5% weight increase Gasoline: < 7.5% weight increase No. 2 Diesel: < 6.0% weight increase
Tensile Properties	ASTM D638	Minimum 3,000 psi at break
Compressive Modulus	ASTM D695	Minimum 40 ksi
Static Friction Coefficient	ASTM D1894	0.25 wet maximum
Nail or Screw Withdrawal	ASTM D6117	Nail: 250 lbs minimum Screw: 400 lbs minimum

4.0 SUBMITTAL REQUIREMENTS

Requirements in this section shall be considered supplemental to those found elsewhere in these Minimum Technical Requirements.

4.1. Design

The Design-Build Team shall submit complete Design Calculations, Plans and Special Provisions for review and approval. Design Calculations, at a minimum, shall include deflection calculations and minimum fender pile tip elevations. The Plans shall include a sufficient level of detail to fabricate and construct the fender system. The Special Provisions shall include detailed

material requirements, including properties, associated ASTM test methods and acceptance values; full scale testing and submittal requirements; fabrication requirements; storage and handling requirements; and construction requirements. The material and testing requirements shall be acceptable to the Engineer.

4.2. Post-Design

The Design-Build Team shall submit shop drawings, test results, certifications, and other information as necessary to demonstrate the fender system meets the requirements of the approved RFC Plans and Special Provisions and these Minimum Technical Requirements.

5.0 CONSTRUCTION REQUIREMENTS

The Design-Build Team shall coordinate construction of the fender system with the United States Coast Guard. The Design-Build Team shall install the fender system in accordance with the approved RFC Plans and Special Provisions.

ACCESS SYSTEM

1.0 DESCRIPTION

The Design-Build Team shall design, furnish, fabricate and install an Access System to routinely accessed areas of the structure to provide for an accessible and maintainable bridge.

2.0 DEFINITIONS

Access System refers to the system of walkways, ladders, platforms, handrails, stairs and any other component, the primary purpose of which is to access and/or safety for operations and maintenance personal during routine inspection and maintenance activities.

3.0 DESIGN REQUIREMENTS

The Design-Build Team shall design and detail a complete, OSHA-compliant system that will provide safe, reliable access to routinely-accessed areas of the bridge not readily accessible by other means, including but not limited to, the following:

A. Machinery and Electrical systems at the pivot pier
B. Machinery and Electrical systems at the rest piers
C. Aids to navigation that are both on the fenders and on the swing span
D. Traffic, pedestrian and barrier gates
E. Other locations as deemed appropriate by the Design-Build Team and as noted in these Minimum Technical Requirements

Stairs are preferred over ladders for vertical access. Ladders are permissible where, in the opinion of the Engineer, stairs cannot reasonably provide the access without complicating the design.

4.0 MATERIALS

Walkway grating, stairs, platforms, ladders, handrails, and all appurtenances shall be fiberglass-reinforced plastic components. The design, manufacture, fabrication, and installation shall be in accordance with approved RFC Special Provisions and requirements for FRP Elements elsewhere in these Minimum Technical Requirements.

Structural steel incorporated into the walkway system shall conform to the 2012 NCDOT *Standard Specification for Roads and Structures.*

Adhesive anchors used for attached to concrete elements shall conform to the 2012 NCDOT *Standard Specifications for Roads and Structures,* Project Special Provision for Adhesively Anchored Anchor Bolts or Dowels, and these Minimum Technical Requirements. The Design-Build Team shall provide anchor bolts suitable for horizontal installation. Upward installations (inclined and vertically) are not permitted.

5.0 CONSTRUCTION REQUIREMENTS

The Design-Build Team shall fabricate and install Access System components in accordance with Fiberglass-Reinforced Plastic Elements in these Minimum Technical Requirements.

FIBERGLASS-REINFORCED PLASTIC ELEMENTS

1.0 DESCRIPTION

The Design-Build Team shall develop Plans and Special Provisions governing the design, fabrication and installations of all fiberglass-reinforced plastic (FRP) items with all appurtenances, accessories, and incidentals necessary to produce a complete, operable, and serviceable installation in accordance with the design and these Minimum Technical Requirements.

2.0 SUBMITTAL REQUIREMENTS

Requirements in this section shall be considered supplemental to those found elsewhere in these Minimum Technical Requirements.

The Design-Build Team shall submit design calculations sealed by a Professional Engineer registered in the State of North Carolina for all FRP items and systems.

The Design-Build Team shall submit shop drawings of all fabricated FRP items and accessories clearly showing material sizes, styles, part or catalog numbers, complete details for the

fabrication and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes and connection details.

The Design-Build Team shall submit manufacturer's published literature including structural design data, structural properties, load/deflection tables, corrosion resistance data, certificates of compliance, test reports, and concrete anchor systems.

The Design-Build Team shall submit sample pieces representing method of manufacture, quality and color of each FRP item to the Engineer for review and approval.

3.0 QUALITY ASSURANCE

All FRP items shall be furnished by manufacturers having at least 10 years' experience in the design and manufacture of similar products and systems.

The Design-Build Team shall provide proof of ISO 9001:2015 certification, along with two additional industry-recognized quality assurance programs for the manufacturer's facilities and/or products.

The Design-Build Team shall demonstrate that heavy metals content of the FRP materials complies with current EPA requirements.

4.0 MATERIALS

4.1. General

The proposed materials, manufacturing methods, and quality and workmanship of the finished products shall generally meet or exceed commonly accepted industry standards with regard to material composition, strength and stiffness properties, corrosion and chemical resistance, fire rating, UV resistance, durability, longevity, and dimensional tolerances for this application. In addition, the item-specific criteria in the following sections shall be satisfied.

The outer surface of all FRP elements shall be smooth and uniformly gray in color. All material furnished under these requirements shall, in the opinion of the Engineer, closely match each other and the materials provided for the Fender System.

4.2. Grating and Stair Treads

Walkway grating shall be single-piece construction with the tops and bottoms of bearing bars and cross bars in the same plane, reinforced with continuous rovings of equal number layers in each direction, exhibiting a square mesh patter and bi-direction strength.

The manufacturing process shall result in a slip-resistant surface.

Grating design loads shall be less than the manufacturer's published recommended maximum loads. Grating shall be designed for a uniform load of 100 psf, and a concentrated load of 300 lbs. Deflection shall not exceed the lesser of 3/8 inch and L/120.

4.3. Stair Treads

Stair Treads shall be of a one-piece molded construction, exhibiting a rectangular pattern and unidirectional strength in the tread span direction, reinforced with continuous rovings in each direction.

The manufacturing process shall result in a slip-resistant surface.

Stair Treads shall meet the manufacturer's published recommended loading and deflection requirements.

4.4. Pultruded Structural Shapes and Handrails

The Design-Build Team shall manufacture all structural shapes, posts, and handrails by the pultrusion process with a glass content (by weight) between 45 percent and 55 percent. The Design-Build Team shall provide structural shapes, posts and handrails that are composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements.

The complete handrail shall be capable of resisting a uniform load of 50 plf or a concentrated load of 200 lbs, applied at the top rail in any direction, with a factor of safety of 2.0.

4.5. Pultruded Ladders

The Design-Build Team shall manufacture all ladder side rails, rungs and mounting brackets by the pultrusion process. The Design-Build Team shall provide all shapes that are composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements.

Side rails shall be tubes. Rungs shall be circular. The manufacturing process of the rungs shall result in a slip-resistant surface. Surface-applied texture is not allowed.

Ladders shall be fully shop-assembled. Rungs shall penetrate the wall of, and be both mechanically and chemically bonded to, the tube side rails.

4.6. Hardware

The Design-Build Team shall provide Type 316 stainless steel fasteners and 18-8 stainless steel rivets.

5.0 CONSTRUCTION REQUIREMENTS

The Design-Build Team shall install all FRP components in accordance with the manufacturer's instructions, including cutting, drilling, and using resin products.

BIRD DETERRENT SYSTEM

1.0 DESCRIPTION

The Design-Build Team shall identify critical areas of the bridge vulnerable to the degrading effects of roosting and perching and clearly denote these on the plans. The Design-Build Team shall detail, furnish and install a bird deterrent system consisting of screens, spikes, or a combination thereof. Bird deterrent system components shall not inhibit access to items or areas requiring routine maintenance. See Bridge Electrical System – Navigation Aids elsewhere in these Minimum Technical Requirements for bird deterrent requirements on navigation lights.

2.0 MATERIALS

Screen system shall consist of Type 316 stainless steel expanded metal screen, framing, stitching and hardware.

Spikes shall be stainless steel with pointed tips. Use products manufactured by Bird-B-Gone, Bird -X, Nixalite, or approved equal. Secure to the structure using corrosion-resistant, UV-resistant materials per the manufacturer's recommendation.

For anchoring to concrete, the Design-Build Team shall use Type 316 stainless steel anchor bolts, adhesively anchored in accordance with 2012 NCDOT *Standard Specifications for Roads and Structures* Section 420 and Project Special Provisions.

3.0 SUBMITTAL REQUIREMENTS

Requirements in this section shall be considered supplemental to those found elsewhere in these Minimum Technical Requirements.

3.1. Design

The Design-Build Team shall submit Plans that include limits of application and attachment details in the Plans. The Design-Build Team shall submit Special Provisions hat shall include material and construction specifications in the Special Provisions. Limits, materials, and methods of attachment are subject to approval by the Engineer.

3.2. Post-design

The Design-Build Team shall submit material samples for review and approval, including all associated hardware and proposed method(s) of attachment/installation.

4.0 CONSTRUCTION REQUIREMENTS

Metal screen: weld stainless steel in accordance with AWS D1.6. Grind smooth any burrs, nicks, projections or rough portions prior to installation. Welding to the bridge is not permitted. The finished metal screen shall not have any openings larger than two inches in any direction.

Bird spikes: attached in accordance with the manufacturer's recommendation.

Damage to the structural steel paint system on the bridge shall be repaired in accordance with Section 442 of the 2012 NCDOT *Standard Specifications for Roads and Structures* and as required to maintain the manufacturer's warranty on the paint system.

OPERATION OF BRIDGES

1.0 GENERAL

The Design-Build Team shall assume responsibility for operating and maintaining the existing bridge and the proposed bridge from the time the normal operating procedure is affected by construction activities until the new control system is in place, complete and fully operable in its final condition from the proposed Bridge Tender's House at the bridge site ("local") and from the existing Bridge Tender's House at Pasquotank County Bridge No. 19 over the Pasquotank River in Elizabeth City ("remote").

Factors considered as affecting the normal operating procedure include work on the bridge machinery, work on the bridge electrical control system, work that affects the traffic gates, work that affects the navigational waterway other than temporary, short-term operations, and work that otherwise affects the operator's view of the roadway, sidewalk, or navigation channel.

During this period of Design-Build Team-supervised operation, provide at least one operator at the existing bridge in accordance with United States Coast Guard (USCG) regulations for this specific bridge location. Training will be provided by the Department for no more than 20 weeks at the beginning of the period of Design-Build Team-supervised operation on a schedule approved by the Engineer, the costs of which shall be considered incidental to satisfying this requirement. Subsequent training of successive bridge operators shall be the responsibility of the Design-Build Team. The Design-Build Team shall ensure that all bridge operators are trained in the performance of their duties and certified by the Bridge Maintenance Supervisor.

Requirements for certification of a bridge operator are as follows:

A. Read the complete Perquimans River Drawbridge Operator's Manual.

B. Demonstrate ability to operate the bridge and express knowledge of the operation (under normal and emergency conditions) to the Bridge Maintenance Supervisor

C. Complete four (4) hours of instruction by Bridge Maintenance Electricians

D. Complete eighty (80) hours of instruction by other operators or the Supervisor, to include a minimum of 10 openings per shift

E. Complete check-off on normal and emergency procedures

F. Complete sixteen (16) hours of General Safety Training as listed in the *Perquimans River Drawbridge Operator's Manual*. The Department will provide initial training. Additional training shall be provided by the Design-Build Team

The Design-Build Team shall provide adjustment or corrections required during the period of Design-Build Team-supervised operation at no additional cost.

The bridge operator requirements shall apply when at least one of the two bridges (existing or proposed) is in place and operational, whether the road is or is not open to traffic. If the existing swing span is removed prior to installation of the proposed swing span, the bridge operator requirements may be suspended until the proposed span is installed. Upon installation of the proposed swing span, the bridge operator requirements may be reinstated at the sole discretion of the Engineer, the determination of which will be based in part on the feasibility of operating the span and adherence to Maintenance of Waterway Traffic elsewhere in these Minimum Technical Requirements.

2.0 SUPERVISED BRIDGE OPERATION

In addition to the training provisions elsewhere in these Minimum Technical Requirements, The Design-Build Team shall provide a minimum of two certified bridge operators to supervise the operation of the bridge by Department personnel for two periods of fourteen (14) consecutive calendar days (up to 16 hours per day, but not less than the normal operating hours of the bridge) after the Department has taken over operation of the swing span. The initial fourteen-day period of supervised operation required under this paragraph shall include operating the bridge from the Bridge Tender's House. The subsequent fourteen-day period shall include operating the bridge from the Remote Control Station, during which at least one Design-Build Team bridge operator shall be located each of the Bridge Operator's House and the Remote Control Station with a reliable means of communication between the two locations. The Design-Build Team shall maintain water navigation in accordance with Maintenance of Water Traffic elsewhere in these Minimum Technical Requirements.

Personnel provided by the Design-Build Team under this requirement shall be capable of operating the bridge, supervising its operation, and making any adjustments or corrections that may be required in the mechanical and electrical equipment of the bridges. They shall also be able to further instruct and qualify Department employees in the operation of the bridge. The Design-Build Team shall provide any adjustments or corrections required during the two 14-day periods at no additional cost to the Department.

3.0 EQUIPMENT FAILURES

In the event of a failure during Design-Build Team-supervised operation required under these Minimum Technical Requirements, the Design-Build Team immediately notify the Department verbally. The Design-Build Team shall submit the written documentation to the Engineer within 5 days. Documentation shall include the following:

A. Time and date of the failure

B. Name(s) of the Design-Build Team on-site supervisor and bridge operator

C. Detailed description of the failure

D. Preliminary assessment of the cause of the failure

E. Proposed action to resolve the failure, including time and materials required

If repair is not possible within a time acceptable to the Department, temporary resolution measures shall be submitted to the Engineer for review and approval.

MANUFACTURER REFERENCES

Product references by manufacturer, trade name, or catalog number shall be considered as having established the quality standards of material and equipment required for the subject installation. It shall not exclude products of similar design and equal quality, the determination of which is at the sole discretion of the Engineer.

SUBSTITUTIONS

Machinery and equipment proposed for use in accordance with the Contract Documents shall be manufactured by a company that has a minimum of 10 years of experience in manufacturing such equipment and has demonstrated proficiency in the manufacture of such equipment. Substitutions for equipment named in the RFC Documents are permitted, provided the design and quality standards established by the named equipment are satisfied by the proposed substitutions. All substitutions shall be subject to the approval of the Department.

COORDINATION

The Design-Build Team shall coordinate all work required to fully execute the work with all concerned parties. Coordination activities shall include, but are not necessarily limited to, the following:

A. Coordinate installation and testing of the bridge drive and control systems.

B. Coordinate progress schedules, including dates for submittals and delivery of equipment.

C. Conduct meetings among subcontractors and other concerned parties to establish and maintain coordination and schedules.

D. Resolve coordination matters in dispute.

E. Participate in progress meetings to report on progress, coordination issues affecting progress, and schedule changes. Prepare meeting minutes and transmit to all attendees and concerned parties.

F. Coordinate documents, including the following:

   a. Prepare coordination drawings to organize installation of projects for efficient use of available space, sequence of installation, and potential conflict identification.

b. Prepare and maintain a master schedule identifying responsibilities under each section of the Project Special Provisions prepared by the Design-Build Team that relate to the work, including submittals, equipment delivery and installation, testing, and utilities.

c. Maintain "red-line" As Constructed Drawings for the duration of the contract documenting all modifications to the RFC Plans.

G. Coordinate submittals and related work, including the following:

a. Review shop drawings, product data, and samples for compliance with the Contract Documents.

b. Check field dimensions, clearances, and relationships to available space and anchor locations.

c. Check compatibility with equipment and work of other specialties, electrical characteristics and operational control requirements.

d. Coordinate controls, interlocks, wiring of pneumatic switches, and relays.

e. Coordinate wiring and control diagrams.

f. Review the effects of any changes of work on the work of other specialties.

g. Verify information and coordinate with maintenance of record documents.

h. Identify variations from the Contract Documents and product or system limitations that which may be detrimental to successful performance of the completed work.

H. Coordinate substitutions and modifications.

a. Review proposals and requests from subcontractors.

b. Verify compliance with the Contract Documents and for compatibility with the work and products of other specialties.

c. Submit proposed substitutions to the Department with recommendations for action.

DOCUMENTATION OF TESTS

The Design-Build Team shall conduct and maintain records of machinery and equipment testing. Test records shall include at least the following:

A. Item, group of items, or system tested

B. Name of testing agency and name of inspector

C. Name of manufacturer's representative present during testing

D. Date, time and duration of test

E. Type of test, acceptance criteria, and results

F. Indication of whether retesting was required and results.

In addition, the Design-Build Team shall be responsible for assembling background documentation for dispute and claim settlement. Documentation shall be submitted to the Engineer upon request.

EQUIPMENT START-UP

The Design-Build Team shall provide the Department written notice at least fourteen (14) days prior to equipment start-up.

The Design-Build Team shall be responsible for the following activities:

A. Verify that utilities, connections, and controls are complete and equipment is in operable condition.

B. Provide the services of a factory authorized start-up representative at the time of energizing and for the Functional Checkout as required in these Minimum Technical Requirements.

C. Conduct start-up and adjustment of the electrical control system. Record date and time of start-up and results.

D. Record times and additional information required for operation and maintenance manuals.

MOVABLE BRIDGE FUNCTIONAL CHECKOUT

1.0 GENERAL

The Design-Build Team shall develop testing procedures, conduct comprehensive Functional Checkout Inspections in the presence of the Department, and submit Functional Checkout Reports for review and approval. Two distinct Functional Checkout Inspections shall be performed with distinct Functional Checkout Reports submitted.

- Locally Operated Functional Checkout Inspection
- Remotely Operated Functional Checkout Inspection

Remotely Operated Function Checkout may not commence until the bridge has been accepted for local operation.

When the bridge is ready for Functional Checkout Inspections, notify the Department no less than fourteen (14) days before scheduling.

Prior to the start of Functional Checkout Inspections, all machinery shall be final bolted and final aligned as documented in the submitted and approved Machinery Alignment Report, and all

aspects of the movable span and control system shall have previously been tested by the Design-Build Team to confirm compliance with the Contract and RFC Documents.

If testing shows that components are defective, inadequate, functioning improperly or incorrectly adjusted, make all corrections, adjustments, repairs or replacements necessary at no additional cost to the Department. The affected systems shall be retested.

After satisfactory completion of Functional Checkout Inspections as determined by the Department, a 14-day Operational Testing Period will begin.

2.0 TESTING PROCEDURES

The Design-Build Team shall submit a detailed testing procedure to the Department for each Functional Checkout Inspection and receive approval prior to scheduling Functional Checkout Inspections. The testing procedure shall systematically demonstrate that the movable span is fully functional in all respects. The testing procedures shall clearly indicate acceptance criteria consistent with these Minimum Technical Requirements, the RFC documents, and the final design calculations.

