SPECIAL PROVISIONS

SEMI-FINAL SUBMISSION

FOR

NORTH HERO – GRAND ISLE DRAWBRIDGE

PROJECT BHF 028-1(26)

June, 2017

STATE OF VERMONT AGENCY OF TRANSPORTATION

HDR, Inc.

Semi-Final Submission

North Hero Grand Isle Drawbridge

Special Provisions

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AMEND SECTION 501 – HPC STRUCTURAL CONCRETE

xx. 501.01 DESCRIPTION, is hereby modified by adding the following paragraph:

"Furnish and place high performance portland cement concrete for structures where specified on the Plans for mass concrete placements."

xx. 501.06 – FIELD TESTS, is hereby modified by replacing the first paragraph with the following:

"The Contractor shall provide assistance, equipment, materials, and curing for field sampling and testing as required by the Thermal Control Plan and Engineer for mass concrete work. All costs shall be included in the Contract unit prices under Section 631. The Engineer shall perform all acceptance sampling and testing in accordance with the Agency's Quality Assurance Program. For bridge deck pours, the Contractor shall perform all on-site Quality Control (QC) sampling and testing. The person performing the QC sampling and testing shall have, as a minimum, current ACI Concrete Field Testing Technician Grade I Certification."

xx. 501.07 – WEATHER AND TEMPERATURE LIMITATIONS – PROTECTION OF CONCRETE, is hereby modified by replacing the second paragraph with the following:

"Placement and curing procedures shall be per the Thermal Control Plan or as approved by the Engineer prior to actual placement."

Add the following items:

(c) The Contractor shall prepare a Thermal Control Plan prior to placement of the mass concrete.

(d) The maximum concrete temperature at the point of discharge shall be as specified in the Thermal Control Plan.

xx. 501.08 – THIS SUBSECTION RESERVED, is hereby modified by adding the following:

"501.08 – THERMAL CONTROL PLAN:

The Thermal Control Plan shall at a minimum include a Heat Dissipation Study (Reference ACI 207 or thermal modeling software) as well as to describe the measures and procedures the Contractor intends to use to satisfy the following Temperature Control Requirements for each mass concrete element:

(1) The Maximum Temperature Differential shall be limited to 35 degrees F. The temperature differential between the interior and exterior portions of the designated mass concrete elements during curing will be maintained to be less than or equal to this Maximum Temperature Differential, and

(2) The Maximum Allowable Plastic Concrete Temperature shall be limited to 160 degrees F.

A change to the Temperature Control Requirements specified above can be addressed in the Thermal Control Plan through Heat Dissipation Studies to demonstration that deleterious effects to the concrete can be avoided through adherence to the Thermal Control Plan. Such a change requires approval by the Engineer.

As a minimum, the Thermal Control Plan shall include the following:

(1) Concrete mix design. If the mix will be cooled, the Contractor shall define the methodology and necessary equipment to achieve these mix temperatures.

(2) Duration and method of curing.

(3) Methods of controlling temperature differentials, inclusive of active coolant systems not previously defined within the Plans.

(4) An analysis of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the proposed mix design, casting procedures, and materials. It shall show complete details and determine the maximum temperature differentials within the concrete mass.

(5) Temperature sensor types and locations including installation details.

(6) Temperature Monitoring System including system description, operating plan, recording and reporting plan, and remedial action plan.

(7) Field measures and documentation procedures to ensure conformance with the maximum concrete temperature and temperature differential requirements.

(8) Field methods of applying immediate corrective action should the temperature differential approach the Maximum Temperature Differential and Maximum Allowable Concrete Temperature.

The Contractor shall submit the Thermal Control Plan to the Engineer for approval a minimum of thirty working days prior to concrete placement. The thermal control plan shall be signed by an Engineer licensed in the State of Vermont. If the test plan utilizes software for data collection, a copy will be provided to VTrans at no additional cost. Mass concrete placement shall not begin until the Engineer has approved the Thermal Control Plan.