Present specific, step by step procedures to demonstrate and provide data for evaluation of each function of the movable bridge. Include for each test quantitative measurements (i.e., amperes, pressure, torque, etc.), their method of measurement, and their method of recording. Machinery loading shall be quantified.

The testing procedure shall include a checklist with clear acceptance criteria that demonstrates the proper operation of all aspects of the movable span, and shall include, but not be limited to the following:

A. Bridge Sequence:
    a. Demonstrate the correct operation of the bridge as described in these Minimum Technical Requirements and in the RFC documents.

B. Emergency Stops:
    a. Demonstrate Emergency Stop of the movable span at or during each phase of opening and closing the bridge (phases include ramping up or down, full speed, and creep speed

C. Traffic Gates, Sidewalk Gates, and Barrier Gates:
    a. Demonstrate proper operation of each gate arm, including the barrier gate locking mechanism.
    b. Demonstrate opening and closing times. Time shall not exceed 15 seconds in either direction.
    c. Demonstrate door switch safety interlocks and manual operations using hand crank.

D. Interlocks:

   a. Simulate the operation of each limit switch to demonstrate correct operation and interlocking of systems.

   b. Demonstrate bypass operation for each failure for each required bypass.

   c. Simulate each failure for which there is an alarm message to demonstrate correct message displays.

   d. Provide comprehensive testing of interlocks to demonstrate that unsafe or out of sequence operations are prevented.

E. Navigation Lights:

   a. Demonstrate all navigation lights are functioning and that the correct colors are illuminated at all positions of span opening.

F. PLC:

   a. Demonstrate all functionality of the PLC for local and remote operations, including proper operation after a power failure, in accordance with these Minimum Technical Requirements.

G. Power Source:

   a. Demonstrate the incoming power source provides voltage within 2% of rated voltage while supplying load and for proper phase rotation.

   b. Demonstrate the generator is supplying acceptable power quality while under operation. Verify proper voltage and phase rotation.

   c. Demonstrate acceptable transfer of power during normal power failure and returning to normal power when normal electrical service is restored.

H. Machinery Systems:

   a. Demonstrate proper alignment and smooth operation of all machinery systems under electrical power.

   b. Demonstrate operation of all machinery systems under manual power.

   c. Provide quantifiable loading for driven mechanism.

   d. Confirm all rubbing surfaces are lubricated and all lubrication fittings are installed.

I. Deck Joints:

   a. Demonstrate compliance with the Design Criteria stated in these Minimum Technical Requirements

J. Span Imbalance:

   a. Demonstrate compliance with the Design Criteria stated in these Minimum Technical Requirements

3.0 LOCALLY OPERATED FUNCTIONAL CHECKOUT

The Locally Operated Functional Checkout Inspection and subsequent Report shall demonstrate to the Department that all aspects of the movable span are final aligned, final bolted, and fully functional when operated from the local Bridge Tender's House. This inspection shall follow the approved testing procedure and as directed by the Engineer to demonstrate compliance with the Contract.

In addition to demonstrating all operational features of the movable span when controlled from the Bridge Tender's House, all machinery shall be demonstrated to be operated via manual methods.

The Design-Build Team shall prepare and submit a Locally Operated Functional Checkout Report, which shall include results from all field tests on all aspects of the swing span including but not necessarily be limited to:

A. All completed test forms from the approved Functional Checkout Test Procedure indicating all items met their acceptance criteria
B. Generator field test results
C. Machinery Alignment Report

The swing span will be considered functionally accepted or functionally complete with local operation only after the Locally Operated Functional Checkout Report has been approved by the Department and the locally operated Operational Testing period has been completed.

4.0 REMOTELY OPERATED FUNCTIONAL CHECKOUT

The Remotely Operated Functional Checkout Inspection and subsequent Report shall demonstrate to the Department that all aspects of the movable span function properly when operated from the Remote Control Station.

The testing procedure shall be similar to that used for local operation and comprehensively demonstrate all control and operational features of the bridge. Additionally, proper function of all surveillance equipment shall be demonstrated and included in the testing procedure checklists. This inspection shall not be conducted until an approved testing procedure is received.

The Design-Build Team shall prepare and submit a Remotely Operated Functional Checkout Report, which shall include results from all tests related to the remote operation of the swing span:

A. All completed test forms from the approved Functional Checkout Test Procedure indicating all items met their acceptance criteria.

The swing span will be considered functionally accepted or functionally complete with remote operation only after the Remotely Operated Functional Checkout Report has been approved by

the Department, the remotely operated Operational Testing Period has been completed, and operations and maintenance training has taken place.

5.0 OPERATIONAL TESTING PERIOD

Upon successful completion of each Functional Checkout Inspection, an operational testing period of not less than fourteen (14) days shall be conducted. During this operational testing period, all aspects of the swing span shall be tested and observed by the Engineer. The swing span shall be operated a minimum of five (5) times daily at different times of day, including early morning, mid-day, mid-afternoon, and nighttime. Should anything during these operational tests show that any aspect of the swing span, in the judgment of the Engineer, is defective or functions improperly, such adjustments and/or replacements shall be made by the Design-Build Team as to make the installation completely acceptable to the Engineer, and at no extra cost to the Department.

TRAINING

The Design-Build Team shall provide classroom and on-site training for Department operations and maintenance personnel, in addition to any factory training which is required throughout other sections of these Minimum Technical Requirements.

For maintenance training, the Design-Build Team shall:

A. Provide a minimum of 24 hours of classroom and on-site training for three (3) persons. Distribution of time may be divided as required but with a minimum of eight (8) hours on-site.

B. Coordinate the location and time of the training with the Department.

C. Include the following topics:

   a. Lubrication.

   b. Preventive maintenance for all machinery including drive system, locking devices and barriers.

   c. Electrical equipment.

   d. Adjusting of control system parameters.

   e. Emergency generator operation.

   f. Local and remote control system troubleshooting.

D. Perform maintenance training within the Operational Testing period following the Remotely Operated Functional Checkout.

For operations training, the Design-Build Team shall:

A. Provide a minimum of 8 hours on-site training for three (3) persons.

B. Include the following in training:

C. Operation of bridge under all conditions

D. Interlock functions

E. Bypass functions.

F. Emergency stops

G. Manual operation of all machinery and traffic devices

H. Emergency generator operation

I. Interpretation of trouble alarms

J. Perform operations training for local and remote functions prior to completion of the Operational Testing period following Locally and Remotely Operated Functional Checkout, respectively

OPERATION AND MAINTENANCE MANUALS

The Design-Build Team shall prepare and submit manuals containing complete descriptive literature, catalog cuts, reduced size shop drawings and other information that completely detail operation and maintenance instructions for the electrical and mechanical systems of the swing span.

Operation and maintenance ("O&M") information shall be compiled in booklets. Each booklet shall utilize a 9 by 12-inch rigid heavy duty, three hole, plastic binder with metal rings and hinges. Clearly print all materials so that the submittals, drawings, catalog cuts and all other information is legible, accurate and distinct. Reduced size drawings and illustrations must be legible so that dimensions and lettering are readable. Fold all large format pages to the page size necessary for inclusion in the manuals. Drawings included in the booklets shall be black on white background. Print the material on durable media. Use water resistant inks and printing methods that offer permanence and durability.

The booklets shall be neatly and clearly labeled with a descriptive title, including the name of the project, location, year of installation, Department, Design-Build Team, including the Engineer-of-Record.

Each booklet shall contain a Table of Contents and have tabbed dividers for each section. All information included in the manuals shall represent the As-Built condition. Wherever information not applicable to an installed component is on a sheet, the information which is not applicable shall be clearly marked-out.

The information shall generally be grouped such that each booklet contains the following contents. The organization of the information may vary from the following, subject to the approval of the Department, provided all information listed below is included.

Booklet One

A. Operator's Instructions, covering in full the step-by-step sequence of operation of the bridge and its auxiliaries, and noting all precautions required for correct operation. Include complete instructions for the following:
    a. Selection of the power supply (commercial or stand-by)
    b. Normal operation of the electric motors on commercial power source.
    c. Auxiliary operation of the drive motor(s) and all machinery system motors energized by the stand-by generator. Include in this description the method of transfer to stand-by operation, the arrangement of the machinery, and the necessary controls.
    d. Manual Operation of the swing span. In addition to the instruction for operation, include in this description, the location of all equipment necessary for manual operation of each machinery system.
B. Detailed maintenance instructions for adjusting, calibrating and operating all of the electrical and instrumentation equipment, including the manufacturer's recommended preventative maintenance lubrication schedule.
C. Recommended procedures and frequency for cursory and detailed inspections of the electrical equipment.
D. A set of descriptive leaflets, bulletins, and drawings covering all items of equipment and apparatus made a part of the completed bridge operation and control, the service lighting system, the heating system, the instrumentation system, the lightning protection system, and the grounding system.
E. The catalog number of each piece and, where applicable, a complete parts list, to be used in case it becomes necessary to order replacement parts from the manufacturer. Local manufacturer’s contact information for service shall also be provided. The Design-Build Team shall furnish this information for all equipment such as motors, switches, circuit breakers, relays, controllers, cables, etc.
F. Copies of all warranties on equipment supplied to the project.

Booklet Two

A. Complete electrical spare parts list.
B. All schematic wiring diagrams.
C. Control console and control panel layouts and wiring diagrams for all equipment.
D. Schedule of electrical apparatus.
E. Complete speed-torque-current curves for main drive motors
F. All conduit layout and installation drawings.
G. All approved as-built electrical drawings.

Booklet Three

A. A system layout showing all machinery components.

B. A detailed description of the function of each principal component.

C. A summary description of the control system and procedure for operating the bridge using the main drive motors, auxiliary drive motors if provided, and manual means.

D. Reduced size copies (11" x 17") of machinery shop drawings and lubrication charts.

E. Certified parts drawings and descriptions of proprietary machinery units.

F. Manufacturer's standard literature and instructions for installation, operation, lubrication, adjustment, and maintenance for each component and assembly.

G. A list of the names, addresses and telephone numbers of all subcontractors and manufacturers furnishing and installing the equipment and systems together with a record of the local representatives for the equipment and systems installed.

H. Recommended procedures and frequency for cursory and detailed inspections of the mechanical equipment.

I. Information on trouble-shooting problems that may be encountered during operation for each of the major pieces of equipment. Include things to look for, signs of irregular operation and suggested solutions.

The Design-Build Team shall submit a draft of each O&M manual at least sixty (60) days prior to Local Operation Functional Checkout. The Department will review the draft submittal and provide comments to the Design-Build Team within thirty (30) days of the draft submittal date. The Design-Build Team shall submit revised versions of O&M manual at least fourteen (14) days prior to Locally Operated Functional Checkout. The Design-Build Team shall provide an electronic copy of each approved O&M booklet in PDF format at the same time the approved O&M manuals are provided.

BRIDGE TENDER'S HOUSE AND REMOTE CONTROL STATION

1.0 DESCRIPTION

The Design-Build Team shall design and construct the Bridge Tender's House at Perquimans County Bridge No. 8 to accommodate local operation of the swing span. The Design-Build Team shall design and implement modifications to the Bridge Tender's House at Pasquotank County Bridge No. 19 to provide for remote operation capabilities of the swing span at Perquimans County Bridge No. 8.

2.0 DEFINITIONS

Bridge Tender's House refers to the building that houses the bridge operator and all the controls for on-site, or local, operation of the swing span.

Remote Control Station refers to the space within the Bridge Tender's House at Pasquotank County Bridge No. 19 dedicated to remote operation of the swing span.

Remote Operating System refers to the compilation of electrical devices and equipment, software, hardware, data transmission, programming, cameras, monitors, communication devices, and other features necessary to provide for a complete, fully functioning control monitoring system for the swing span, located within the existing bridge tender's house at Pasquotank County Bridge No. 19.

3.0 DESIGN REQUIREMENTS

3.1. Bridge Tender's House

The Design-Build Team shall design the Bridge Tender's House in accordance with current editions of the North Carolina State Building Code, North Carolina Energy Conservation Code, and NFPA 101 Life Safety Code. The Bridge Tender's House for the proposed bridge shall be a single-story structure located adjacent to the bridge in the southeast quadrant, behind the rest pier on the Hertford side of the navigation channel (similar location as the existing Bridge Tender's House relative to the swing span). The proposed Bridge Tender's House shall be permanently supported on a foundation independent of the bridge structure, located such that the point of entry/egress faces, and is easily accessible from, the sidewalk on the east side of the bridge.

The Design-Build Team shall design the interior of the Bridge Tender's House for minimum usable floor space of 300 square feet, including restroom facilities, a kitchenette, a supply/storage closet, a desk, and the bridge control console. Additional square footage shall be provided for all equipment (with required operating clearances) comprising the various systems, including bridge operation and controls, lighting, heating and air conditioning, communications, and security. The Design-Build Team shall ensure the layout provides unobstructed views of the roadway, sidewalk, and navigation channel from the operator position at the control console. The Design-Build Team shall provide a continuous walkway around the exterior of the bridge tender's house at the same level as the sidewalk.

The Design-Build Team shall use reinforced concrete for the walls and floor. The Design-Build Team shall provide a sloped roof with a durable roofing material. Asphalt shingles are not permitted. The Design-Build Team shall provide architectural materials, finishes and treatments as required by Section 106 commitments to be provided by the Department.

Materials and systems selected for the building envelope (e.g., windows and doors) and interior (e.g., flooring and insulation) shall be carefully selected to provide a safe, comfortable environment for the bridge operator; maximize energy efficiency and minimize maintenance. All exterior walls, surfaces, windows, and doors shall be bullet-resistant, capable of meeting the standards of UL 752, Level 2.

At a minimum, the Design-Build Team shall provide plumbing (including fixtures and accessories), sewer, potable water, HVAC, double-hung marine-glazed impact-resistant

aluminum windows, a bullet-resistant aluminum entry door, solid core bathroom door, skid-resistant floor tile, and interior lighting. Interior partition walls shall be framed construction. Interior walls shall be finished with gypsum board and painted. Appliances, a desk and two chairs shall also be provided.

Smoke detection, fire alarm, and security alarm features shall be provided and coordinated with the Bridge Electrical System requirements elsewhere in these Minimum Technical Requirements.

3.2. Remote Control Station

The Design-Build Team shall design modifications to the layout of the Bridge Tender's House at Bridge No. 19 to accommodate an independent control console, control system, communication devices and video monitors, as required for remote monitoring and operation of the swing span without restricting operator movement, obstructing sight lines, or otherwise interfering with normal operation of the Bridge No. 19 bascule spans. The layout shall be compatible with the Remote Operating System and consistent with the approved Remote Operations Plan, as required elsewhere in these Minimum Technical Requirements. Modifications to and/or relocation of existing exterior walls is not permitted.

The Design-Build Team shall demonstrate that the proposed (modified) condition of the Bridge No. 19 bridge tender's house complies with the current version of the North Carolina Energy Conservation Code. The Design-Build Team shall evaluate the adequacy of the existing HVAC system at Bridge No. 19 to effectively and efficiently condition the interior space following the addition of the Remote Control Station and Remote Operating System and replace, modify, or supplement, if necessary.

As-built plans of the Bridge Tender's House at Bridge No. 19 will be provided by the Department for reference at the time they become available. The Design-Build Team shall be responsible for verifying the accuracy of those plans.

4.0 SUBMITTAL REQUIREMENTS

Requirements in this section shall be considered supplemental to those found elsewhere in these Minimum Technical Requirements.

4.1. Design

Plans, Special Provisions, and Design Calculations for the Bridge Tender's House and Remote Control Station shall be signed and sealed by an Architect registered in the State of North Carolina.

4.1.1. Bridge Tender's House

Preliminary Plans shall include, at a minimum, the floor plan, roof plan and elevation views of all sides for review and approval, showing all dimensions, materials, finishes and colors. Preliminary Special Provisions shall include, at a minimum, an outline of relevant specifications

for complete construction of the house, including all structural, mechanical, electrical, plumbing and architectural systems. Final and RFC Special Provisions shall include all detailed requirements governing performance; quality assurance and control; delivery storage and handling; warranty terms and conditions; materials; fabrication; preparation; installation; finishes; tolerances; and cleaning and protection. See additional requirements for the generator structure elsewhere in these Minimum Technical Requirements.

4.1.2. Remote Control Station

Preliminary Calculations shall include, at a minimum, energy calculations and remaining usable floor space on the operator level following addition of the Remote Control Station and Remote Operating System. Preliminary Plans shall include, at a minimum, a floor plan and interior elevations, showing limits of modifications, placement of additional control and monitoring features, and preliminary assessment of impacts on operator site lines from the Bridge No. 19 control console following addition of the Remote Control Station and Remote Operating System. Preliminary Special Provisions shall include, at a minimum, an outline of relevant specifications for all modifications required for installation of the Remote Control Station and Remote Operating System (where not already specified under Special Provisions for the Bridge Electrical System). Final and RFC Special Provisions shall include all detailed requirements governing performance; quality assurance and control; delivery storage and handling; warranty terms and conditions; materials; fabrication; preparation; installation; finishes; tolerances; and cleaning and protection.

4.2. Post-design

The Design-Build Team shall submit three (3) samples of all materials, products, colors and/or finishes to the Department for review and approval prior to ordering or taking delivery of any aesthetics-related products or materials.

5.0 CONSTRUCTION

The Design-Build Team shall construct the Bridge Tender's House and Remote Control Station in accordance with 2012 NCDOT *Standard Specifications for Roads and Structures*, the State Building Code of North Carolina, Project Special Provisions found elsewhere in the RFP, RFC Plans and Special Provisions developed by the Design-Build Team, these Minimum Technical Requirements, and all applicable divisions of the Construction Specifications Institute (CSI) provisions for work.

MOVABLE BRIDGE MACHINERY

1.0 DESCRIPTION

1.1. General

The Design-Build Team shall design all required machinery, produce Plans and Special Provisions in accordance with the Submittal Requirements elsewhere in these Minimum Technical Requirements, fabricate, test, install, align, lubricate, paint, and place into satisfactory and permanent operating condition all bridge machinery.

1.2. Reference

The Design-Build Team shall furnish and install all machinery items in compliance with the applicable requirements of the latest standards and codes of, but not limited to, those organizations designated in these Minimum Technical Requirements.

1.3. Qualifications, Personnel, and Facilities

The Design-Build Team shall complete all design, fabrication, cleaning, installation, alignment, lubrication, testing and all other work required for bridge machinery using an adequate number of experienced engineers, mechanics and service personnel who are thoroughly trained and familiar with the required methods specified for correct completion of the work.

For the installation, alignment and fastening of the bridge machinery, use an adequate number of trained and skilled millwrights. The millwright foreman shall have past experience in the installation of machinery on at least two (2) previous movable bridges.

The Design-Build Team shall equip the mechanics, millwrights and service personnel with the necessary instruments, tools and other equipment necessary to assure the related components have been furnished within acceptable tolerances; and to make any adjustments required to attain correct installation and satisfactory operation.

1.4. Rules, Regulations and Organizations

The Design-Build Team shall ensure that all work complies with all applicable federal, state and local rules, regulations and ordinances. In the event of a conflict between these Minimum Technical Requirements and the federal, state and local codes, standards, rules, regulations and ordinances the most stringent requirement applies.

2.0 DESIGN CRITERIA

2.1. General

A. All bridge machinery shall be designed in accordance with AASHTO *Movable*.

B. The machinery shall be designed using customary English Units of feet, pounds, degrees, Fahrenheit, etc.

C. The units shown in the Plans shall be English Units.

D. All machinery shall be electro-mechanical. Hydraulic machinery shall not be allowed, with the exception of electro-hydraulic thruster operated brakes.

E. The machinery shall be designed for an 80-year life, assuming 300 open-close cycles annually.

2.2. Machinery Loads

A. Loads for moving, stopping, stabilizing, and holding the span shall be in accordance with AASHTO *Movable*, except where modified herein.

B. For sizing the prime mover, Maximum Starting Torque shall include inertial loads. Acceleration used for inertial calculations shall be consistent with what is specified for the control system, and shall not exceed 10 seconds.

2.3. Bridge Operation

A. When operated by the drive machinery, the swing span shall open in the counterclockwise direction and close in the clockwise direction. Anything installed which would interfere with the span from being rotated in the opposite direction from normal operation shall be capable of being removed and reinstalled.

B. Normal operation: All mechanisms shall be driven by electric motors controlled and sequenced by the control system. The time to rotate the bridge 90 degrees including acceleration, deceleration, and creep time shall not exceed two (2) minutes. The total time of operation for the swing span to go from the closed position to the open position and back to the closed position, including the time to operate warning and barrier gates and all wedge, lifting, and locking devices, but exclusive of passage of marine traffic, shall not exceed six (6) minutes.

C. Auxiliary Operation: In the event of loss of utility power, a backup generator shall provide sufficient power to operate all mechanisms. The time for one complete operating cycle (closed to open and back to closed) shall not exceed twice the time of normal operation. Switching from normal operation to auxiliary operation shall be able to be done without leaving the Bridge Tender's House.

D. Manual Operation: All mechanisms shall be provided with a manual method of operation, and all items necessary for manual operation shall be provided. An electrical interlock shall be provided at each mechanism preventing the electrical equipment from being energized if the manual actuator is in position. Manual operation of each mechanism shall not require effort from more than two people simultaneously.

2.4. Mechanical Features

A. The swing span shall have a disk-type center bearing, consisting of a phosphor bronze disk with a convex spherical surface and a hardened steel disk with a concave spherical surface, each contained within a steel housing and constrained such that sliding only occurs at the spherical surfaces of the disks. The center

bearing shall be designed to support the full dead load of the swing span, and the top disk shall resist transverse movement from a horizontal load equal to the driving force of 150% full load torque of the end lift mechanism(s) at one end of the bridge. The pivot bearing shall be oil lubricated with provision for checking oil level. The pivot bearing disks shall be accessible for inspection and replacement without jacking the swing span more than 1 inch.

B. Rotation of the swing span 90 degrees shall be provided by span-mounted pinions driving against curved rack segments mounted to the center pivot pier. Rack pinions shall be driven by electric motor(s) transmitting power through enclosed gear reducers.

C. Span drive motor redundancy shall be provided such that the span can be rotated under electric motor power if one span drive motor fails or is removed for maintenance. In addition to motor redundancy, provision shall be incorporated in the design to operate the span driving machinery manually.

D. At least two rack pinions shall be provided and pairs shall be positioned diametrically opposite. Torque shall be equalized at each pinion. The shafts outside of motors and reducers shall be supported by bronze-bushed bearings.

E. If a 360-degree rack is not provided, allowance for 10 degree overtravel each direction shall be provided combined with redundant overtravel limit switches. Rack segments shall not be less than 72 inches.

F. At least one motor brake and two machinery brakes shall be provided. Brakes shall be failsafe, such that they release under power and set with loss of power. Manual release shall be provided for all brakes. Torque capacity of brakes for stopping and holding the span in any position shall meet requirements of AASHTO *Movable*. Brakes shall have field adjustable setting time delays.

G. At least eight (8) steel balance wheels shall be provided and pairs shall be positioned below the swing span superstructure, diametrically opposite with at least two balance wheels in each quadrant. Maximum overturning moment due to wind specified for Maximum Starting Torque in AASHTO *Movable*, combined with an imbalance moment, shall be resisted by one balance wheel at the service limit state. The imbalance moment shall be specified by the Design-Build Team, shall be clearly indicated on the design calculations and shall not exceed the imbalance moment due to wind specified for Maximum Starting Torque. All balance wheels shall be designed for the same load. Balance wheels shall be provided with bronze bushings. Shims shall be provided between balance wheel supports and the swing span structure.

H. A 360-degree circular steel track shall be provided below the balance wheels. Track segments shall not be less than 72 inches and shall have a smooth transition between segments at joints. Track shall be thick enough to distribute the balance wheel load to the pier, but not less than 1 inch.

I. End lift mechanisms shall be provided at each corner of the swing span to deflect the span the amount specified in AASHTO *Movable*. When driven, end lift machinery shall be locked in place to prevent back-driving under live load. End lift machinery at each end of the swing span shall be mechanically independent. The prime movers for the end lift machinery shall be electric motors. Provisions shall be incorporated for operating the end lift machinery manually. All end lift machinery shall be accessible from the rest piers or platforms mounted to the rest piers, fenders, or swing span. Platforms mounted to the swing span shall not interfere with the navigation channel. All end lift machinery shall be operated simultaneously.

J. Center wedges shall be provided at the center pier and shall be designed to resist the full center pier live load reaction and impact. Wedges shall be driven to firm contact, but shall not deflect the swing span. The prime mover(s) for wedge operating machinery shall be electric motor(s). Provision shall be incorporated for operating the center wedge machinery manually.

K. A centering device and span lock shall be provided at each end of the swing span. The centering device shall align the centerline of the swing span with the centerline of the approach spans to within 1/4 inch. The locking mechanism shall be designed to resist the greatest turning moment created by the span operating machinery at motor breakdown torque. Provision shall be incorporated for manual operation.

L. All sliding elements shall have one surface bronze and the other steel.

M. All sliding surfaces, and any surfaces requiring lubrication, shall have provision for lubrication. Each component shall have at least one lubrication fitting, and access shall be provided to each fitting location without the use of lubrication line extensions. Lubrication fittings shall be visible from access platforms, clearly marked, and easily reached by maintenance personnel. Where feasible, access shall be provided by stairs in lieu of ladders. All locations shall be accessible without temporary ladders or platforms.

N. The Design-Build Team shall provide instrumentation machinery as necessary and compatible with span position limit switches required by the control system.

3.0 REQUIRED SUBMITTALS

All machinery submittals shall be submitted in accordance with the Submittal Requirements found elsewhere in these Minimum Technical Requirements.

The Design-Build Team shall include all machinery submittals on the approved CPM Schedule.

3.1. Design Submittals

The Design-Build Team shall provide, at a minimum, Preliminary and Final Design Calculations, Plans, and Special Provisions, and RFC Plans and Special Provisions as outlined elsewhere in these Minimum Technical Requirements.

Machinery Design Calculations/Plans/Special Provisions may be subdivided for different systems and submitted separately to complement the Design-Build Team's schedule. For example, submittals related to the Turning Machinery may be submitted separately from the End Lifting Machinery. Preliminary design shall include, at a minimum, design loading and power requirements of the prime mover.

Design calculations shall be submitted prior to, or concurrently with, Plans of the same level. Approved Preliminary Movable Span Structural Plans shall be submitted as FYI with Preliminary Machinery Plans. Approved Final Movable Span Structural Plans shall be submitted as FYI with Final Machinery Plans and Special Provisions.

RFC Plans and Special Provisions shall be approved by the Department prior to ordering of materials or starting fabrication.

3.1.1. Design Calculations

The Design-Build Team shall submit detailed calculations to the Department for review and approval prior to or concurrently with Plans of the same. Final calculations shall be prepared, signed and sealed by a Professional Engineer registered in the State of North Carolina. The calculations shall demonstrate machinery design compliance to the requirements of all applicable specifications including these Minimum Technical Requirements. Submitted calculations shall include, but not be limited to, the selection and design of the span drive machinery, center bearing, balance wheels and track, end lift machinery, center wedge machinery, span locking machinery, and centering machinery.

3.1.2. Plans

Plans shall be developed by the Design-Build Team in accordance with these Minimum Technical Requirements. RFC Plans shall be signed and sealed by a Professional Engineer licensed in the State of North Carolina.

3.1.3. Special Provisions

Special Provisions shall be developed by the Design-Build Team in accordance with these Minimum Technical Requirements, in conjunction with the Plans, to provide all construction requirements for the Bridge Machinery. RFC Special Provisions shall be signed and sealed by a Professional Engineer licensed in the State of North Carolina.

3.2. Post-Design Submittals

Post-design machinery submittals shall be submitted in accordance with Submittal Guidelines in these Minimum Technical Requirements, including working drawings, installation procedures, testing procedures, operational and material testing results, operation and maintenance manual(s), lubrication chart and schedule, and machinery alignment report.

In addition to all Working Drawings, material certifications, and Functional Checkout submittals described elsewhere in these Minimum Technical Requirements, the following submittals are required as a minimum:

A. Machinery Installation Procedure
B. Reducer Testing Procedure
C. Reducer Test Results
D. Operation and Maintenance Manual
E. Lubrication Charts and Schedule
F. Machinery Alignment Sample Measurement Tables
G. Machinery Alignment Report
H. As-built Plans

3.2.1. **Working Drawings**

Working drawings, as necessary for the fabrication, assembly and field installation of machinery, shall be prepared by the Design-Build Team and shall be submitted to the Department for approval. The working drawings shall include sufficient level of detail such that the machinery parts may be duplicated without reference to patterns, other drawings not provided to the Department, or individual shop practices, and assembly of the proposed system(s) can be completed solely by reference to the working drawings.

Working drawings, catalog cuts and certifications shall be submitted for approval for all mechanical equipment proposed for purchase or fabrication. Working drawings shall be construed to mean general and detailed plans, shop drawings or drawings used for purposes of fabrication, installation and assembly of mechanical components that are the product, either direct or indirect, of the Design-Build Team or manufacturer of the mechanical components.

Working drawings shall be supplied to the Department for review, comment, and approval, but in no case shall the Design-Build Team be relieved of responsibility for results obtained by the use of these working drawings.

The Design-Build Team shall furnish assembly and erection drawings with identifying marks and essential dimensions for locating parts and assemblies on the bridge and/or foundations. The use of opposite hand or mirror image assembly drawings is not acceptable.

The Design-Build Team shall 1) show proprietary parts in outline on the drawings; 2) furnish complete dimensions and data to enable a determination of the adequacy of the unit; 3) furnish certified dimensional prints stating the name, part and job number; and 4) give pertinent load and speed ratings; provisions for lubricating, the method of lubrication, location and type of all lubrication, and vent fittings. If a product is modified in any way from the description submitted by its original manufacturer, provide a drawing that details the modifications and assigns a special part number to that part to avoid supply of replacement parts not similarly modified.

Component catalog cuts are permitted provided that they detail every aspect of the component, such as, but not limited to the following items: identification number, rating, dimensions, bore tolerances, keyway tolerances, finishes, lubrication fittings, coatings, paint, and electrical requirements. Catalog cuts provided shall mark out all data and items that are not pertinent to the item used.

Data for components that require electrical actuation shall be supplied with all pertinent electrical data such as power requirements and wiring diagrams, such that they may be coordinated with the Electrical Contractor.

The Design-Build Team shall review all working drawings prior to delivery to the Department for compliance with the following:

A. Proposed means and methods of fabrication, assembly and installation

B. Components and materials to be used

C. Design assumptions

D. Coordination with Structural and Electrical work

E. Schedule

The Design-Build Team's review of the working drawings shall be evidenced by signature and date of review and stamp or annotation to this effect on each page or sheet of the submittal.

An item number shall be furnished to identify each component on required assembly layout working drawings.

The grade and extent of finish machining, with all tolerances and allowances, shall be stated for each part for which a specific fit and/or finish is required. The dimensions of finished surfaces shall be as defined by the ANSI B46.1 Surface Texture and by the ANSI B4.1 Preferred Limits and Fits for Cylindrical Parts.

3.2.2. **Machinery Installation Procedure**

The Design-Build Team shall prepare a detailed written installation procedure for all machinery components. The procedure shall include location and means of storage of equipment, sequence of installation, alignment methods, bolt tightening methods and torque values for all bolts. The Design-Build Team shall install and align all units and components as recommended by the manufacturer of that product, and furnish printed copies of those instructions and procedures with the submitted Machinery Installation Procedure. Preparation of the mounting surfaces and associated components required for the installation shall be included.

Resumes for all supervising Engineers and millwrights associated with machinery installation and alignment shall be included with the written installation procedure. The installation procedure shall demonstrate to the Department that the Design-Build Team has full knowledge of machinery connections and alignment procedures and that the work shall be performed by qualified millwrights.

Installation of the machinery shall not begin until a procedure and resumes have been submitted by the Design-Build Team that are satisfactory in the sole opinion of the Department and approval has been granted by the Department. The Design-Build Team shall correct and resubmit the procedure and/or submit resumes for alternate personnel as necessary to the satisfaction of the Department. This resubmission procedure, if required, shall not be considered cause for delay.

No machinery items shall be shipped to the job site until the Design-Build Team has obtained an approved installation procedure.

3.2.3. **Material Certification and Test Results**

Certified test results documenting chemical and mechanical properties in accordance with the applicable ASTM specifications shall be submitted to the Department for all metals used for fabricated components of machinery. Where Non-Destructive Testing (NDT) is required, submit certified test results regardless of results of tests.

3.2.4. **Reducer Testing**

All reducers used in any Bridge Machinery shall be tested in accordance with the requirements herein. A detailed test procedure shall be submitted and be approved at least fourteen (14) days prior to the start of any testing. Upon completion of testing, a report and Certificate of Compliance shall be submitted for each reducer.

The reducer manufacturer shall shop test all reducers by running them at the normal operating speed at no load for at least two hours (one hour each direction) and at 150% full-load torque at normal speed for 1 hour (30 minutes each direction) in the presence of the Engineer or his duly appointed representative.

These tests shall be run with the reducers filled to the required mark with new oil of the viscosity the manufacturer recommends on his lubrication chart for normal operation. Half of the run shall be one direction and the other half in the opposite direction. Immediately before the start of the test, and ten (10) minute intervals thereafter, the following measurements shall be made and recorded and the records shall be submitted with the Certificate of Compliance:

A. Temperature of ambient air

B. Temperature of oil near bottom of housing

C. Surface temperature of each shaft extension adjacent to shaft seal

D. Sound level at point above and to each side, three (3) feet distant from center of unit

No temperature shall exceed 180°F or the safe working temperature of the shaft seals, whichever is lower. Temperature rise shall not exceed 80°F. No sound level shall exceed 90 dBA.

During testing, each reducer shall be checked for unusual noise (thumping or any non-uniformity), excessive bearing clearance, oil leakage, and any other unusual operating

characteristics. The units shall operate smoothly, and without excessive vibration or temperature rise.

The proper distribution of load on the gear teeth shall be demonstrated by the application of bluing dye applied to each gear before the spin test. All teeth shall exhibit at least 80% contact. After each direction of load test, remove inspection covers to allow inspection of teeth. Any pitting or other distress noted on teeth may be cause for rejection. Photographs of the contact patterns shall be taken and preserved in the records to be submitted with the Certificate of Compliance.

All malfunctions shall be recorded and corrected, and the units retested, if necessary, before release from the manufacturer's shop. After the unit has passed the test, a Certificate of Compliance shall be submitted by the Design-Build Team to the Department.

For differential reducers, the test shall be set up such that load sharing of the differential can be verified. Load variation of output shafts shall not exceed 5% of each other.

3.2.5. Machinery Operation and Maintenance Manual

Operation and Maintenance Manuals shall be provided in accordance with other sections of these Minimum Technical Requirements.

3.2.6. Lubrication Charts and Schedule

The Design-Build Team shall furnish three (3) copies of Lubrication Charts and Schedule on mylar full-size (22 inches by 34 inches) as well as reduced half-size for inclusion in the operating and maintenance manuals. The lubrication chart shall show the location of all lubrication fittings and other points of lubrication for the mechanical and electrical equipment, which will require lubrication of any kind. The chart shall show the kind of lubricant to be used at each point and the frequency of lubrication. A full-size print of the chart shall be framed under Lexan in a neat wooden frame with backing and shall be placed prominently visible within the Bridge Tender’s House.

The Design-Build Team shall submit the lubrication chart and schedule to the Department for review and approval. Final lubrication chart shall not be made until the chart has been approved by the Department.

3.2.7. Machinery Alignment Report

The Design-Build Team shall prepare a letter report that details the final alignment of the machinery. The report shall list the date and temperature at the time of measurement. The report shall contain tables that list all components, the component’s allowable misalignment tolerance and/or alignment requirements or recommendations as specified by the manufacturer or herein, and the measured alignment.

Sample tables, clearly indicating what measurements will be included in the Machinery Alignment Report to document component alignment, shall be submitted and approved by the

Department prior to performing final alignment measurements. All measurements included in the Machinery Alignment Report shall be witnessed and confirmed by the Department.

The report shall include at a minimum:

A. Open gear, tooth contact, backlash and cross mesh measurements performed at a minimum of three (3) equally spaced teeth per rack segment. The backlash measurements shall be performed at each side of the gear.

B. Bushing/journal clearance measurements, and show maximum gap and location.

C. Coupling alignment measurements

D. Brake alignment measurements

E. Balance wheel/track clearance measurements

F. End Lift/Center Wedge withdrawn clearance

G. End Lift/Center Wedge driven contact ratio

H. The vertical deflection at each corner of the structure caused by driving the End Lift devices.

4.0 MATERIALS AND PRODUCTS

4.1. Standard Products

The Design-Build Team shall, in so far as practical, use materials and equipment that are the standard, catalogued products of manufacturers regularly engaged in the production of such products; and that are the latest standard design; and that comply with the requirements of the contract documents. Where two units of the same category equipment are required in the system use products of the same manufacturer; although, components of the system need not be the products of one manufacturer.

The Design-Build Team shall provide each major manufactured component with a name plate, securely affixed in a conspicuous place, with the manufacturer's name and address, the model and serial number. The nameplate of the distributing agent is not acceptable.

4.2. Steel Castings

Steel castings shall conform to the requirements of ASTM A27 and/or ASTM A148.

All steel castings shall be fully annealed. Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. All castings shall be sandblasted or otherwise effectively cleaned of scale and sand and all fins, seams, gates, risers, and other irregularities shall be removed, to present a smooth, clean, and uniform surface. All unfinished edges of castings shall be neatly cast with rounded corners, and all inside angles shall have ample fillets. All surfaces requiring finish shall have adequate material allowance for machining to finish dimensions. Finish all surfaces of castings in contact with other metal to 125

micro-inches as measured under ANSI B46.1, unless a finer finish is specified. Machined bosses shall be provided on cast steel machinery parts to give proper seats for bolt heads and nuts.

Blow holes appearing upon finished castings shall be so located that a straight line laid in any direction will not cut a total length of cavity greater than one inch in any one foot, nor shall any single blow hole exceed one inch in any dimension or have an area greater than one-half square inch. Blow holes shall not have a depth injuriously affecting the strength of the casting. Minor defects, which do not impair the strength may, with the approval of the Department, be welded by an approved process and be inspected by magnetic particle examination. The defects shall be removed to solid metal by chipping, drilling, or other satisfactory method, and, after welding, the castings shall be annealed if required by the Department. Castings which have been welded without the Engineer's permission shall be rejected.

All castings shall be ultrasonically tested in accordance with ASTM A609, Method A, Quality Level 2. Castings that do not pass this test may be rejected. Test results, whether positive or negative, shall be submitted to the Department. Test records meeting Quality Level 3 or 4 may be considered for weld repair, provided the fabricator submits a procedure to the Department for review and approval. All repair procedures shall include a means to qualify the repair. Test records meeting Quality Level 5 or higher shall be cause for rejection, and not be allowed for weld repair. Rejection shall result in the Design-Build Team providing a new casting meeting the acceptance criteria.