TEMPERATURE MONITORING SYSTEM:

The temperature monitoring and recording system for mass concrete shall consist of temperature sensors connected to a data acquisition system capable of printing, storing, and downloading data to a computer. Temperature sensors shall be located such that the maximum temperature difference within a mass concrete element can be monitored. As a minimum, concrete temperatures shall be monitored from the center of

the concrete mass, the base of the mass, the surface of the mass, and the center of an exterior outer face that is the shortest distance from the center of the concrete mass.

Temperature readings shall be automatically recorded on an hourly basis or as required by the Engineer. A redundant set of sensors shall be installed near the primary set. Provision shall be made for recording the redundant set, but records of the redundant sensors need not be made if the primary set is operational.

Methods of concrete consolidation shall prevent damage to the temperature monitoring and recording system. Wiring from temperature sensors cast into the concrete shall be protected to prevent movement. Wire runs shall be kept as short as possible. The ends of the temperature sensors shall not come into contact with either a support or concrete form, or reinforcing steel.

When any equipment used in the temperature control and monitoring and recording system fails during the mass concrete construction operation, the Contractor shall take immediate remedial measures to correct the situation as specified in the Thermal Control Plan.

Temperature reading will begin when mass concrete placement is complete. Temperature readings will continue until the maximum temperature differential (not maximum temperature) is reached and a decreasing temperature differential is confirmed as defined in the Thermal Control Plan. Furnish a copy of all temperature readings daily.

If monitoring indicates that the temperature differential is approaching the maximum temperature differential of 35 degrees F, the Contractor shall take immediate corrective action as defined in the Thermal Control Plan to retard further increase of the temperature differential. The Contractor will make the necessary revisions to the approved Thermal Control Plan to satisfy the temperature control requirements on future placements. Revisions to the plans must be approved by the Engineer prior to implementation.

Temperature monitoring and recording is considered incidental to mass concrete work.

DAMAGED OR DEFECTIVE CONCRETE:

If mass concrete temperature differentials are exceeded, provide all analyses and test results deemed necessary by the Engineer for determining the structural integrity and durability of the mass concrete element, to the satisfaction of the Engineer. The Agency will make no compensation, either monetary or time, for the analyses, tests or any impacts upon the project.

Any cracks in the structural element greater than 0.016 inches resulting from the contractor’s inability to properly maintain concrete temperature differentials, shall be repaired using epoxy injection at no additional cost to the Agency. The effectiveness of repairs shall be demonstrated by the contractor using evaluation methods acceptable to the Agency. The Engineer will be responsible for accepting or rejecting the repairs after the field evaluation.”

The Contractor shall submit a repair plan to the Agency prior to any work being performed. The plan shall define the method of repair, materials to be used and temperature or environmental controls to be utilized. The repair submittal shall be signed by an Engineer licensed in the State of Vermont.

BRIDGE OPERATION AND MAINTENANCE

xx. DESCRIPTION. This work consists of the operation (tending) and maintenance from Notice to Proceed thru Substantial Completion. This responsibility includes the existing bridge, any temporary bridge and the new bridge. The movable bridge shall be operated in accordance with the Coast Guard Permit requirements.

The Bridge(s) shall be operational from May 15th thru October 15th in accordance with the Coast Guard Permit. The bridge shall be opened on the hour from 6 am to 8 pm and on demand for emergency vessels. The contractor may negotiate a temporary permit change directly with the Coast Guard.

xx. MATERIALS. The contractor shall provide all labor, materials, tools and equipment required to operate and maintain the bridge and any auxiliary and or support systems. Lubricants and hydraulic fluids shall be those specified in the approved shop drawings. Any changes of hydraulic fluids or lubricants shall be submitted to the engineer for approval in advance of ordering the materials.

xx. CONSTRUCTION REQUIREMENTS. The contractor shall provide access by a third party to perform NBIS mandated inspections. This access shall include all materials and equipment required to perform the work.