All castings shall be visually inspected in accordance with ASTM A802 and meet acceptance 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 repair, provided the fabricator submits a procedure to the Engineer for review and approval. All repair procedures shall include a means to qualify the repair.

All castings shall be magnetic particle examined in accordance with ASTM E125. The following level of discontinuities will be acceptable:

Type I	Cracks/Hot Tears	¼” max
Type II	Shrinkage	Degree 3
Type III	Inclusions	Degree 3
Type IV	Chaplets	Degree 2
Type V	Porosity	Degree 1

Test results, whether positive or negative, shall be submitted to the Engineer. All surface discontinuities may be considered for weld repair, provided the fabricator submits a procedure to

the Engineer for review and approval. All repair procedures shall include a means to qualify the repair.

All weld repairs shall be performed prior to heat treatment so that no weld repairs are necessary after machining. In addition, machining to remove surface defects shall be performed prior to heat treatment.

4.3. Steel Forgings

Steel forgings shall conform to the requirements of ASTM A668 or ASTM A291.

The Design-Build Team shall use annealed forgings where possible and reduce to size all forged shafts from a single bloom or ingot until perfect homogeneity is secured. For all forged parts provide a bloom or ingot cross-sectional area of at least three times that required after finishing. The Design-Build Team shall forge material only at temperature greater than or equal to a red-heat and provide forged rounds for shafts that are true, straight, and free from all injurious flaws, seams, or cracks. Prior to heat treatment, bore a hole lengthwise through the forging for shafts with a finish diameter greater than eight inches. The Design-Build Team shall: 1) provide forgings with adequate material allowance for machining to finish dimensions; 2) reject all shafts with areas that do not clean up after machining; 3) inspect forgings with ultrasonic evaluation per the conditions of ASTM A668 supplement requirement S7 and Practice A388; and 4) submit all test results to the Engineer. Indications in excess of 1/4 inch may be cause for rejection.

For forgings that are to be welded to plate steel, ensure that the forgings meet the requirements of ASTM A668 supplement requirement S4 for low carbon content.

4.4. Structural Steel

All steel plate and structural shapes used for machinery and machinery supports shall conform to the requirements of ASTM A709 Grade 36 or Grade 50, or ASTM A36.

4.5. Weldments

Welding required for machinery or machinery supports shall be done in accordance with the requirements of the latest edition of the AWS D1.5 Bridge Welding Code. Groove welds shall be 100 percent inspected by ultrasonic methods. Acceptance criteria shall be that given in AWS D1.5 Bridge Welding Code for tension welds. All machining shall be performed after welding and stress relieving.

The fitting up and welding procedure shall be such that distortion of the work will be a minimum. If necessary to obtain this result, suitable welding fixtures shall be used. The Design-Build Team shall submit welding procedures, together with the working drawings to the Department for approval.

Welding joint sizes and details shall be shown on working drawings. Where multi-pass welds are required, welding procedures shall be submitted on or with shop drawings.

After completion of welding and before final machining, the weldment shall be stress relieved in accordance with the requirements of Section 4.4 of AWS D1.5. The Design-Build Team shall submit a schedule of the proposed stress relief heat treatment to the Engineer for his approval. The schedule shall include a description of the part and an explanation of the proposed heat treatment, including the rate of heating, the soaking temperature, the time at the soaking temperature, the rate of cooling, and the temperature at which the part is to be withdrawn from the chamber. Soaking times less than one hour will not be approved.

4.6. Shafting and Pins

The Design-Build Team shall furnish shafts that are accurately finished, round, smooth, and straight; and when turned to different diameters, provide rounded fillets at shoulders and chamfers at shaft ends. At the journal-bearing areas on shafts and pins provide surfaces that are accurately turned, ground, and polished with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. The Design-Build Team shall finish journal surfaces to the limits specified in AASHTO *Movable*.

The Design-Build Team shall provide shafts of forged steel. Hot rolled steel of equivalent strength and ductility may be substituted for shafting with a finished diameter of four (4) inches or less. Cold finished shafts and pins shall not be permitted. The Design-Build Team shall provide ANSI Standard B4.1 FN2 fit at hub locations and machine finish each shaft over its entire length to obtain a smooth finish concentric with the bearing centerline. For shafts with holes, install plugs prior to final assembly at each end of shaft.

4.7. Bearings and Bushings

All bearings not located within manufactured components shall be sleeve type with bushings fabricated from material conforming to the requirements of ASTM B22. Housings shall be cast steel or structural steel.

Bushings shall be restrained from movement relative to housing.

Pillow block bearings shall have split housings and bushings and be provided with captured bronze or brass liner shims at the split. Liner shims shall be ¼” thick, with one 1/8” thick piece and 1/8” consisting of laminations not more than 0.003” thick.

The Design-Build Team shall: 1) finish machine the outside diameters of the bushings to provide an ANSI Class LC-1 fit with their associated housing bores; 2) provide sufficient stock in the bushing inside diameter to permit final machining of the bore after assembly in their housings with the full liners in place; and 3) polish bushing bores to a surface texture of 16 microinches in accordance with ANSI B46.1 and provide an ANSI B4.1 RC6 fit between bushing and shaft.

All bushings shall have grease grooves that have smooth edges that blend smoothly in the bearing surface. The Design-Build Team shall provide an entry hole for the grease fitting that intersects and lies completely within the grooves and provide machine cut grease grooves.

4.8. Open Gearing

Open gearing shall only be used for rack segments and main pinions. All other reduction gearing shall be enclosed in gearbox speed reducers.

Rack segments and main pinions shall have 20-degree involute, cut teeth in accordance with the proportions of the ANSI/AGMA 201.02, Tooth Proportions for Coarse-Pitch Involute Spur Gears.

All open gears shall conform to the requirements of AASHTO *Movable* and the requirements for accuracy of the AGMA Standard 2001-D04, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth. The open gears shall conform to AGMA Quality No. 7 or higher. The AGMA quality number shall be stated on the applicable shop drawings.

The teeth of all gears shall be cut from solid rims or blanks. The teeth shall be provided with the appropriate root radius to limit stress concentration, but still allow for proper operation. 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 0.020-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 planning 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.

4.9. Gearbox Speed Reducers

Speed reducers for all Bridge Machinery shall be from one manufacturer. Speed reducers shall have mounting holes located such that final field drilling and reaming for permanent fasteners is feasible.

Speed reducers shall conform to the requirements of AASHTO *Movable* Specification 6.7.6 and shall also conform to AGMA Product Standard 6013-B16, Standard for Industrial Enclosed Gear Drives, and shall carry the AGMA symbol on the nameplate.

Gears and shafts shall be heat-treated alloy steel suitable for the intended service. Gearing in enclosed reducers shall conform to AGMA Quality No. 9 or higher.

Housings shall be of cast steel or welded plate construction. Inspection covers shall be provided to permit inspection of the gearing inside and located such that the covers can be opened without draining the oil.

Provisions shall be made for filling, draining, and ventilating the housings; and a sight gauge shall be mounted on each unit to read the recommended lubricant level. Ventilation openings shall come equipped with a moisture (hygroscopic) breather and particle filtration unit.

The drain provisions shall include a shut-off valve between a drain pipe cap and each reducer. A hose bibb or other device suitable for connecting a 1" drain hose shall be provided for the reducer.

A drain hose shall be provided for use when oil must be drained from the reducer. The hose shall be a minimum of 50 feet long. The hose shall be provided with a storage reel.

The inside of the housings shall be sandblast cleaned prior to assembly and be protected from rusting.

Lubrication of the gears and bearings shall be automatic and continuous while in operation.

The reducers shall be rated for a service factor of 1.0 at 150% horsepower rating of its driving motors. The AASHTO *Movable* requirements for peak or breakdown torque shall be taken to mean that the stress levels may be a maximum of 50 percent higher than normal. Additional testing requirements are included herein under Required Submittals.

4.10. Couplings

All couplings shall transmit torque through metal parts, and hubs shall be keyed to their respective shafts. Couplings allowing angular or offset misalignment shall be of standard manufacture and have published misalignment tolerances.

All couplings and shaft fits and finishes shall meet the requirements of AASHTO *Movable* Article 6.7.8.1 for hubs on shafts. Couplings shall be finish-bored and have keyways machined to dimensions and tolerances established on the working drawings and be installed in the shop.

The couplings shall have provisions for lubricating all contact surfaces and the housings shall be oil-tight under all operating conditions.

4.11. Brakes

Brakes shall be spring set and electrically or hydraulically released, and shall be failsafe such that they are set in the absence of electric current. All brakes shall have a manual release.

Torque settings for brakes on the span drive machinery shall be field adjustable and shall have a field adjustable setting time delay. All thruster brakes shall be equipped with an external braking torque adjustment spring with gauge showing the brake torque setting. The torque setting shall be easily visible and accessible for adjustment once the brakes are installed.

4.12. Fasteners

4.12.1. General

All bolts connecting machinery parts to each other or to supporting steel shall be either high-strength bolts conforming to the requirements of ASTM F3125 Grade A325 or turned bolts, conforming to the requirements of ASTM A449. All bolts shall be heavy hex series specified in ANSI 18.2.6 with coarse thread series per ANSI B1.1.

All nuts shall conform to the requirements of ASTM A563 and have dimensions in accordance with heavy hex series specified in ANSI B18.2.6 with coarse thread series per ANSI B1.1.

All bolts shall be provided with a hardened washer conforming to the requirements of ASTM F436 placed below the turned element. The Design-Build Team shall use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

The Design-Build Team shall clean all contacting surfaces of machinery elements and structural steel to be bolted together in accordance with the 2012 NCDOT *Standard Specifications for Roads and Structures* before bolting.

All bolt heads and nuts shall bear on seats square with the axis of the bolt. Where fasteners bear on castings, the casting shall be machined square with the axis of the bolt.

4.12.2. **Turned Bolts**

The Design-Build Team shall: 1) use turned bolts for all connections of machinery to machinery supports and for machinery connections directly to the structure; 2) turn the diameter of the bolt shank such that it is 1/16-inch larger than the diameter of the threads; 3) supply a surface finish of 63 micro-inches as measured under ANSI B46.1; 4) use two heavy hex nuts with turned bolts; and 5) following acceptance of the final machinery alignment, carefully ream holes for turned bolts in mating structure to provide for an ANSI B4.1 LC6 fit with the body of the bolt. Turned bolts shall provide resistance for the service limit state with allowable static stresses as defined by Section 6 of AASHTO *Movable*. Each component secured with turned bolts shall have at least two turned bolts installed.

4.12.3. **High-Strength Bolts**

Where turned bolts are not used, provide high-strength bolts. All-high strength bolt assemblies shall be provided in accordance with the 2012 NCDOT *Standard Specifications for Roads and Structures*, and tensioned in accordance with these Minimum Technical Requirements.

4.12.4. **Anchor Bolts**

Where machinery is anchored to a concrete surface, use anchor bolts in accordance with the 2012 NCDOT *Standard Specifications for Roads and Structures*.

4.13. Keys and Keyways

Keys and keyways shall be provided between components mounted to, and moving with, a rotating shaft and their respective shafts. Unless specified otherwise, keys and keyways shall conform to the dimensions and tolerances for parallel keys of ANSI B17.1. For connections with one key, the side fit between key and keyway shall conform to ANSI B4.1 FN2 fit, and the top and bottom fit shall conform to ANSI B4.1 LC4 fit. For connections requiring two keys, key and keyway fit shall conform to ANSI B17.1 Class 2 fit. All keys and keyways shall have key

chamfer and keyway radius as suggested by ANSI B17.1, regardless of fit. All keys and keyways shall be finished to 63 microinches as measured under ANSI B46.1.

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. Subject to the Department's approval, keys that are not set into the closed-end keyways shall be held by safety set screws, or other effective means. Keyways shall not extend into any bearing.

4.14. Shims

The Design-Build Team shall: 1) provide stainless steel shims required for leveling and alignment conforming to ASTM A240, Type 316, drilled for all bolts that pass through with ¼" oversize holes, and trimmed to the dimensions of the assembled unit; 2) provide shim packs capable for adjustment from 0 inches to twice the nominal shim pack dimension; and 3) provide sufficient thicknesses to permit 1/64 inch variations of the shim allowance plus one full allowance shim. Corrosion resistant precision thickness and/or tapered shims may be required to obtain alignment. Shims with slots or slotted holes shall not be permitted.

4.15. Grout

The Design-Build Team shall provide non-shrink grout meeting the requirements of the 2012 NCDOT *Standard Specifications for Roads and Structures*, with strength and other properties as required by the Design-Build Team's design. For machinery components mounted to concrete, grout shall completely fill the area between machinery components and concrete surfaces.

4.16. Lubrication

Standardization of the lubrication for the mechanical and electrical systems is required. The Design-Build Team shall coordinate with all the system suppliers to ensure that the type of lubricant supplied shall be kept to as few as possible.

The Design-Build Team shall provide all bearings and other grease lubricated machinery components with giant button head fittings.

Upon completion of fabrication, plug all grease fitting locations until the components are installed and regular lubrication is started. Immediately after erection and prior to operation, lubricate all rotating and sliding parts.

The Design-Build Team shall provide removable hinged or bolted covers in order to access lubrication fittings and other routine maintenance devices that might be covered by machinery guards.

The Design-Build Team shall furnish all equipment necessary for routine maintenance lubrication of the equipment on the bridge. Each grade or class of grease shall be provided with its own separate grease guns or other equipment normally used for application of the lubricant. The Design-Build Team shall furnish two grease guns suitable for the furnished lubrication

fittings. If more than one type of grease fitting is used for the same lubricant, grease applicators shall be provided for each type of fitting. Each device shall have a permanently attached nameplate listing the specific lubricant within. The Design-Build Team shall furnish each lubricant listed on the approved Lubrication Chart in an amount necessary for one (1) year of recommended lubrication after final completion of the project.

4.17. Spare Parts

The Design-Build Team shall provide the following minimum spare parts and deliver to a location designated by the Department:

A. 1 complete coupling of each type and size. Provide hubs rough bored.

B. 1 complete set of seals and gaskets for each type and size of coupling

C. 1 spare set of brake pads for each brake

D. 2 desiccant breathers for each reducer

E. 5 lubrication fittings of each type used

The Design-Build Team shall:

A. Prepare spare parts for long-term storage as recommended by the manufacturer

B. Wrap and box in a durable wooden container

C. Tag all individual spares with clear identification using the part number and description as shown on the approved shop drawings

D. Clearly and permanently mark the outside of the spare parts boxes, identifying the contents of the box

4.18. Tools

A complete set of tools and tool cabinet shall be furnished. The Design-Build Team shall provide one set of wrenches suitable for machinery maintenance and to fit all nuts and bolt heads in the machinery installation. Wrenches shall be drop-forged steel with chrome plating. In addition, a full set of square-shank flat head and Phillips head screwdrivers shall be furnished which will fit all machinery and electrical components together with an assortment of punches, files, chisels and a 32 oz. ball peen hammer. Punches and chisels shall be forged, hardened and tempered chrome vanadium steel.

The provided tools, grease, and grease guns shall be stored in a location approved by the Engineer in a cabinet or toolbox made of galvanized steel and having provisions for a padlock. Cabinet or toolbox shall be constructed of 24 Ga. material minimum.

4.19. Machinery Guards

All driving mechanisms and power transmission apparatus shall be guarded. Guards and shields must meet the full intent of requirements outlined in OSHA 1910.219. Guards shall be fabricated from 12-gauge steel. Guard supports shall be standard structural shapes fabricated

from ASTM A36. Guards shall be secured to supports utilizing tack welded bolts and wing nuts, suitable for hand tightening. Bolt holes shall be oversized such that assembly and disassembly can be accomplished without interference. Supports and guarding shall be shop painted. Guards shall be lightweight, yet provide enough rigidity to avoid significant deflection that would contact any rotating parts. All hardware shall be stainless steel.

4.20. Quality Control

The Department reserves the right to receive on demand a test report from an independent laboratory certifying that the equipment furnished meets these Minimum Technical Requirements. The cost of the testing will be paid by the Department if the material is found to be compliant, but it shall be paid by the Design-Build Team if the material is deemed non-compliant.

The Department reserves the right to reject an entire shipment of material if an item or group of items is found to be defective within a 30-day period following receipt of materials.

5.0 CONSTRUCTION

5.1. Shop Fabrication

The Design-Build Team shall provide the Engineer no less than ten (10) working days' notice before beginning work at foundries, forge and machine shops so that inspections and tests may be arranged. The Design-Build Team shall provide the Department the names and locations of casting, forging and machining suppliers; subcontractors and other suppliers; and furnish copies of orders that have been placed, prior to the start of any work.

The Design-Build Team shall allow the inspector, designated by the Department, free access and facilities for inspection of materials and workmanship in foundries, forge and machine shops. Such inspections are to facilitate work and avoid errors, but it is understood the Design-Build Team is not relieved of the obligation of assuring compliance with the plans and specifications or the necessity of replacing defective materials and workmanship. Any work performed while free access has been refused will be automatically rejected.

The inspector shall have full authority to reject materials or workmanship which does not fulfill the requirements of the contact documents.

The Design-Build Team shall perform all testing and furnish test specimens, certified copies of chemical and physical tests and certificates of compliance to the Engineer without additional charge. Initial acceptance of material and finished parts and assemblies shall not preclude subsequent rejection if found deficient. Correction of the deficiencies and/or replacement of materials shall be the responsibility of the Design-Build Team. Any materials, components or assemblies rejected after receipt at the bridge site shall be removed and replaced without additional cost to the Department.

5.2. Shop Inspection and Testing

The Design-Build Team shall completely assemble all machinery components to assure they fit as required and perform critical measurements to verify conformance with the approved working drawings.

5.3. Defective Materials and Workmanship

The Design-Build Team shall remove and replace, without additional cost to the Department, components determined defective and not made acceptable during inspection and testing. No claims for additional compensation due to delays resulting from defective materials and/or components will be recognized.

The Design-Build Team shall correct, without additional cost to the Department, defects resulting from faulty materials, workmanship, components or installation errors that are revealed during the warranty period. If corrections are not made in a timely manner the Department will make the necessary corrections and charge the costs to the Design-Build Team.

5.4. Shipment and Storage

The Design-Build Team shall clean all machinery components and assemblies of dirt, grit, chips, corrosion and other injurious substances before shipment and coat unpainted surfaces with an approved corrosion-inhibiting preservative.

All exposed moving contact surfaces shall be adequately protected during shipment. Take all precautions to assure these surfaces are not damaged during shipping and handling. Any damage or change in condition of a previously accepted material may be cause for rejection.

The Design-Build Team shall completely protect machinery parts from weather, dirt and foreign materials during shipment. The Design-Build Team shall store machinery parts indoors while awaiting installation and erection at the site and mount assembled units on skids or otherwise crate or protect during handling and shipping.

The Design-Build Team shall:

A. Bag and/or crate for shipment all mounting hardware and other small parts

B. Avoid co-mingling the parts

C. Identify each part with its number and keep separate from other parts

D. Provide tags recording the part number wired to the containers for each part prior to shipment

E. Coat bolts, nuts and other steel parts with approved rust-inhibitor

5.5. Erection

5.5.1. General

Erection and adjustment of machinery shall be by millwrights with demonstrated skill in this type of work. All machinery contact surfaces shall be thoroughly cleaned prior to field assembly.