Maintenance of the existing and new movable bridge shall include:

a. Monthly lubrication of bridge machinery components as indicated in the maintenance manual
b. Perform adjustments of control and safety system components to maintain reliable operation
c. Perform minor maintenance repairs such as traffic gate arms, lights, limit switches, generators, etc.
d. Perform janitorial services to maintain the bridge piers and operator spaces.
e. Service the bridge sanitary holding tanks
f. Snow removal within the project limits

Maintenance of the temporary bridge shall be in accordance with the manufacturer's requirements and shall be the sole responsibility of the Contractor.

The existing bridge, the temporary bridge and the new bridge shall be maintained and operated in accordance with the maintenance requirements and the USCG bridge permit. Any fines or penalties incurred as a result bridge improper maintenance, operation or any other cause resulting in reliability issues shall be the responsibility of the contractor.

Bridge Tending: The contractor shall maintain a crew of qualified bridge tenders to operate the movable bridge (includes a temporary bridge if appropriate) in full compliance with Vermont labor laws and the USCG bridge permit requirements. The period of this work shall be

upon turnover of the bridge by VTrans to the contractor and through substantial completion (xx months).

The contractor shall conduct a 2 day training session for VTrans staff on the operation and maintenance requirements of the new bridge.

Routine Maintenance: Routine maintenance is defined as monthly lubrication, control system limit switch adjustments, visual inspection for hydraulic leaks and damaged components, janitorial services (includes changing bulbs), generator servicing, snow plowing, mowing and vegetation control.

Minor maintenance repairs include gate arm damage repair, guard rail damage, sign repairs, fender system repairs. These repairs shall be implemented by the Contractor with materials supplied by VTrans.

xx. EMERGENCY OPERATIONS. The Contractor may be required to operate the bridge outside of the May 15 through October 15 period. The Contractor shall operate the bridge as directed. The cost for this work shall be submitted to VTrans as extra work at the negotiated labor, equipment, and material rates.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Bridge Operation and Maintenance) measured for payment will be on a lump sum basis, in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Bridge Operation and Maintenance will be paid for at the Contract Lump Sum price prorated monthly over the Contract duration from Notice to Proceed to Substantial Completion as shown on the accepted baseline schedule.

Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Bridge Operation and Maintenance)	Lump Sum

ARCHITECTURAL FOR CONTROL HOUSE AND BASCULE PIER

xx. DESCRIPTION. This work shall consist of the Architectural elements of the Project. The Architectural elements in the Control House are identified on the drawings including:

(a) Standing Seam Metal Roofing System with insulation and vapor barrier
Ceiling System

(b) Bullet Proof Glazing and Door System
Waterproofing/ Flashing / Brick Veneer System

(c) Brick Veneer System w/ Insulation / Waterproofing

(d) Interior Partitions and Furring

(e) Interior metal guards and railings

(f) Interior Flooring System

(g) Stone Wool Ceiling System

The Architectural elements in other areas include:

(h) Steel Doors / Frames and Door Hardware

(i) Metal Cold Formed Framing/Insulation/GWB/Finish Partitions

(j) Metal Guards and Metal Railings

(k) Painting of all Architectural items and related items by Other Sections elements that are not provided with factory finish.

Related Items by Other Sections:

Plumbing Fixtures i.e. sinks and toilets

Concrete knee-walls under bullet-proof glazing

Structural Steel Framing of Control House

Cast in Place Concrete interior partitions, openings and headers

Cast in Place Concrete Stairs

Electrical wiring, switches, race-ways, Lighting Fixtures

HVAC Systems, diffusers, supply registers, fans, heating unit systems.