5.5.2. Alignment and Bolting

The Design-Build Team shall:

A. Erect, assemble, and align the machinery in accordance with the approved Machinery Installation Procedure, and in accordance with manufacturers' recommendations

B. Adjust all parts mounted to steel for precise alignment and orientation by means of shims

C. Pull tightly against supporting members by use of clamps, temporary bolts, or other approved means before drilling and reaming holes for connecting fasteners.

Tapered shims may be necessary to obtain alignment, and shall be furnished at no additional cost to the Department.

Machinery components mounted to concrete shall be provided with a non-shrink grout completely filling the area between machinery and supporting concrete surface after final alignment has been confirmed and accepted. The Design-Build Team's RFC documents shall make it clear if loading through adjusting elements is acceptable or if the entire load shall by supported by grout only.

Racks and rack pinions shall be aligned such that the total backlash is within the recommendations of AGMA for the size of teeth and center distance, teeth exhibit 70% contact across the effective tooth face width, and cross mesh shall not exceed 0.001" per inch of tooth face throughout the range of operation.

Contact requirements for end lifts and center wedges shall be established by the Design-Build Team and be justified and shown in the design calculations.

Track top surface shall be flat and positioned level and balance wheels shall be adjusted such that the clearance between any wheel and track shall not exceed 1/16 inch. No more than two balance wheels shall be in contact with the track simultaneously in any position of the swing span, and the wheels in contact shall be adjacent.

Bolt holes in structural steel for attaching machinery components with turned bolts shall, generally, be drilled from the solid after final alignment of the machinery. During erection, a sufficient number of undersized, sub-drilled holes are permissible for the use of undersize, temporary bolts. When final alignment is achieved, drill and ream the remaining bolt holes and install full size bolts. Remove the temporary bolts, ream the undersize holes and install full size bolts.

In locations where existing bolt holes in the bearings and structures are to be reamed to accept a larger diameter turned bolt, use some of those holes for temporary bolting to achieve alignment.

When properly aligned, ream the unused holes to full size, install the full-size bolts; remove the temporary bolts, ream the remaining holes to full size and install full-size bolts.

Accuracy of the reamed holes through the machinery component, shims and structural steel is required to maintain correct alignment of the machinery. Use a structural steel reaming jig, affixed to the drill and secured to the work piece to prevent the reamer from deviating and assure a cylindrical hole throughout its length. Check holes with a bolt hole micrometer.

The Design-Build Team shall:

A. Torque all high-strength bolts in accordance with the 2012 NCDOT *Standard Specifications for Roads and Structures* and these Minimum Technical Requirements, and tension turned bolts to at least 70% of the bolt proof load or as recommended by the equipment manufacturer.

B. Coat threads for all turned bolts with anti-seize compound before assembly to avoid corrosion or galling and ease future removal.

5.6. Painting

5.6.1. General

The Design-Build Team shall:

A. Clean and paint all machinery, equipment and supports as required using a three (3) coat system in accordance with the 2012 NCDOT *Standard Specifications for Roads and Structures* and these Minimum Technical Requirements.

B. Submit an outline of painting materials and methods with the shop drawings.

All coats shall be by the same manufacturer and shall be compatible with one another.

Factory painted machinery shall be hand-tool or solvent cleaned and overcoated with a prime coat and a top coat of the approved paint system in the appropriate color.

5.6.2. Shop Painting

The Design-Build Team shall prepare surfaces in accordance with the paint manufacturer's recommendations. Where blasting may be injurious to the component, prepare surfaces with wire brushing or other approved means.

The Design-Build Team shall use masking to avoid painting machinery surfaces which are in normal rubbing contact, such as shaft journals and bushings, and sliding guides.

After properly cleaning the surfaces, the Design-Build Team shall apply one prime coat and one intermediate coat of shop paint in accordance with the paint manufacture's recommendations to all unfinished machinery surfaces. Surfaces which will be in non-moving contact at field assembly shall receive only prime coat.

5.6.3. **Field Painting**

Upon completion of final alignment and final bolting of machinery, and after removing all accumulated grease, oil, dirt and other material, apply a final finish coat. This third coat shall be one of the following colors for safety identification:

Federal Safety Green:	All stationary machinery components, such as machinery frames, bearing housings, brackets, etc.
Federal Safety Orange:	All moving parts such as shafts, coupling, wedges, etc. (Note: No rubbing surfaces, such as journal surfaces on shafts, are to be painted.)
Federal Safety Red:	Apply to all electrically actuated parts such as motors, brakes, actuators, etc.

5.7. Machinery Functional Checkout

All machinery shall be tested during the Functional Checkout Inspections specified in these Minimum Technical Requirements

The Design-Build Team shall provide a complete crew of machinists to be available during testing to and make all adjustments and corrections required to complete the tests.

During the test runs, observe and inspect all machinery assemblies to determine if everything is in proper running order and fully meets the requirements of the contract documents, special provisions and the manufacturer's performance standards. The Department and representatives of the machinery and electrical control manufacturers shall be present and witness all field testing. Temperature rises in mechanical and electrical equipment shall not exceed design and/or manufacturer's limits.

If testing shows that components are defective, inadequate, functioning improperly or incorrectly adjusted, make all corrections, adjustments, repairs or replacements necessary before final acceptance at no additional cost to the Department.

BRIDGE ELECTRICAL SYSTEM

1.0 DESCRIPTION

1.1. General

The Design-Build Team shall design, detail, fabricate, test, install, program and place into satisfactory and permanent operating condition the complete electrical power and controls system as described in these Minimum Technical Requirements. The Design-Build Team shall produce Plans and Special Provisions in accordance with the Submittal Requirements elsewhere in these Minimum Technical Requirements.

1.2. Reference Standards

The Design-Build Team shall furnish and install all electrical items in compliance with the applicable requirements of the latest standards and codes of, but not limited to, those organizations designated in these Minimum Technical Requirements.

1.3. Rules, Regulations and Organizations

The Design-Build Team shall ensure that all work complies with all applicable federal, state and local rules, regulations and ordinances. In the event of a conflict between these Minimum Technical Requirements and the federal, state and local codes, standards, rules, regulations and ordinances the most stringent requirement applies.

The Design-Build Team shall file with the Engineer a certificate of final electrical inspection and acceptance by the Board of Fire Underwriters or an approved inspection agency.

1.4. Qualifications and Personnel

All construction and installation shall be made by workmen skilled in this type of work and under the supervision of an experienced and qualified electrical supervisor. All personnel shall be capable of executing the work in a neat and workmanlike manner such that the work will present a neat and mechanical appearance when completed.

2.0 DESIGN CRITERIA AND CHARACTERISTICS

2.1. General

A. Electrical equipment shall be selected, designed, fabricated and installed in accordance with AASHTO *Movable* and the National Electrical Code, unless noted otherwise in these Minimum Technical Requirements.

B. Plans shall be developed for the electrical work. The units shown in the Plans shall be English Units.

C. Where not explicitly noted, materials for devices, supports, fasteners and miscellaneous components shall be selected for outdoor use in a marine environment, compatible with the corrosion designation for this project elsewhere in the RFP.

2.2. Electrical System Characteristics

The following provides a description of general operating features required for the electrical system. It does not represent an all-inclusive detailed scope of work, nor shall the Design-Build Team be relieved of any obligation to provide a complete system that satisfies the requirements of the RFP, AASHTO *Movable*, the National Electrical Code, these Minimum Technical Requirements, and other prevailing codes and requirements, as applicable.

A. The swing span shall be capable of being locally operated from the Bridge Tender's House and remotely from the Remote Control Station.

B. The control system shall not permit simultaneous local and remote operation.

C. Traffic warning gates, barrier gates, pedestrian gates, signals, and roadway signage shall be provided and interconnected with the bridge control system to ensure correct sequence of operation.

D. The control system shall incorporate programming logic, interlocks, and other safety features specifically designed to facilitate remote operation of the swing span.

E. The control system shall include safety interlocks so that operations cannot be performed out of correct order. Keyed bypass switches shall be provided to override interlocks.

F. Emergency stop buttons shall be provided to safely bring the bridge to a stop by applying brakes during any point of span operation. E-stop buttons shall be provided in the Bridge Tender's House and at the Remote Control Station.

G. A generator shall be provided to power the bridge and associated functions in case utility power is disrupted.

H. Intercommunications shall provide intercom, public address and radio communication from the Bridge Tender's House and the Remote Control Station.

I. Submarine cabling shall be used to convey power and communications across the navigation channel.

J. The closed-circuit television camera system shall incorporate enhanced fields of view, operational features, and other physical characteristics to facilitate remote operations.

K. Phone lines for the bridge shall be provided, including dedicated lines for security, internet and alarm systems.

3.0 REQUIRED SUBMITALS

All electrical submittals shall be submitted in accordance with the Submittal Requirements found elsewhere in these Minimum Technical Requirements.

The Design-Build Team shall include all electrical submittals on the approved CPM Schedule.

3.1. Design Submittals

Electrical Design Calculations/Plans/Special Provisions may be subdivided for different systems and submitted separately to complement the Design-Build Team schedule. Design calculations shall be submitted prior to or concurrently with Plans of the same level. Approved Released For Construction (RFC) Electrical Plans and Special Provisions shall be obtained prior to ordering of materials or starting fabrication.

3.1.1. Design Calculations

The Design-Build Team shall submit detailed calculations to the Department for review and approval prior to or concurrently with Plans of the same. Final calculations shall be prepared, signed and sealed by a Professional Engineer registered in the State of North Carolina. The calculations shall demonstrate electrical design compliance to the requirements of all applicable specifications including these Minimum Technical Requirements. Submitted calculations shall

include but not limited to voltage drop calculations, lighting level calculations, electrical load for sizing electrical service.

3.1.2. Plans

Electrical Plans shall be developed and submitted by the Design-Build Team to complement the special provision and to provide all construction requirements for the Bridge Electrical work. RFC Plans shall be signed and sealed by a Professional Engineer licensed in the State of North Carolina.

3.1.3. Special Provisions

Electrical Special Provisions shall be developed and submitted by the Design-Build Team to complement the Plans and to provide all construction requirements for the Bridge Electrical work. RFC Special Provisions shall be signed and sealed by a Professional Engineer licensed in North Carolina.

3.2. Post-Design Submittals

Post-design electrical submittals shall be submitted in accordance with the Submittal Guidelines elsewhere in these Minimum Technical Requirements. The Design-Build Team shall include working drawings, installation procedures, testing procedures, operational and material testing results, and operation and maintenance manuals.

In addition to electrical shop drawings and Functional Checkout submittals described elsewhere in these Minimum Technical Requirements, the following submittals are required as a minimum:

A. Electrical Installation Procedures

B. Operation and Maintenance Manuals

C. Testing Procedures

D. Testing Results

E. Spare Parts List

F. As-built Plans

3.3. Shop Drawings and Submittals

The Design-Build Team shall review all shop drawings prior to submitting to the Department. The Design-Build Team's review of the working drawings shall be evidenced by signature and date of review and stamp or annotation to this effect on each page or sheet of the submittal.

The Department will not be responsible for errors of working drawings, even though approval has been indicated, or for quantities or bills of material which may be included. Any failure of the Department to correct errors on working drawings, or implied approval thereof, shall not relieve the Design-Build Team of the full responsibility for the safe and adequate execution of the work in accordance with the Scope of Work and these Minimum Technical Requirements and shall result in no additional contract time or cost to the Department.

After review of the working drawings by the Department or their Representative, no changes shall be made without resubmission for approval by the Engineer, and all changes or revisions later made shall be clearly marked and dated.

Full size drawings shall be submitted in half size format on those items requiring construction from such drawings. Descriptive leaflets shall be provided for standard catalog items which are mass produced.

The Design-Build Team shall submit shop drawings for all cabinet enclosures, motors, panelboards, transformers, switches, raceways, conductors, wiring devices, lighting fixtures, lamps, service equipment, boxes, control equipment, fasteners and other such equipment, and methods of fastening to structures. The Design-Build Team shall not purchase equipment without approval of shop drawings.

Shop drawings shall include manufacturer's test data, shall be certified by the manufacturer, and shall identify the application for which they are proposed.

Equipment identification shall be the same as shown on the drawings. Standard drawings showing more than one model or size shall be marked to indicate the model or size proposed.

Shop drawings of cabinets containing electrical equipment shall include outside dimensions, areas for conduit penetrations, one-line diagrams, wiring diagrams, schematic and interconnection diagrams, terminal block arrangements and numbers if such terminal blocks are intended for connection of field wiring, and operating instructions.

The Design-Build Team shall provide layout drawings and geographic wiring diagrams for the control desk and for the programmable controller cabinets.

The Design-Build Team shall submit shop drawings when installation and mounting details of switches, fixtures, and devices are different from or not specifically detailed on the drawings.

If requested by the Engineer, the Design-Build Team shall submit for inspection samples of the proposed substitute items at no cost to the Department. All support data shall be submitted in quintuplicate for checking. The Department, or their Representative will not be liable for any materials purchased or work done or any delay incurred prior to their review. Failure of the Department or their Representative to note unsatisfactory materials as received will not relieve the Design-Build Team from responsibility. Manufacturers' guarantees or warranties on materials shall be delivered to the Department upon receipt of the materials.

** Note ** Deleted text regarding delivery of As-Built drawings.

** Note ** Deleted text regarding format of As-Built drawings.

4.0 MATERIALS

4.1. General

All ferrous metal work shall be hot-dip galvanized in accordance with ASTM A123 or ASTM A153, whichever is applicable. If any galvanizing is damaged, make repairs according to NCDOT galvanizing repair procedures. Lock washers shall be provided on all mechanical fastenings.

In order to prevent deterioration due to corrosion, all bolts, nuts, studs, washers, pins, terminals, springs, hangers, cap screws, set screws, tap bolts, brackets, and other hardware fastenings and fittings shall be of an approved corrosion-resisting material such as stainless steel. Hot-dip galvanizing, per ASTM Specification A 153, will be considered approved treatment for all non-moving ferrous hardware. Do not mismatch material types to cause galvanic reactions.

4.2. Structural Steel

Material for support of limit switches shall conform to the requirements of ASTM A36 structural carbon steel. Bolts used shall conform to the requirements of ASTM F3125, Grade A325, Type 1 bolts and hardened steel washers shall be provided. Bolts, washers, and nuts shall be hot dipped galvanized.

4.3. Raceways

4.3.1. Conduit

Aluminum conduit, intermediate metal conduit, and electric metallic tube will not be permitted. Limit conduit support spacing to 5 feet. Use only PVC-coated galvanized rigid steel conduit for all above-ground, non-embedded applications in dry locations. Use only Schedule 80 PVC for installation underground or embedded in concrete and for wet locations. Conduits shall be 3/4" minimum trade size, comply with AASHTO *Movable*, and meet NEC fill requirements.

UL-listed liquid-tight flexible metal conduit with a bonding jumper may be used for electrical connections to equipment and devices that require periodic adjustment (maximum length of 2 feet).

Equivalent number of 90-degree bends between boxes in any one conduit shall be limited to three.

4.3.2. Cable Trays

Use ladder-type cable trays that comply with NEMA standards and that can sustain a minimum of 50 plf on a 12 ft span with a safety factor of 2. Orient trays parallel or perpendicular to the main structural lines of the structure. Trays shall be mechanically connected at joints, fittings, and terminations, and shall provide a continuous ground path. The interconnections of the sections, fittings and other components shall provide a rigid mechanical assembly when properly supported and with splice plates properly installed to avoid structural weakness. Tray splices

shall be located at the 1/4 points of the span between supports. Drilling or welding of the steel bridge members will not be permitted.

4.3.3. Installation

Raceway installation details, including joints, couplings, drainage, bends, penetrations, supports, attachments, cleaning and identification shall be in accordance with industry standards and clearly delineated in the plans and special provisions prepared by the Design-Build Team.

4.4. Conductors

4.4.1. General

Insulated conductors and conductor accessories shall be provided in sufficient quantities for a complete installation. Installation shall be in accordance with the National Electrical Code, and shall include placement, splicing, terminating, identification, testing, and verification of each circuit and conductor.

Conductors at 480 volts (power conductors) potential shall not be routed in the same raceway as conductors at 120 volts potential or less (control conductors).

4.4.2. Submarine Cable

The Design-Build Team shall furnish and install submarine cables in accordance with AASHTO *Movable* (and all documents referenced therein) to provide for cross-navigation channel power and control of all movable machinery, traffic control devices, navigation lighting, swing span roadway lighting, and any other devices, equipment and systems necessary for completion of the work. Each cable shall include a minimum of 10 percent spare conductors and at least one spare 1 1/2" diameter conduit for future use. Submarine cables shall terminate in a terminal cabinet with terminal blocks at each end.

The Design-Build Team shall obtain the necessary permits and install the submarine cables as required by the United States Coast Guard, the United States Army Corps of Engineers, and other agencies or authorities having jurisdiction.

4.4.3. Swing Span Flexible Cable

Provide flexible cable between submarine terminal box at the pivot and the swing span. Flexible cable shall be installed to withstand full bridge swing movement and shall be supported to minimize pulling tension and abrasion. Provide pulling grips at each end of the flexible cable. Provide low density polyethylene sheeting or other low abrasive material below the flexible cable on top of pier. Direct contact between the flexible cable and concrete on the pier shall be prevented.

4.4.4. Circuit Identification

Each circuit shall be identified at both ends with an identification tag. Tags shall be of a printed material permanently attached to outer jacket of the cable and to each end of the respective

conductors for multi-conductor cables. Identification shall be permanent and waterproof. Once installed, the marking shall not be removable except by cutting it loose from the cable.

4.4.5. Installation and Placement

The drawing of wire and cables into conduits shall be done without injury to the wires or their insulation or covering.

All cables shall be installed as recommended by the manufacturer. The manufacturer's recommended maximum pulling tension and minimum bending radius shall be adhered to during installation. Use the necessary guides, pulleys, sleeves, and pulling aids to prevent abrasion and damage to the cables during installation. Lubricants recommended by the cable manufacturer and acceptable to the Engineer shall be used for the pulling of conductors or cables. Both ends of every single length of conductor shall be permanently and clearly tagged with approved tags marked in accordance with the same number and designation shown on the wiring diagrams. All outgoing wires No. 8 AWG or smaller in the control desk, on the switchboards and panels and in terminal cabinets shall be connected to terminal blocks.

Spare conductors of a multi conductor cable shall be left at their maximum lengths for possible replacement of any other conductors in the cable. Each spare conductor shall be coiled and then taped to the conductors being used.

Twisted shielded pair conductors or instrument conductors shall not be terminated at any point except at point of origin or point of finish. Where instrument conductors are required to connect to other instrument conductors, the individual conductors and shielding shall be spliced in accordance with the manufacturer’s instructions. The splice connections shall then be taped and wrapped to ensure adequate seal from noise and environment in accordance with the manufacturer’s instructions.

Conductors inside terminal boxes and at the control panels and control desk shall be installed in plastic wire ways or shall be neatly formed into cables and laced with two strands of an approved wax-treated linen cord, with the individual conductors leaving the cable at their respective terminal points. These conductors shall be looped to allow not less than three (3) inches of free conductor when disconnected. These formed cables shall be held securely away from the terminals and from contact with the cabinet by means of approved insulating supports. Wiring duct meeting JIC standards will be acceptable.

All terminal strips shall be provided with approved permanent terminal markings for each connected conductor in service. The marking shall be placed on a material which will not be affected by age or moisture and shall be given two coats of clear lacquer after the markings are placed thereon or as stated elsewhere in these Minimum Technical Requirements.

Splicing of conductors will not be permitted except for wiring to service lighting fixtures and receptacles. All splices, T taps, and free ends of 600 volt cables shall be insulated. General use cables shall be insulated with type 33 tape. High ambient cable shall be insulated with type 70 tape.

Wherever it becomes necessary to terminate, joint, or branch conductors, terminal blocks in boxes shall be used.

Cable connections for No. 8 and smaller, for making terminations and splices shall be with high pressure indent type pressure connectors.

All insulated conductors shall be electrically tested after placement. All circuits, including lighting circuits, shall be tested with the circuit complete except for connections to equipment. All splices shall be complete prior to testing. Any circuit failing to test satisfactorily shall be replaced, or repaired and retested as directed by the Engineer.

4.4.6. Tests After Placement

All insulated conductors shall be tested for continuity and conductor identification. In addition, all insulated conductors of multi-conductor cable shall be tested for short circuits. The Design-Build Team shall provide portable, battery powered, ring testers, and other test equipment as required to conduct these tests.

A. Continuity tests shall include all tests necessary to confirm that each conductor is continuous throughout its entire length.

B. Identification tests shall include all tests necessary to confirm that the conductor being investigated originated and terminates at the locations designed in the Circuit List.

C. Short circuit tests shall include all tests necessary to confirm that no conductor of a multi-conductor cable is short circuited to another conductor in that cable.

D. Power and Control Cable Rated below 2,000V: All insulated conductors, except instrumentation cable, rated less than 2,000V shall be tested with a 1,000V Megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptable resistance values shall be in excess of 100 Megohms. The Design-Build Team shall submit test results.

E. Instrumentation Cable: All insulated conductors of supervisory and communication cable shall be tested with a 500V Megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and the cable shielding tape and between the two conductors in each pair. Minimum acceptable resistance values shall be 50 Megohms divided by the actual cable length in miles.

4.5. Boxes

All exterior surface mounted pull, junction, splice, and terminal boxes shall be 14-gauge stainless steel, NEMA 4X, and shall be provided with hinged, overlapping covers of the same material, with pad-lock provisions. Wall-mounted boxes installed in the new Bridge Tender's House shall be NEMA 12.

Drain holes shall be provided in the boxes. All boxes shall be provided with mounting lugs and shall be securely fastened to the structure with not less than four stainless steel through-bolts.

All cast-iron boxes shall be bossed, drilled, and tapped for threaded conduit ends, which shall enter squarely. No box or enclosure shall be drilled for more conduits than actually enter it.

Boxes for surface or exterior mounted wiring devices shall be weatherproof rated, cast-iron, hot-dipped galvanized, Type FS, FD, or approved equal.

Framework for supporting boxes, switches, and other externally mounted electrical devices shall be fabricated from structural steel Type A36 not less than 3/8-inch-thick, or if material of thickness less than 3/8 inch is used it shall be hot-dip galvanized.

All mounting bolts, nuts, washers, and other hardware used for fastening boxes, disconnect switches, devices, lighting outlet boxes, conduit clamps, and similar devices shall be stainless steel. Bolt heads and nuts shall be hexagonal, and bolts smaller than 3/8 inch in diameter shall not be used except as may be necessary to fit the mounting holes in small devices, outlet boxes, and similar standard equipment.

4.6. Wiring Devices

General use, single pole, or 3 way switches shall be heavy-duty, industrial-grade as manufactured by Arrow-Hart, Bryant, General Electric, Hubbell, or approved equal.

General use, duplex receptacles shall be heavy-duty, industrial as manufactured by Arrow-Hart, Bryant, General Electric, Hubbell, or approved equal. GFI protection shall be provided by GFI circuit breakers or GFI receptacles where required by the NEC.

Devices installed outdoors shall meet NEC Art. 410-57 and shall be corrosion-resistant, with gray fiberglass weatherproof covers, suitable for wet locations and UL listed.

Cover plate for flush installations shall be .040 inch thick satin finished Type 302 stainless steel. Cover plates for indoor surface installation shall be cast aluminum or cadmium-plated cast-iron. Covers shall fit Type FS or FD boxes without overlapping edges or corners.

In addition to other convenience outlets noted elsewhere in these Minimum Technical Requirements, provide a minimum two convenience outlets at, or near, the mechanical equipment on each pier.

4.7. Nameplates

Nameplates shall be provided for all major pieces of equipment named on the approved RFC Plans, for all devices on the control desk and in panels. The nameplates shall be made of laminated micarta or textolite with chamfered edges and shall be engraved to show BLACK letters on a WHITE background. They shall be mounted with stainless steel screws. Nameplates for devices shall be consistent with schematic wiring diagrams prepared by the Design-Build Team. Fuse nameplates shall show the type, ampere, and voltage rating of the fuses.

4.8. Motors

Motors shall be built in accordance with NEMA standards. All exposed metal surfaces shall be protected with a moisture-proof corrosion-resistant polyester paint or coating. Exposed unpainted and uncoated metal surfaces shall be of a heavy-duty corrosion-resistant material. The rotors shall be balanced mechanically and electrically. All windings shall be provided with special insulation to retard decrease in insulation resistance due to excessive moisture. Each motor shall have Class B insulation.

The motors shall be installed with approved sizes and types of wire terminals and splice fittings for the connection of the motors to the circuit wiring. Each motor shall be furnished with a cast-iron frame, bearing brackets with re-lubrication fittings and conduit connection box.

Each motor having a horsepower of 1/3 HP or larger shall be 480 volt, 3-phase, 60 Hertz, totally enclosed, non-ventilated, 30 minute rated, squirrel cage induction motor.

Where motors are supplied as an integral part of another item, the motors shall be of a NEMA design and speed compatible with that item.

Motor mounted solenoid brakes supplied with the traffic gate and pedestrian gate assemblies shall be motor-mounted, totally enclosed spring-set, solenoid-release, disc brake with hand release lever.

4.9. Panelboards

The Design-Build Team shall provide and install cabinets in accordance with AASHTO *Movable*. Mounting height above the floor shall be 6'-6" at the top.

4.9.1. Cabinets

Panel shall be dead front type and enclosed in a code gauge galvanized sheet steel cabinet complete with hinged door, lock and two keys, finished in ANSI 61 Light Gray enamel paint, with circuit directory filled out in type and with all exposed metal surfaces prime coated and factory painted. All locks shall be keyed alike. Cabinets shall be of sufficient size to provide gutter space no less than that required by the Underwriter's Laboratories and in no case less than four (4) inches.

4.9.2. Mains

Mains shall be equipped with automatic circuit breakers for branch circuit protection. Buses shall be rigid copper or copper alloy, installed to provide consecutive phasing. Solid neutral bus shall have solderless connectors, shall be insulated from the cabinet and shall have an ampacity equal to the ampacity of the phase buses. Equipment grounding bus shall be bonded to the cabinet, shall have solderless connectors and a main lug. All copper parts shall be plated to prevent corrosion.

4.9.3. **Branches**

Branch circuits shall be changeable without additional machining, drilling or tapping. Branch circuit connections shall provide sequence phasing, with connections permanently identified on the face of the front of the panel interior.

4.9.4. **Circuit Breakers**

Circuit breakers shall be of the indicating type, providing distinctive "on", "off", and "tripped" positions of the operating handle. All multi-pole breakers shall be so designed that an overload in any one pole automatically causes all poles to open. Multi-pole breakers shall have a single operating handle. Single pole 15 and 20 ampere branch breakers shall be UL listed for switching duty.

Breakers shall be thermal magnetic type having inverse time delay thermal trip on overloads and instantaneous magnetic trip on short circuit. Circuit breakers shall be quick-break, quick-make on manual, as well as automatic operation. Each circuit breaker shall be independently removable without disturbing adjacent units or other bus connections and shall be fastened to the main bus bars with a bolt-on connection. All copper parts shall be plated to prevent corrosion.

All 100 ampere frame breakers shall have an interrupting rating of 10,000 amperes A.C. All larger frame size breakers shall have an interrupting rating of 22,000 amperes.

4.10. Dry Type Transformers

Dry type transformers suitable for indoor mounting shall be provided in the quantity, voltage, phase, KVA rating, and method of mounting as required. Transformers shall be UL 1561 listed and labeled "Suitable for non-sinusoidal current loads" with a K factor not to exceed a rating of K-30.

Transformers shall be Class AA. The temperature rating shall rise above ambient, as listed below. Primary taps shall be as listed below.

	Below Normal	Above Normal	Temp. Rise
Single phase less than 25 kVA	Two 5 percent	---	115ºC
Single phase 25 kVA and larger	Four 2-1/2 percent	Two 2-1/2 percent	80ºC

Transformers shall be provided with electrostatic shields between the primary and secondary windings. Transformers shall have a rated sound level of 45 decibels or below when measured in accordance with NEMA Standards. Wall hanger brackets especially designed to accommodate the transformers shall be provided with all wall-mounted transformers.

Transformers shall be thoroughly cleaned, then given a rust resisting primer coat and two or more finish coats of paint or enamel. Transformers shall be finished with ANSI 61 Light Gray indoor paint.

The Design-Build Team shall submit manufacturer's data on power/distribution transformers, including certification of transformer performance efficiency, percentage regulation at 100% and 80% power factor, no-load and full-load losses in watts, % impedance at 75° C, hot-spot and average temperature rise above 40° C ambient, sound level in decibels, and standard published data.

4.11. Motor Starters Contactors

The new starter contactors shall conform to NEMA Standards. All motor starters shall have full voltage overload relays, auxiliary contacts and all accessories specified herein. Motor overload elements shall be provided to match motors provided in accordance with manufacturer's instructions.

Motor starters shall be 3-pole, magnetic type with indicting motor circuit protectors. Circuit breakers for motor protection shall be of the adjustable instantaneous type sized for the motor to be connected.

Metering equipment for service voltage and current readings shall be provided and the readings displayed on the control panels at both the Bridge Tender's House and the Remote Control Station.

An incoming line transient surge protection device (SPD) shall be provided and installed. The SPD shall be a heavy-duty unit with audible alarm, modular design, self-test capability, modular design, rated for 200ka for service entrance protection at 277/480 volt grounded wye. Unit shall be UL 1449 3rd edition listed.

4.12. Span Drive Motors and Motor Controllers

4.12.1. General

Each span drive shall consist of a motor, flux vector drive, tachometer, and overspeed limit switch. Each motor shall be equipped with an encoder for flux vector drive feedback.

The motor and drive combination shall be provided from the same vendor.

The span drive and controller must be capable of 4 quadrant operation, including over hauling loads in either direction, at any speed, from fully stopped to full speed. The highest torque (in either direction) is determined by the worst case AASHTO *Movable* loads.

The motor shall be sized in accordance with AASHTO *Movable*. The drive and motor combination shall be sized to provide torques and speeds required by all AASHTO *Movable* load combinations and be within the manufacturer's torque/speed/time limitations. The drive and motor shall be sized so that the maximum torque (at any speed) does not exceed the maximum structural or mechanical design limitations. Adjustable drive torque limiting is acceptable.

The (speed torque) or (speed current torque) curves need only be provided for the motor and drive combination.

The motor and drive shall be rated to operate at full load through the bridge operating temperature range.

The motor and drive combination shall be equipped with an in-sight disconnect.

4.12.2. Motors

The Design-Build Team shall provide the induction motor(s) (squirrel cage type) with the following characteristics:

A. Totally Enclosed, may be fan cooled

B. Continuous duty

C. Space heater equipped

D. Rated for flux vector drive service

E. Housings protected for marine duty

F. Ambient operating temperature: 40° C or better

4.12.3. Flux Vector Drives

Drive shall meet all requirements of IEEE 519 to limit harmonic distortion at the drive input terminals. Limit Total Harmonic Distortion (THD) to reduce harmonics to the allowable limits in excess of the prescribed limits of the utility company.

Drive shall be capable of operating at different speeds and torques. Maximum torque shall be limited. Drive shall be equipped with over current, over heat detection. Drives shall be equipped with space heaters. Drive shall include relay closure input for emergency stops.

4.12.4. Shop Tests

The motor and drive combination shall be shop tested, showing normal and over-hauling loads in both motor directions, at speeds required for bridge operation, including zero (0) speed. Speed and acceleration profiles shall be typical for bridge operations. Motors shall be tested for a sufficient length of time to demonstrate no over-heating or over-current problems. Shop testing shall also demonstrate correct fault condition operations.

The motor and drive combination shall be shop tested with generator or other alternate power source showing frequency and voltage variations within limitations.

4.13. Auxiliary Span Motors

4.13.1. General

Auxiliary span motors may be used instead of flux vector drives for backup or redundancy purposes only. The motor shall be sized so that the maximum torque (at any speed) does not exceed the maximum structural or mechanical limitations. The motor shall be sized to meet the worst case AASHTO *Movable* load conditions. The motor shall be sized so that all bridge operations are within the manufacturer's torque/speed/time limitations, considering the minimum

bridge operating period on a continuous basis. The manufacturer must certify the appropriate duty cycle. This specifically includes (but not exclusively): starts per hour, over torque during acceleration and deceleration, over torque due to various AASHTO *Movable* conditions, and motor duty cycle; at the highest bridge operating ambient temperature. The control system shall have interlocks preventing motor use beyond the current/torque/time limitations. Motors shall be equipped with an in-sight disconnect. The proposed duty cycle, motor speed torque curves, and motor manufacturer's certifications shall be submitted to the Engineer.

4.13.2. **Motors**

The Design-Build Team shall provide the induction motor(s) (squirrel cage type), which may be multi-speed, with the following characteristics:

A. Totally Enclosed

B. Space heater equipped

C. Housings protected for marine duty

D. Ambient operating temperature: 40° C or better

4.13.3. **Shop Tests**

The motor shall be shop tested, confirming the manufacturer's speed torque curves. The motor temperature shall not exceed limitations over the worst-case duty cycle and repetition rate.

The motor and drive combination shall be shop tested with generator or other alternate power source showing frequency and voltage variations within limitations.

4.14. Service and Distribution

4.14.1. **General**

Commercial electric service for all bridge functions will be supplied by Hertford Public Utilities at 480 V nominal, 3-phase, 4-wire, grounded wye, 60-Hertz. See Utilities Scope of Work found elsewhere in this RFP. The Design-Build Team shall provide surge protection on incoming service meeting the requirements of UL 1449, third edition, and in accordance with AASHTO *Movable*.

4.14.2. **Service Disconnect**

The Design-Build Team shall provide disconnect switches in accordance with AASHTO *Movable*. Coordinate with the electric utility provider the number and location disconnect switches required.

The utility meter will be provided and installed by the power company. The meter pack shall be provided by the Design-Build Team.

4.14.3. Service Grounding

The Design-Build Team shall verify the electrical service supplying the bridge is solidly grounded. Coordinate with the electrical utility provider as needed.

4.14.4. Equipment and Structure Grounding

The bridge, Bridge Tender's House, generator structure and electric service shall be grounded and inter-bonded integrally with the Lightning Protection System in these Minimum Technical Requirements.

4.14.5. Lightning Protection System

The Design-Build Team shall provide and install a complete lightning protection system with UL Master Label, including air terminals, conductors, attachment hardware and ground terminals in accordance with AASHTO *Movable* and NFPA 780 for the bridge, bridge tender's house, and generator structure.

4.14.6. Ground Resistance

Ground resistance shall have a value of 10 (ten) ohms or less after connection to the service equipment and shall be measured with an approved ground tester.

Ground resistance measurements shall be taken as follows:

A. The resistance of each individual ground rod shall be measured at the time of installation and before connection to the ground bus. If the resistance is greater than 25 ohms, a second rod shall be driven near the rod being tested.

B. The resistance of the ground bus shall be measured, with all rods connected to the bus prior to connection to the service equipment.

C. The resistance of the ground bus shall be measured with all rods connected to the bus after connection to the service equipment.

Submit results of the test to the Engineer.

4.15. Lighting

The Design-Build Team shall provide all fixtures, equipment, components, and other materials related to the swing span. Lighting requirements for the swing span apply to the bridge tender parking area, generator structure, Bridge Tender's House (interior and exterior), roadway, sidewalks, navigation channel, and maintenance areas. Navigation lighting can be found elsewhere in these Minimum Technical Requirements. For complete roadway and sidewalk requirements, coordinate these Minimum Technical Requirements with the Lighting Scope of Work elsewhere in the RFP.

Provide LED fixtures and light levels to meet IES requirements where not directed elsewhere in the RFP. Provide a minimum of 20 foot-candles of illumination in and around all equipment in the machinery and electrical areas, including access ways to those areas.

Provide shock-absorbing lamp receptacles for fixtures on the swing span and other locations where vibration may be detrimental to lamp life.

Design the interior lighting at the Bridge Tender's House to produce a uniform glow through the windows when viewed from the outside (lantern effect). The interior lighting system shall not impair the operator's visibility of the exterior through the windows during nighttime hours.

Illumination within the field of view of the CCTV system cameras (elsewhere in these Minimum Technical Requirements) shall provide a level of clarity during nighttime hours that is acceptable to the Engineer. Illumination within the navigation channel shall provide for safe navigation, in the opinion of the Engineer and the USCG, during nighttime hours,

Verify that a continuously illuminated pathway exists between the parking area and the Bridge Tender's House. Supplement with additional lighting as required.

Provide fixtures and all component electrical parts that are UL listed. Submit catalog cuts of fixtures with complete photometric data to the Engineer for review and approval. Colors and finishes are subject to review and approval by the Engineer.

4.16. Navigation Aids

The Design-Build Team shall provide and maintain all aids to navigation during and after construction, including (but necessarily limited to) navigation lights, signals, reflective markers, audible warning devices, and marine communications in accordance with the rules and regulations outlined in United States Coast Guard (USCG) requirements as detailed in the Code of Federal Regulations, Title 33, Chapter I, Subchapter J, Part 118 (33 CFR 118), and all phases of such work shall be completed to the satisfaction and approval of the USCG.

4.16.1. Navigation Lights

The Design-Build Team shall provide navigation lighting in accordance with the Lighting Scope of Work found in the RFP and in Section 11.2.1 of the Lighting Project Special Provision. Protect navigation lighting with bird spikes.

4.16.2. Channel Markers

The Design-Build Team shall provide reflectors, signs and other devices as required by the USCG and 33 CFR 118 to clearly mark the active channel(s) during and after construction.

4.16.3. Air Horn

The Design-Build Team shall provide a complete, weather-proof air horn signaling system consisting of an air compressor, duplex air horn, piping and all hardware necessary for operation in accordance with USCG requirements.

4.17. Communications

4.17.1. Intercom

The Design-Build Team shall provide a two-way communication system between machinery areas and the Bridge Tender's House that works similar to an office telephone system with station-to-station calling from any station on the system and all call to all stations on the system from the main intercom panel. Each station must have a hands-free capability. A call initiated from one station to another must open a channel and give a tone at the receiving end. The receiving party must have the capability of answering the call by speaking into the open speaker channel, or by picking up the local receiver and speaking into it. All intercom equipment must be capable of operation in a high noise environment. Provide a handset mounted adjacent to the control console, in a weatherproof enclosure near the machinery at the pivot pier, and at the generator.

Components of the system exposed to the detrimental effects of weather and the environment shall be appropriately rated, fabricated and installed. All cabling between system components shall be installed from point to point in accordance with the manufacturer's recommendations with no intermediate splices.