General. Under otherwise specified, all work shall be performed during the approved coast guard marine outage period….. All Products shall come with full range of available colors and finishes for Architect's Selection. All products require submittals (Product Data and Shop Drawings) for review and approval prior to purchase or installation. Submittals shall be bundled for each Product Section listed below (i.e. A through XX. Contractor must disclose what components do not meet the performance standards established in the Specification and additional review time will be required if substituted materials are submitted. Materials and systems that the Contractor believes to be "Equal" in performance can be submitted without any disclosure of a substitution and normal review time will be afforded provided that a comparison of the performance criteria is clearly indicated. When materials specified have ASTM Testing Standards associated with their product, an or equal product submittal must provide a comparison of the performance data (ASTM Testing Number and compliance comparison). All Products specified shall provide standard manufacturer's warranty and all components and materials to provide a complete system per manufacturer's recommendations. All required Architectural elements not specified or detailed are to be furnished and installed per manufacturer's recommendations when applicable or custom fabricated by Contractor and submitted for approval to Architect.

xx. PRODUCTS.

(a) Standing Seam Metal Roofing System with insulation and vapor barrier per FM Assembly #122413-0-0 (or equal)

Cover – Morin-a Kingspan Group Company – MorZip/SRR-16 aluminum

Securement- Morin-a Kingspan Group Company 146A AccuTrac Hextra

Vapor Barrier Membrane – Firestone V-Force Barrier Membrane.

Cover Board – United States Gypsum Company SECUROCK Glass-Mat Roof Board

Insulation Board – Firestone Building Products Co, LLC – ISO 95+ GL

Securement Board – SSSP15260

Thermal Barrier – United States Gypsum SECUROCK Gypsum-Fiber Roof Board

Steel Deck – 22 to 16 ga steel (see/ confirm with Structural

Securement(Deck)-ITW Commercial Const. North American-#12HWH Teks 5

All penetrations for Mechanical, Plumbing, etc. shall be provided and sealed per roofing manufacturer's standard penetration details.

The Roofing Manufacturer is to provide Submittal with all coordinated roofing components with Factory Mutual Rating for Project Location and data to confirm conformance with Building Energy Codes.

(b) Ballistics Glazing and Door System.

Insulgard Security Products – TH600 Bullet, Blast, Impact and Wind Resistant Architectural Aluminum Framing System with insulated glass clad polycarbonate application, with Ballistics Level 3 Protection per U.L. Standard 752.

Ballistics Manufacturer to provide all enclosure details, and miscellaneous metals details and materials to provide a Ballistics Level 3 between the concrete knee-wall below to the bottom of the roof above, as well as the door and door surround. They will also provide all exterior door hardware and locking mechanisms. The Ballistics Glazing and Door System shall be based on Structural Wind Loads for Project Location and provide Structural Engineering as required to accompany Submittal.

(c) Brick Veneer System w/ Waterproofing / Insulation.

Standard size running bond brick is to be anchored with stainless steel anchors to a concrete knee-wall shown on Structural Documents. This system is to provide an air/vapor barrier, rigid insulation, masonry ties/anchors, base flashing and weeping systems compliant with NFPA 285 Fire Tested Wall Assemblies. The brick is capped with a continuous sill.

Brick: modular clay brick compliant with ASTM C62 and FBX

Brampton Brick – Crossroads Series, color – Newton

Cast Stone Sill: American ARTSTONE custom fabrication

Masonry: Contractor to provide ACI recommended mortar and weeping system as well as perimeter weatherproof seals.

Wall Cavity Assembly: Owens Corning CommercialComplete Wall Systems for brick veneer wall assemblies. Refer to Architect's Guide to NFPA 285 Tested Owens Corning CommercialComplete Wall Systems Table 2 for acceptable components in wall system.

(d) Interior Partitions and Interior Furring.

½ Height Partition: Interior ½ height partitions to be 5/8" Abuse and Moisture Resistant GWB on 6" metal studs spaced 16" o.c. with expansion anchors at base spaced at 16" o.c. ½ Height Partition to have solid surface cap with standard FRP System for wall base, wall finish, and full trims and sealants to match finish color. Installation is to follow manufacturer's recommendations.

Metal Framing: Clark Dietrich 25-Gauge Galv. Steel

Batt Insulation: Owens Corning EcoTouch PINK FIBERGLAS

5/8" GWB: US Gypsum- Sheetrock/Mold Tough/AR Firecode Core

Partition Cap/ Window Sill: ¾" Corian solid surface– Dove Grey.