4.17.2. Public Address System

The Design-Build Team shall provide a one-way handset communication system from the control console in the Bridge Tender's House to the roadway and sidewalk approaches at each end of the swing span, the navigation channel, and the pivot pier. Include an "all call" feature that enables the operator to call all zones at once. Speakers shall be mounted facing both directions in the channel for marine traffic and facing oncoming traffic at the roadway.

4.17.3. Marine Radio

The Design-Build Team shall provide a marine radio communication system that complies with USCG requirements. Provide a hand-held, portable radios tuned to an appropriate channel with a 120V charger adjacent to the control console in the Bridge Tender's House. The radio shall be operable on or off the charger.

Evaluate the effectiveness of the existing marine radio communication system at the Remote Control Station to communicate with boaters in proximity to the swing span. Modify, supplement, or replace as needed to provide a reliable means of marine radio communication for the bridge from the Remote Control Station.

4.17.4. Closed-Circuit Television

The Design-Build Team shall provide a closed-circuit television system for bridge operation and security. The system shall provide clear, unobstructed views of the roadway, sidewalk, navigation channel (under the bridge as well as upstream and downstream), limited access areas of the bridge, Bridge Tender's House (interior and exterior), generator, parking lot, and other areas deemed necessary for safety and security. The CCTV system shall be designed so that

failure of a single camera will not impair safe operation of the bridge from the Remote Control Station. For field of view requirements related to remote operation, see Remote Operations elsewhere in these Minimum Technical Requirements.

The CCTV system shall include a network of cameras to provide the required visibility. The network of cameras shall include a combination of fixed and pan/tilt/zoom devices located throughout the project to produce the required field of view and shall be fully visible and operable from the Bridge Tender's House and the Remote Control Station. The cameras shall be high-definition (minimum 1080p), color, auto iris, infrared night-vision security cameras of a solid-state design, housed within marine-rated weatherproof IP66 (or better) enclosures (including fans, heaters and wipers).

The CCTV system shall include high-resolution (minimum 1080p), color video displays with anti-glare screens for visibility under adverse lighting conditions. The number and arrangement of monitors at each control location (2 minimum) shall allow simultaneous viewing of all areas of the site critical for safe operation with no more than four (4) images displayed on a single monitor. See Remote Operations elsewhere in these Minimum Technical Requirements for additional display considerations at the Remote Control Station.

The CCTV system shall include digital video recording capabilities to simultaneously record video using all cameras and shall be able to play back, at any time, video footage captured from all cameras from the previous fifteen 15 days (minimum).

4.17.5. **Telephone, Television and Internet**

The Design-Build Team shall provide telephone, cable television and Internet within the Bridge Tender's House. Coordinate with the local utilities as necessary.

4.17.6. **Security Alarm System**

The Design-Build Team shall provide an auto-dial centrally-monitored alarm system with redundant external auto communication capabilities for detecting unauthorized entry by means of door and window sensors, glass breakage detection, and detection of motion within the Bridge Tender's House. The system shall comply with NFPA 731, and North Carolina State Building Code, and other authorities having jurisdiction, as applicable. Include remote annunciation, as well as arming and disarming capabilities, at the Remote Control Station.

4.17.7. **Fire Alarm System**

The Design-Build Team shall provide an auto-dial centrally monitored smoke detection and fire alarm system with redundant external communication capabilities in the Bridge Tender's House. Use smoke detectors with internal alarms and battery backup that comply with all requirements and directives of NEC, NFPA 72, the North Carolina State Building Code, and other authorities having jurisdiction, as applicable. If multiple devices are installed, they shall be interconnected. Include remote annunciation at the Remote Control Station. Provide pull station near exit doors.

4.18. Programmable Logic Controller

The Design-Build Team shall provide redundant programmable logic controllers (PLC) for all analog and digital logic functions required to control, interlock, and coordinate the bridge control system and associated components. The PLC shall be Allen-Bradley Control Logix. The PLC equipment shall be installed in a cabinet.

Configure the PLC system so that both the main and redundant processors are programmed with identical information, operate on the same time base and run in complete synchronization, except that the redundant processor outputs are electrically isolated from the main system. In the event that trouble or failure of the main processor occurs, transfer to the redundant processor for bridge operations shall be made by manual means and of such ease that non-technically oriented personnel may make the transfer without difficulty.

The Design-Build Team shall provide one spare PLC and at least one I/O card of each type used at the local and remote site.

The power supply module shall be isolated from the commercial power supply source by a constant voltage transformer/power conditioner to prevent electrical system noise and voltage fluctuations from interfering with the operation of the central processing unit (CPU). The CPU shall be rated for 1,000 VA, 120 volts, with a nominal voltage of 115 volts. To supplement and protect the power supply for each PLC system, provide an Uninterruptible Power Supply (UPS) power supply to maintain power to the PLC during interim loss of power. UPS shall be capable of providing uninterrupted power for a minimum of 20 minutes.

4.18.1. Quality Control

All PLC equipment (CPU, I/O frames, input cards, output cards, multiplexer, cables, etc.) shall undergo a minimum of 100 hours continuous burn-in prior to shipment. Burn-in shall be done while carrying temperature between rated limits of the device and cycling the equipment through a program. PLC equipment, including programming devices, shall be tested so as to ensure their proper operation in the presence of both radio frequency and electrical noise.

4.18.2. Redundant Control Processor

The programmable logic controller system shall be arranged such that both the main and redundant processors shall be programmed with identical information, operate on the same time base and run in complete synchronization, except that the redundant processor outputs shall be electrically isolated from the main system. In the event that trouble or failure of the main CPU occurs, transfer to the redundant CPU for bridge operations shall be made by manual means and of such ease that non-technically oriented personnel may make the transfer without difficulty. Location of the manual transfer switch shall be on the door of the main PLC cabinet and shall utilize a key switch with indicating lights to indicate the CPU in service.

4.18.3. **CPU Memory**

A. Provide memory with a battery backup power system. Batteries shall be able to support the memory for not less than three months without external power.

B. A key operated selector switch shall disallow changes in the stored program while in the "Operate" position.

C. The status of the inputs and outputs shall be checked at the time they are called for in the program rung the CPU is operating on.

D. The outputs shall be available to be turned "ON" or "OFF" as soon as its rung has been scanned.

E. The CPU shall check the parity of each word at the time it is scanning that word. The CPU shall contain "trouble" lights to indicate memory parity errors or processor malfunctions.

F. All CPU operating logic shall be contained on plug-in cards for ease of replacement. Chassis-wired logic is not acceptable.

G. The memory unit shall have spare program capacity equal to 20 percent of the memory used.

4.18.4. **Systems Input and Output (I/O's)**

A. I/O frames shall be completely pre-wired for a full complement of I/O boards.

B. Additional I/O frames (up to the maximum PLC capacity) can be added at any time in the field.

C. I/O modules shall have key slots, which are unique for each card type, so that the wrong card type cannot be inadvertently installed in a slot that was programmed for a different card type.

D. I/O cards shall be replaceable without removing panel wiring.

E. I/O cards shall provide at least one common terminal for every two inputs or outputs.

F. Inputs and outputs shall be provided with reed relay or optical isolation between field circuits and internal circuitry.

G. Status lights shall be provided for each input or output amplifier indicating a signal is present to turn the input or output "ON".

H. Outputs shall be fused, and the fuses shall be easily removable without the use of special tools.

I. Output cards used for other loads shall have a minimum continuous load capacity of 1.5 amperes, and shall be capable of operating and withstanding the operating and surge characteristics of a NEMA size 4 starter.

J. The Design-Build Team shall provide surge protection on all I/O leaving the Bridge Tender’s House.

4.18.5. **Data Logging System**

The Design-Build Team shall provide a subsystem capable of report generation at the Bridge Tender's House and at the Remote Control Station. The system shall output to a multifunction printer/scanner/copier via USB or wireless connection, capable of printing up to 32 pages per minute at 1200 dpi resolution.

This subsystem shall store operational and alarm data and shall print a report summary on command. Each printout shall include day-of-year, time-of-day, and the message as they appear in these Minimum Technical Requirements. Printer output minimum anticipated messages shall show all bypasses and as follows:

- Phase loss/Phase reversal detected
- Motor hand brake released
- Drive out of service
- Span overspeed
- Smoke/heat detected in Bridge Tender's House
- Intruder alert
- Heat tracing system fault

A Bridge Activity Report shall be included as part of the data logging system. The report shall contain the following information:

- Date, time of opening initiated, time of span open position, time span motors stopped and position of the span when stopped, time span motors began to close, time span motors stopped and span position, and the time the bridge was opened to vehicular traffic.
- Each time the span motors are stopped, whether opening or closing, the Data Logging System shall store the activity report with the time and position of the span regardless of whether the span is fully open or fully closed.

4.18.6. **Programming**

The Design-Build Team shall provide programming software that is fully compatible with the PLC equipment. The Design-Build Team shall provide two (2) fully compatible laptop computer systems, complete with modem hardware and software with a baud rate suitable for the modem equipment provided. The laptop computers and all software shall be turned over to the Department at the completion of the project. All software licenses shall be transferred by the Design-Build Team to the Department. Storage of laptop computer shall be within the PLC cabinet on a fold down work table mounted to the PLC cabinet door at the local and remote site.

The PLC's shall have the following capabilities:

- Connect or disconnect programming equipment, while the PLC CPU is operating, without interfering with CPU operation.

- Copy software to/from programming equipment,
- The programming equipment shall be able to monitor CPU timers, memory, etc. real time while the PLC is operating. The programming equipment may be local (in the control house) or the remote location (remote control console).

4.18.7. **Cabinet**

The Design-Build Team shall furnish cabinets as described later in these Technical Requirements.

4.18.8. **System Hardware**

The system shall be complete with all power supplies, racks, interface modules, fault monitors, and any other internal devices required.

4.18.9. **Documentation**

Operations and maintenance manuals shall be furnished in accordance with these Minimum Technical Requirements. In addition, these manuals shall include operation of the equipment, programming of the equipment, theory of operation, maintenance information, schematics of all cards or units within the system, and point-to-point wiring diagrams.

The Design-Build Team shall provide documentation of the PLC program, which shall include at least the following information:

A. Logic diagram printout
B. Rung address
C. Contact addresses and English contact description
D. Cross reference of rungs which control contacts
E. Cross reference of contact controlled by each rung
F. English comments before each series of rungs
G. Cross reference to relay numbers in plans

4.18.10. **Factory Tests**

The Design-Build Team shall pre-test the PLC at the factory to ensure that the ramp functions operate correctly.

The Design-Build Team shall develop and submit to the Engineer a pre-testing plan for the PLC. The testing plan shall systematically check the requirements of the PLC to verify conformance with the Contract requirements. The Design-Build Team shall: 1) submit the testing plan to the Engineer for review and approval; 2) develop and utilize testing certification forms to provide objective evidence of successfully testing; and 3) complete all testing of the programmable controller independent of the Engineer and submit signed certification forms attesting to the successful testing to the Engineer. Once the Design-Build Team has successfully pre-tested the

programmable controller and submitted the corresponding certification forms, the Design-Build Team shall again pre-test the programmable controller in the presence of the Engineer to demonstrate it meets the requirements of the Contract.

The bridge control console, or a similar test panel, shall be provided to derive the control signals and indicators required to simulate span position.

The Design-Build Team shall notify the Engineer thirty (30) calendar days prior to scheduled completion of the Design-Build Team's pre-tests so that the Engineer can arrange for a witness to the confirmation tests.

4.19. Control Panels

4.19.1. General

The general requirements as follows apply to all panels and enclosures. Panel-specific requirements are included elsewhere in these Minimum Technical Requirements.

The following panels and enclosures shall be provided:

A. Control Console

B. Remote Control Console (at Bridge No. 19 in Pasquotank County)

C. Motor Control Center or Switchboard Cabinet

D. Control Cabinet

All load relays shall be 10 ampere, 600V rated.

All welds on the exposed surfaces shall be ground smooth. Finished surfaces shall be free from waves, bellies or other imperfections. Exterior surfaces shall be sandblasted, ground smooth, filled, primed, sanded and finished.

All instrument cutouts, mounting studs, and support brackets shall be located accurately. Unless specified otherwise, doors shall be hinged and shall have turned-back edges and additional bracing where required to assure rigidity. Hinges shall be of the piano or concealed type. Door latches shall be of the three-point type to assure tight closing.

Interior surfaces shall be finished with gloss white lacquer applied over suitable primers.

Interconnecting wiring shall be provided between all electrical devices mounted in the panels and enclosures. If the devices are to be connected to external equipment, they shall be connected to terminal blocks.

All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. All wire terminations shall be made with ring tongue nylon self-insulating wire terminals. Wire terminals shall be installed using a high compression indenting crimping tool that assures a full crimp by releasing the terminal only when the crimp is complete. All control and instrument wiring used within the panels shall conform to NEC and NEMA standards.

Wiring to each control switch shall be individually bundled and shall be installed with a "drop loop" of sufficient length to allow its removal from the panel for maintenance without disconnecting the wiring.

Terminal blocks shall be provided for conductors requiring connection to circuits external to the specified equipment, for internal circuits crossing shipping splits, and where equipment parts replacement and maintenance will be facilitated.

Terminal blocks shall be provided with corrosion resistant plating on non-ferrous hardware.

Terminal blocks shall be grouped for easy accessibility unrestricted by interference from structural members and instruments. Sufficient space shall be provided on each side of each terminal block to allow an orderly arrangement of all leads to be terminated on the block.

Each terminal block, device, fuse block, terminal, and both ends of each conductor, shall be permanently labeled to coincide with the identification indicated on the manufacturer's wiring diagrams. Mounted electronic components shall be identified by marking with contrasting colored ink beside the component.

Individual conductors shall be identified by marking with machine printed labels. The marking shall be done on a sleeve not less than 1/2 inch long. The inside diameter of the sleeve shall be such that it will slip snugly over the insulated wire. Each sleeve shall be marked so that the identification shall be permanent and waterproof.

Internal illumination shall be provided in all panels and enclosures using LED strip fixtures. A lighting switch shall be installed beside the access door inside the panels and enclosures.

A system of convenience outlets shall be provided in each panel and enclosure for use with power tools, portable lamps, and other similar equipment. There shall be provided in each enclosure and the Control Desk a 120 volt AC circuit to feed the interior lighting, the convenience outlets and the illuminated indicators.

Wiring diagrams shall be prepared on sheets approximately 22 inches by 34 inches. Where interconnecting wiring from different items of equipment or sectional wiring diagrams of the same item of equipment appear on different wiring diagram sheets, all interconnections shall be clearly identified.

Information indicated on the Design-Build Team’s drawings shall include wiring of the individual panel items as they actually will appear in the panel, contact arrangements of switches, and internal wiring of relays and instruments.

Elementary diagrams shall be cross-referenced to terminal markings on the connection and interconnection diagrams, but need not show complete details of circuits external to the panels. Each item of panel mounted equipment indicated on the diagrams shall be identified by item number and name.

All control panels shall be factory tested for circuit continuity and operation with the motors prior to shipment to the bridge for installation.

Laminated phenolic nameplates shall be provided on the panel faces for all instruments and devices mounted on the panel faces, except where the instruments or devices are themselves provided with a service engraving. Phenolic nameplates shall be attached to the panels with double-sided adhesive tape.

4.19.2. **Control Console**

A control console shall be provided in the Bridge Tender's House and at the Remote Control Station for operation of the span and its auxiliaries. All devices necessary for the electrical control of the bridge shall be mounted on this console. Each control console shall include a dead-man foot pedal switch that must be depressed to allow operation of the controls on the console.

The control console shall be of neat, substantial construction. It shall be fabricated from not less than No. 11 gauge sheet metal properly formed, and suitably reinforced by steel angles to provide adequate strength. The flat top and inclined portions of the console top shall be 10 gauge brushed stainless sheet steel. The top and front slope shall be of non-reflecting finish.

Removable doors shall be provided in the front of each console, secured with three-way latches. The console shall be neatly fitted up with close joints, and 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.

The bottom shall be of open type construction. The opening shall be framed with standard size strut, arranged to facilitate the clamping of cables or conduits.

The span control switches and other control devices shall be mounted within the body of each console. The indicating lights for each operation shall be mounted inside or adjacent to the control device governing that operation. Provide a push button to test all the lights at once.

A. Indicating Lights: Each lens shall be provided with an engraved legend which shall be readily visible when the lamp is energized. Each indicating light shall be similar to type shown and it shall be suitable for mounting on the desk top provided.

B. Span Operated Counter shall be 120VAC, 6 digit, panel mount, non-reset. Unit shall count 1/2 digit on a closed contact and 1/2 digit on an open contact.

4.19.3. **Control Cabinet**

The control cabinet shall be of neat and substantial construction. It shall be fabricated from not less that No. 12 gauge sheet steel metal properly formed, and suitable reinforced by steel angles to provide adequate strength. The door shall be 12 gauge sheet steel. Cabinet shall have an interior back panel.

4.19.4. Switchboard Cabinet

The switchboard cabinets shall be of neat and substantial construction. It shall be fabricated from not less that No. 12 gauge sheet steel metal properly formed, and suitable reinforced by steel angles to provide adequate strength. The door shall be 12 gauge sheet steel. A cooling fan with filtered intake, thermostat control and exhaust vents shall be provided with each cabinet.

The switchboard cabinets shall be factory tested for circuit continuity and operation with associated equipment prior to shipment to the job site.

4.19.5. Testing

The complete electrical control system shall be pre-tested and shall include the control desk, control cabinet, switchboard cabinets, and remote control console.

External field devices such as limit switches, traffic gates etc., shall be simulated using a test panel capable of being switched to indicate different switch positions. Outputs to field devices shall be simulated using light panels.

The Engineer shall be notified at least 30 days prior to the test so that he can arrange to witness the test.

4.20. Bypass Switches

Bypass switches with keyed locks shall be located on the control console in the Bridge Tender's House and at the Remote Control Station.

4.21. Limit Switches

Limit switches shall be lever arm, plunger, rotary cam or proximity type switches that comply with AASHTO *Movable* and rated for at least 250 VAC or VDC. If proximity switches are proposed, compatibility with the PLC shall be verified. Provide limit switches for over-travel, full closed, near closed, near open, and full open.

4.22. Position Monitoring System

A position monitoring system that complies with AASHTO *Movable* is required. Use a span position resolver compatible with PLC. Digital and supplemental analog displays shall be on the control consoles in the Bridge Tender's House and at the Remote Control Station. At both locations, the analog output indicator shall generally emulate the position and movement of the swing span as viewed from the Bridge Tender's House.

4.23. Pedestrian and Traffic Warning Systems

4.23.1. General

The Design-Build Team shall provide warning gates, barrier gates, traffic signals and warning bells on the bridge and approaches that comply with AASHTO *Movable*, MUTCD, and these Minimum Technical Requirements. The Design-Build Team shall provide advance warning signs as described elsewhere in these Minimum Technical Requirements. The Design-Build

Team shall submit a location plan and proposed operation sequence for all movable bridge-related traffic safety devices to the Engineer for review and approval.

In conjunction with Section 2.2, the locations of all gates and the sequence in which they are designed to operate under normal conditions shall prevent pedestrian and vehicular traffic from entering the movable span (on-coming traffic) while allowing for traffic on the movable span (off-going traffic) to safely advance onto the approach spans. Following the safe exit of all off-going traffic from the movable span, the gates shall block all lanes and the sidewalk prior to opening the span.

The Design-Build Team shall propose additional signs or warning signals (audio and visual) as deemed necessary via coordination with the Department for safe direction of pedestrian and vehicular traffic.

All gates shall include provisions for manual operation using a hand crank. All gate housings shall be corrosion-resistant, marine-duty. Housing doors and manual crank shall be equipped with limit switches to prevent operation with the doors open or the manual crank engaged.

All gates shall be hardwired back to the motor control centers allowing for gate operation during a total PLC system failure. All gates shall be equipped with a hand crank and a power drill crank to allow for manual operation.

The gates shall operate by rotating about a horizontal axis, such that the gates are vertical (upright) when traffic is permitted to cross the span and horizontal (perpendicular to the roadway and sidewalk) when the span is being operated. Where practical, gates shall be provided with the operating mechanism mounted behind the sidewalk and be accessible by maintenance personnel without blocking the roadway. Motor housing access shall be on the back face of the assembly, opposite the roadway, and OSHA-compliant access shall be provided.

4.23.2. **Pedestrian and Traffic Warning Gates**

The Design-Build Team shall provide pedestrian and traffic warning gates across the sidewalk and approaching traffic lane at each end of the bridge. Where practical, a single gate may be used to block the sidewalk and adjacent approaching traffic lane but the warning gate shall not block departing traffic lanes. Warning gates shall have a lightweight aluminum or fiberglass arm with diagonal red and white striping on the arm faces. Each arm shall be equipped with alternating red flashing lights.

4.23.3. **Barrier Gates**

The Design-Build Team shall provide traffic barrier gates to span across the roadway and sidewalk at each end of the bridge. Barrier gates may be of either a single-arm (span the entire length in one piece) or double-arm (mounted on opposite sides of the bridge with interlocking arms at the middle of the roadway) configuration. Barrier gates shall be designed to absorb the energy of a 5,000-pound vehicle traveling up to 50 mph. The barrier gate arms shall be equipped with red and white diagonal striping and flashing lights.

4.23.4. **Traffic Signals**

The Design-Build Team shall provide traffic signals for the bridge in accordance with MUTCD.

4.23.5. **Warning Bells**

The Design-Build Team shall provide warning bells mounted to, or near, the on-coming traffic gates. Each warning bell shall be a 12-inch motor-driven gong-type device that operates at 120 VAC.

4.23.6. **Testing**

The Design-Build Team shall develop a testing plan and requirements for all traffic safety devices and submit to the Engineer for review and approval. The testing plan shall include required technical and material specifications, performance criteria, methods of measurement/evaluation, standards of acceptance, and documentation requirements for shop and field testing of the individual elements and system coordination with the local and remote bridge operating systems.

Should the tests show that any piece of equipment or apparatus, in the judgment of the Engineer, is defective or functions improperly, the Design-Build Team shall adjust, repair or replace so as to make the installation satisfactory to the Engineer at no additional cost to the Department.

Coordinate field verification of all traffic safety devices with Functional Checkout (locally and remotely), as described elsewhere in these Minimum Technical Requirements.

4.24. Standby Generator

The Design-Build Team shall provide a diesel-powered generator set with automatic start and switching features capable of supplying 480V, three-phase power to the bridge, controls, communications equipment, gates, lights, signals, Bridge Tender's House mechanical and electrical systems, navigation aids and other critical safety devices and functions in the event of a normal power supply disruption.

Provide a generator with a minimum starting kVA (SKVA) as required to move the span at no more than 20 percent voltage dip and 10 percent frequency dip. The generator shall be compatible with, and capable of operating, flux vector drives under the worst-case loading if an auxiliary motor is not provided.

Size the fuel tank for 24 hours of continuous operation at 100 percent capacity. Include generator and fuel tank sizing calculations in the Design Calculations submittals. Clearly note on the Plans all functions provided when operating on standby power.

Install the generator on a level concrete foundation adjacent to the parking area no less than 2 feet above the 100-year flood elevation. Provide a fully enclosed, ventilated, free-standing, structure to house the generator that complies with maintenance access and lighting requirements for electrical equipment in these Minimum Technical Requirements. The architectural design of the exterior, (form, materials, colors, finishes, etc.) of the generator structure shall emulate the

Bridge Tender's House. Develop and submit details and specifications in conjunction with the Bridge Tender's House elsewhere in these Minimum Technical Requirements.

Provide sound attenuation consistent with local noise ordinances, as applicable, but under no conditions shall the noise level of the generator operating at 100 percent capacity exceed 80 dBA at any point greater than 10 feet from the generator structure.

Design the control consoles in the Bridge Tender's House and the Remote Control Station to include manual start/stop controls, annunciator panels, and audible and visual alarm indications that the bridge is operating under standby power.

Submit operation and maintenance manuals, parts lists and certified test reports showing the power rating (full continuous derated output), voltage, frequency regulation and other pertinent information.

Submit to the Engineer for review and approval details and special provisions for all elements, features and performance requirements of the generator system, including but not limited to the following:

A. Engine features
B. Starting system
C. Battery charger
D. Automatic transfer switch
E. Cooling system
F. Lubrication system
G. Intake and exhaust system
H. Governing system
I. Safety switches
J. Control system
K. Instrument panel
L. Sub-base
M. Enclosure
N. Alternator
O. Fuel system
P. Fabrication, handling, storage and installation requirements
Q. Shop and field test requirements

The Design-Build Team will not be permitted to use the standby generator set for power during construction of the bridge.

4.25. Electrical Operation and Maintenance Manuals

Operation and Maintenance Manuals shall be provided in accordance with other sections of these Minimum Technical Requirements.

5.0 CONSTRUCTION

5.1. Field Tests

5.1.1. Preliminary Checkout Period

The Design-Build Team shall arrange for and provide all the necessary field tests, as indicated herein and as directed by the Engineer, to demonstrate that the entire electrical system is in proper working order and to the Department's satisfaction is in accordance with the requirements of these Minimum Technical Requirements.

The Design-Build Team is responsible for operation and maintenance, including all costs thereof, for systems or equipment temporarily placed in operation for testing and adjusting purposes or for the convenience or necessity of the Design-Build Team, prior to final acceptance by the Department.

5.1.2. Manufacturer Representatives

Arrange for appropriate representatives of the bridge electrical control equipment to be on site.

These representatives shall be capable of making adjustments to the equipment, of locating faults or defects and correcting them if possible, and of obtaining from the manufacturers without delay, new parts for replacement of apparatus which, in the opinion of the Engineer, do not perform satisfactorily.

These representatives shall be present during Equipment Start-Up and Functional Checkout.

5.2. Sequence of Normal Operation

Provide sequence of operation for bridge opening and closing procedure for normal operation, for severe loading condition, and for operation while running on generator. Procedure shall comply with AASHTO *Movable*, MUTCD, and USCG. Submit procedure to the Department for review and approval.

5.3. Spare Parts

The Design-Build Team shall provide spare parts for the electrical power and control systems in accordance with AASHTO *Movable* and as provided by equipment and systems manufacturers, supplemented by the following:

A. One circuit breaker of each kind and size installed in the panelboards

B. A quantity of 10 percent (1 minimum) of the total for each type and size of control, timing, or overload relay installed.

C. A quantity of 30 percent (3 minimum) of the total for each size and type of thermal overload relay installed.

D. Spare Flux Vector Drive.

E. For the control desk lights:

a. 12 indicating lamps for each type installed

b. 1 color cap of each color and legend

Spare parts shall be provided in sealed, uniform-sized cartons, with typed and clearly varnished labels to indicate their contents. The Design-Build Team shall also provide a directory of permanent type describing the parts. The directory shall state the name of each part, the manufacturer's number, and the rating of the device for which the part is a spare. The spare parts shall also be marked to correspond with their respective item numbers as indicated on the elementary wiring diagram. Each circuit card requiring adjustments shall be adjusted at the bridge prior to final delivery to the State. A lockable steel cabinet shall be provided for storage of the spare parts and instruction manual. Minimum size shall be 48" W x 16" D x 72" H.

5.4. Painting

Exposed metal parts of the electrical equipment installation attached to the steel work of the bridge, such as raceways, boxes, and their accessories, shall be hot-dipped galvanized and shall be painted the same color as the steel work. Interior metal parts shall be primed and painted to match surrounding surfaces.

REMOTE OPERATIONS

1.0 DESCRIPTION

The Design-Build Team shall develop a remote operations plan and furnish and install a complete and independent system for remotely operating, monitoring, reporting and otherwise controlling all functionality of the swing span. See also Remote Control Station elsewhere in these Minimum Technical Requirements.

2.0 DEFINITIONS

Remote Operating System refers to the compilation of electrical devices and equipment, software, hardware, data transmission, programming, cameras, monitors, communication devices, and other features necessary to provide for a complete, fully functioning control and monitoring system for the Perquimans River Bridge No. 8 swing span, located within the existing bridge tender’s house at Pasquotank County Bridge No. 19.

Remote Control Station refers to the space within the existing bridge tender’s house at Pasquotank County Bridge No. 19 dedicated to remote operation of the Perquimans River Bridge No. 8 swing span.

3.0 DESIGN REQUIREMENTS

Design and implementation of the Remote Operating System shall be coordinated with, and is considered an integral component of, the Bridge Electrical System described elsewhere in these Minimum Technical Requirements, including all requirements associated therewith.

3.1. Communication Link

The Design-Build Team shall provide an encrypted, reliable and redundant communication link with firewalls and password protection between the Remote Control Station and the swing bridge. Redundancy capabilities shall be included in the functional acceptance criteria for the Remote Operating System. Encryption shall be per Federal Information Processing Standard (FIPS) 140-1 validated encryption methods. If the primary or redundant communication link is broken, bridge operation shall come to a stop in the same manner as if the E-stop button were pressed. If the primary communication link is lost, the redundant link shall be available with a manual transfer switch. Provide a watchdog timer on communications links. Indicate an alarm when communication is lost.

If radio communication is proposed as a primary or secondary means of communication, the Design-Build Team shall perform a feasibility study to verify its effectiveness and reliability, prepare a report documenting the study results and recommendations, and submit the report to the Department at the same time as, or prior to, Preliminary Plans for review and approval.

The Technical Proposal shall include a detailed description of the proposed communication system. At a minimum the description shall include the following:

A. Plan for determining the extent of existing infrastructure and maximizing its use

B. Supplemental infrastructure needs

C. Features that will be incorporated for redundancy, reliability, safety and security

3.2. Remote Operations and Emergency Response Plan

The Design-Build Team shall develop a Remote Operations and Emergency Response Plan that includes the following, at a minimum:

A. Procedures for the Remote Operating System under standard conditions

B. Nonstandard operating procedures for the Remote Operating System under nonstandard conditions

C. Bridge failure response procedures

D. Accident and emergency response procedures

The Design-Build Team shall anticipate significant coordination with the Department and the USCG in the development of a Remote Operations and Emergency Response Plan that satisfies both agencies' commitments to providing a minimum level of safety for all users and personnel that interact with the swing span in any capacity. Any permitting, construction or acceptance

delays arising from, or directly attributable to, this plan will not constitute relief from liquidated damages.

3.2.1. Operation Under Standard Conditions

Standard operating procedures shall include detailed instructions, including step-by-step sequence of operation of the bridge and its auxiliaries, noting all precautions required for correct operation under "normal" conditions. The sequence of operation shall include required safety measures designed to compensate for lack of firsthand, local auditory and visual confirmation that the roadway, sidewalks and channel are free and clear for a safe bridge opening, up to and including safety interlocks in the control logic requiring operator acknowledgement of enhanced safety protocol prior to operating the span.

3.2.2. Operation Under Nonstandard Conditions

Nonstandard operating procedures shall include detailed instructions for operation of the bridge under any emergent or nonemergent conditions other than "normal" and/or using the standard operating procedures above. Conditions warranting nonstandard procedures include, but are not limited to, the following:

A. Failure of any traffic-related safety device
B. Lack of appropriate indication for any traffic-related safety device
C. Manual bypass of any bridge function for any reason
D. Auxiliary operation under generator power
E. Inadequate or partial visibility of roadway, sidewalk and/or navigation channel
F. Camera failure resulting in less than complete coverage of traffic areas (i.e., introducing a "blind spot")
G. Audio communication interference and/or failure
H. Unauthorized access detected at the swing bridge
I. Loss of data communication with the bridge at any time, including during operation

3.2.3. Bridge Failure Response

Bridge failure response procedures shall include a detailed action plan in the event the swing span fails to open or close as designed and required for safe use of the roadway and navigation channel. At a minimum, the plan shall identify, provide contact information for, engage, and mobilize resources in close proximity to the bridge to facilitate a timely assessment of site safety and initiate an investigation into the cause of the failure. The plan shall also include appropriate reporting requirements to fully document time, date, nature of failure, steps taken by the operator, resource response time, site safety concerns, failure cause determinations, remedial actions taken, and recommendations for future actions, if any.

3.2.4. **Accident and Emergency Response**

Accident and emergency response procedures shall supplement the nonstandard operating procedures and include a detailed action plan for emergency response, including protocol for notifying, and contact information for, emergency services, law enforcement agencies, Department resources to be deployed, the United States Coast Guard, and other entities as deemed necessary by the nature of the conditions and consistent with established Department policies. Emergency response shall not require the remote bridge operator to leave the bridge tender's house at Bridge No. 19 or otherwise prevent safe operation of the Bridge No. 19 bascule spans.

3.3. Remote Viewing Capabilities

Elimination of "blind spots" under normal conditions due to insufficient camera coverage, visual obstructions, weather conditions, and camera failure is critical to safe remote operation of the swing span. The CCTV system furnished and installed in accordance with these Minimum Technical Requirements shall provide redundant and overlapping coverage of all traffic areas on the roadway, on the sidewalk and in the navigation channels. The number and placement of cameras shall provide at least two views of each of these traffic areas from opposing viewpoints.

Video images displayed at the Remote Control Station, and the number of monitors required to display the images, shall simultaneously provide at least one clear, unobstructed view of all traffic areas noted in the previous paragraph. The arrangement of video images on the monitors under normal operating conditions shall emulate, as much as practical, the relative positions of the areas being displayed from the perspective of a bridge operator controlling the swing span from the Bridge Tender's House. If the monitor setup is unable to simultaneously display views of all camera angles, the CCTV system shall be designed to facilitate viewing of all images in a logical order and sequence. To protect against premature or inadvertent operation of the span, the CCTV system shall be interlocked with the Remote Operating System so that the operator is required to acknowledge viewing of all camera angles immediately prior to operating the span in either direction.

Video footage captured and stored by the CCTV system shall be accessible for playback from the Remote Control Station.

3.4. Audio Communication

Intercom, public address, and marine radio communication systems described elsewhere in these Minimum Technical Requirements shall be integrated with, and fully functional from, the Remote Control Station, as applicable for control and monitoring of the bridge.

3.5. Unauthorized Access

Due to the likelihood that the Bridge Tender's House at Perquimans River Bridge No. 8 swing span will be unmanned for long periods of time, unauthorized access to the tender's house and machinery areas shall be prevented using enhanced means and methods, without unnecessarily

hindering routine access to such areas. Local controls shall be tamper-proof and incapable of operation without some form of user authentication (e.g., key or electronic access card). A surveillance system for the Bridge Tender's House (exterior and interior), electrical room, and machinery areas shall be provided. The system shall include video cameras and motion sensors designed to alert the remote bridge operator, and it shall be capable of central monitoring by a third party, the activation and maintenance of which is not the responsibility of the Design-Build Team unless otherwise requested by the Department. Where not otherwise required, additional security lighting shall be provided in and around the surveilled areas to ensure adequate surveillance camera visibility.

The bridge control system shall permit disabling of all bridge functions, either automatically or manually, from the Remote Control Station if unauthorized access is detected at the swing bridge or anywhere along the communications and control system.

3.6. Bridge Controls

Provide a main and redundant PLC at the remote site to control bridge operation. The remote PLC's shall interface with the control console at the Remote Control Station. The remote PLC's shall communicate with the local PLC's at the bridge site. Provide an uninterruptible power supply (UPS) for the remote PLC's.

The Design-Build Team shall evaluate the feasibility and safety implications of incorporating motion sensors, video analytics, or other means of stopping or preventing bridge movement should a pedestrian or vehicle encroach beyond the warning gates at any time during the operating sequence.

The Design-Build Team shall evaluate the feasibility and safety implications of incorporating obstruction sensors in the navigation channel for the purpose detecting potential obstructions during operation and automatically overriding the normal sequence to protect any vessels that may be in the channel and/or prevent damage to the bridge.

3.7. Control Console

A control console shall be furnished and installed at the Local and Remote Control Stations. The console shall adhere to construction requirement elsewhere in these Minimum Technical Requirements. The control console shall be provided with a touch screen display designed to provide information for, and facilitate the operation of, the swing span. The touch screen display shall be fully compatible with the PLC equipment specified elsewhere in these MTR.

The touch screen display shall be programmed to display the operational conditions of swing span before, during and after operation of the bridge. The display screens shall be easy to read, easy to understand, and include at least the following information:

A. Status of communication between the Bridge Tender's House and the remote control station

B. Local/remote control selection

C. Status of utility power at the swing span
D. Selection of bridge control power
E. Status of the traffic signals
F. Status/position of each traffic gate
G. Status/position of each pedestrian gate
H. Status/position of each resistance gate
I. Cycle time of each traffic/pedestrian/resistance gate for current operation and for previous operation
J. Status of Emergency Stop push button
K. Status of main span drive motor(s), rpm, and current draw
L. Status of auxiliary span drive motor (if used), rpm, and current draw
M. Status of each brake
N. Status/position of each machinery component/system
O. Speed of the swing span
P. Position of the swing span
Q. Alarm status and history
R. Generator status

4.0 SUBMITTAL REQUIREMENTS

Requirements in this section shall be considered supplemental to those found elsewhere in these Minimum Technical Requirements.

4.1. Design

The Design-Build Team shall submit a draft Remote Operations and Emergency Response Plan in conjunction with the submission of Preliminary design documents for the Bridge Electrical System. The plan shall be sufficiently developed, in the Engineer's opinion, to clearly delineate the combinations of human behavior, control system logic, and equipment functionality anticipated under all reasonably possible conditions to ensure safe operation of the bridge. The format and presentation of materials that comprise this plan are at the discretion of the Design-Build Team, subject to review and approval by the Department, but they shall be produced in a manner that is well organized, easy to update, readily accessible, durable, reproducible, and easy to understand. The

The Design-Build Team shall submit Preliminary Plans and Special Provisions detailing the equipment, location, display, communication and recording characteristics of the closed-circuit television and recording system.

The Design-Build Team shall submit concepts of each touchscreen display to the Engineer for review and approval in conjunction with Preliminary Plans and Special Provisions.

Plans, Special Provisions, and Design Calculations regarding electrical power and controls shall adhere to requirements for the Bridge Electrical System described elsewhere in these Minimum Technical Requirements.

4.2. Post-Design

The Design-Build Team shall submit shop drawings, working drawings, product data, diagrams, manuals and any other information for devices, equipment, and procedures specific to the Remote Operating System not otherwise required by these Minimum Technical Requirements but otherwise conforming to the description of Post-Design Submittals elsewhere in these Minimum Technical Requirements.

The Design-Build Team shall submit the final Remote Operations and Emergency Response Plan.

The Design-Build Team shall include testing requirements for acceptance of all components of the Remote Operating System are included in the detailed testing procedure for Remotely Operated Functional Checkout, as defined elsewhere in these Minimum Technical Requirements.

5.0 CONSTRUCTION REQUIREMENTS

Installation of the Remote Operation System shall be coordinated with the Remote Control Station, Bridge Electrical System, and other relevant provisions of these Minimum Technical Requirements.

Remotely Operated Functional Checkout shall be directly dependent upon acceptance of the Remote Operation System.