Partition Finish: Marlite Pebbled Standard FRP- Medium Grey

Furring: All concrete walls for all interior spaces in the Project shall have full height furring and finish composed of: galvanized cold formed 25 Gauge metal framing 16" o.c. U.N.O. with insulation to fill metal framing cavity with 5/8" Abuse and Moisture Resistant GWB finished with an FRP panel system. Depth of metal furring is indicated on drawings. Components of Furring System to match ½ Height Partitions above.

(e) Interior Metal Guards and Interior and Exterior Metal Railings.

All profiles to match design drawings. Railings and guards to be stainless steel designed by custom metal manufacturer to provide structural anchorage details to resist required loads ((Handrails - 200lbf applied to any point at any direction, as well as a uniform load of 50lb/ft applied in any direction. Loads do not have to be calculated concurrently) (Guards- capable of withstanding concentrated load of 200lbf applied to 1 sq.ft. at any point on the system.)) per Building Code. Provide professional structural engineering stamp on shop drawings to be submitted for review.

Materials: Architectural Metal Works or equal ASTM Type 316

Railings- 1 ½ O.D. stainless steel tubing

Ballusters- 1" U.N.O. square stainless steel

Base Plates, Tabs, Brackets, Flanges, Anchors, Base Plate, Fasteners– all

316 stainless steel

(f) Interior Flooring System.

(1) Control House Flooring – Nora Commercial Flooring – Nora Grano ed, Color-medium grey. Provide moisture mitigation per manufacturer's recommendations.

(2) All other Interior Flooring – Sealed Concrete – Penetrating Sealer suitable for outdoor exposure conditions that is breathable to allow moisture vapor to escape.

(g) Stone Wool Ceiling System.

A 2'x2' grid system is to be provided in the Control House. A blanket of 6" batt insulation is to be provided over the suspension system.

Ceiling System: Roxul, Rockfon Artic 2x2 ceiling system with a square tegular narrow grid

Batt Insulation: Owens Corning EcoTouch PINK FIBERGLAS

(h) Steel Doors / Frames and Door Hardware.

The Control House Door will be provided by the Ballistics Glazing manufacturer. All other doors on the Project will be provided in this Section. Steel doors will be seamless with 14 gauge galvanized steel with a polystyrene insulated core. Door frames will be 12 gauge galvanized heavy duty steel grouted solid with stainless steel anchors. Doors and Frames are to be shop primed. Doors are to be provided with door stops and rubber silencer and stainless steel kickplates. Doors shall have heavy duty hardware and locksets and heavy duty door closers. Doors are to be within cast in place concrete openings and existing masonry wall opening jamb anchors and all installation is to be provided per the National Association of Architectural Metals Manufacturer's Guide Specification for Installation and Storage of Hollow Metal Doors and Frames (NA AMM 840-99).

Steel Doors: Allegion- STEELCRAFT – L Series 14 GA

Steel Door Frames: Allegion, STEELCRAFT– F-Series at 12 GA. U.N.O. door frames to be 5 ¾" grouted solid.

Hinges: (3) 4 ½" x 4 ½" Butt Hinges per door.- Allegion, Ives Butt Hinges – 5BB1HW.

Stainless Steel Kickplate (both sides): Ives 8400

Door Hardware Typical (corresponding type for double doors): Allegion, Schlage- Heavy Duty Lever Lockset, Rhodes, Entry, Model#ND53PD C123 RHODES 626

Panic Door Hardware: Allegion, Von Duprin 98/99 Series – 996L-NL

Door Closers: Allegion, LCN 4011 Smoothee-Heavy Duty Institutional Adjustable Door Closer

(i) Metal Cold Formed Framing/Insulation/GWB/Finish Partitions. – See Section D similar.

(j) Metal Guards and Metal Railings. – See Section E similar.

(k) Painting.

Surface Preparation General- All surfaces shall be prepared for paint per painting manufacturers recommendation.

Overhead Metal Deck, conduit, HVAC Equipment, Support Structural Steel at ceiling height and above- (1 coat- 3 to 5 mils) Tnemec Series 115 - Unibond.

Painting from ceiling height to below: (2 coats – 2.5 to 3 mils per coat) Tnemic Series 1029 – Enduratone

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (ARCHITECTURAL FOR CONTROL HOUSE AND BASCULE PIER) will be on a lump sum basis.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (ARCHITECTURAL FOR CONTROL HOUSE AND BASCULE PIER) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

Partial Payments will be made as follows:

Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (ARCHITECTURAL FOR CONTROL HOUSE AND BASCULE PIER)	Lump Sum

BRIDGE RAIL TRANSITION

xx. DESCRIPTION. This work shall consist of furnishing and erecting bridge rail transition from steel 3-bar bridge railing with vertical pickets to Steel Beam Guardrail as shown in the Plans and as directed by the Engineer.

The work under this Section shall be performed in accordance with these provisions, the Plans, and Sections 540 and 621 of the Standard Specifications.

xx. GENERAL REQUIREMENTS. Bridge Rail Transition shall consist of

(a) Precast Highway Guardrail Transition. (See Figure 3.8.1)
(b) Bridge Rail to Highway Guard Transition. (See Figure E 401.5.18)
(c) Steel Highway Guard Transition Beam. (See Figure E 401.6.2)

Bridge Rail Transition alternatives shall constitute a crash-tested system, meeting or exceeding NCHRP Report 350 (1993) TL-4 crash rating, and fit within the geometric constraints detailed in the Plans.

xx. MATERIALS.

(a) Materials for Precast Highway Guardrail Transition shall be as required by Section 525.
(b) Materials for Bridge Rail to Highway Guard Transition and Steel Highway Guard Transition Beam shall conform to Section 728 of the Standard Specification, except as required by the railing manufacturer to meet crash test requirements. Deviations from Section 728 shall be supplied to the Engineer for review and approval.

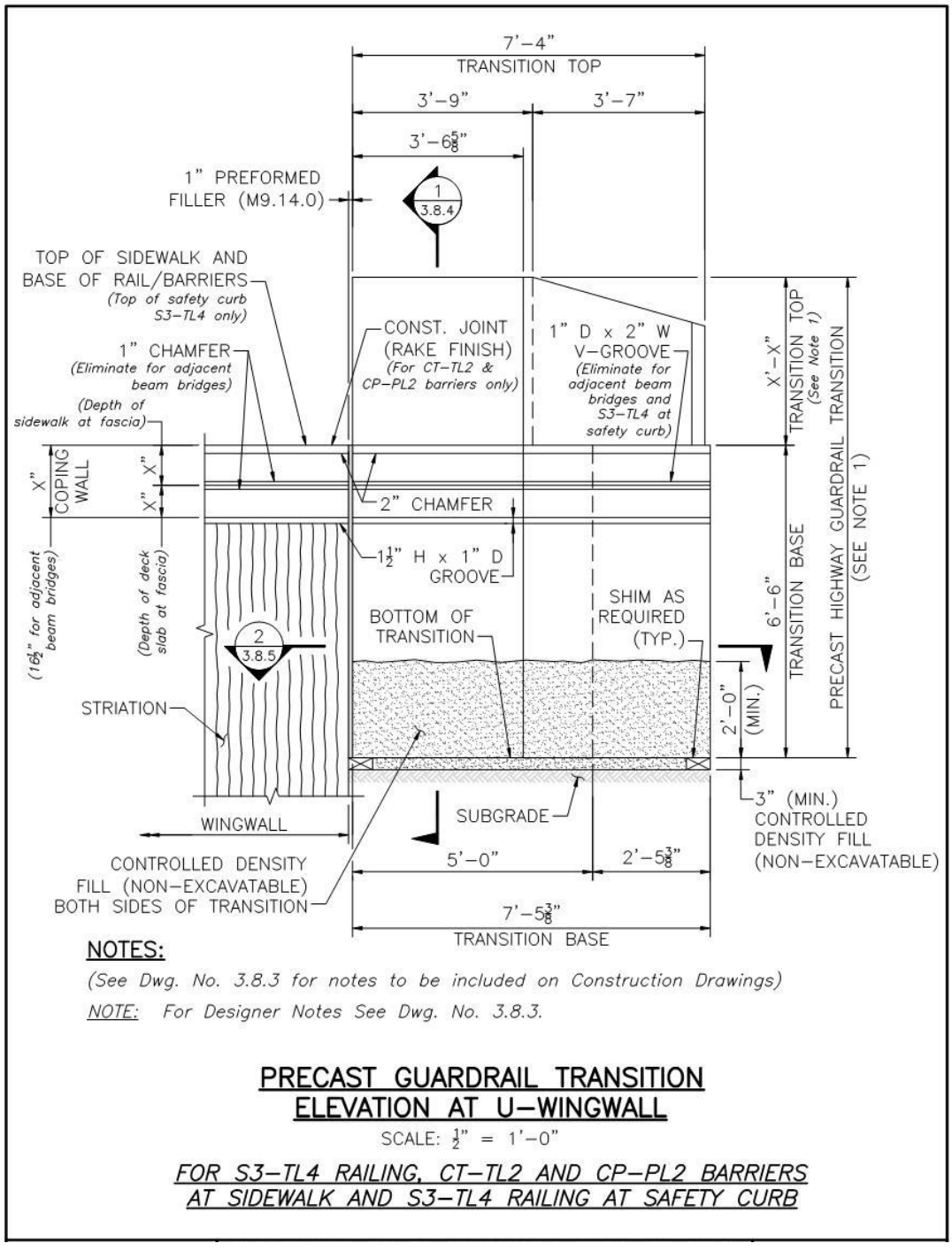
xx. CONSTRUCTION REQUIREMENTS. Bridge Rail Transitions shall be provided and erected to the configuration shown in the Plans.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Bridge Rail Transition) to be measured for payment will be the quantity each used in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Bridge Rail Transition) will be paid for at the full contract unit price per each. Payment will be full compensation for detailing, furnishing, delivering, handling, placing, and delineating the railing components, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
900.620	Special Provision (Bridge Rail Transition)	Each



NOTES:

(See Dwg. No. 3.8.3 for notes to be included on Construction Drawings)

NOTE: For Designer Notes See Dwg. No. 3.8.3.

PRECAST GUARDRAIL TRANSITION ELEVATION AT U-WINGWALL

SCALE: 1/2" = 1'-0"

FOR S3-TL4 RAILING, CT-TL2 AND CP-PL2 BARRIERS AT SIDEWALK AND S3-TL4 RAILING AT SAFETY CURB

Figure 3.8.1

NOTES: *(Include these notes with details shown on Dwg. No's. 3.8.1, 3.8.2 & 3.8.8 thru 3.8.10)*

1. PRECAST GUARDRAIL TRANSITION SHALL BE 5000 PSI, $\frac{3}{4}$ IN, 685 HP CEMENT CONCRETE.

2. GRAVEL BORROW SHALL BE PLACED AND THOROUGHLY COMPACTED TO THE GRADE OF 3" (MIN.) BELOW THE INTENDED BOTTOM OF THE PRECAST GUARDRAIL TRANSITION BASE AND TO A HEIGHT OF 2'–0" (MIN.) ON ALL SIDES OF THE TRANSITION BASE TO FORM A TRENCH IN WHICH TO SET THE TRANSITION. WHERE NO GRAVEL BORROW IS REQUIRED BELOW THE BASE, IT SHALL BE PLACED ON UNDISTURBED SOIL.

3. CONTRACTOR SHALL SET THE PRECAST GUARDRAIL TRANSITION TO THE REQUIRED ELEVATION AND ALIGNMENT, AND BACKILL PRECAST GUARDRAIL TRANSITION WITH CONTROLLED DENSITY FILL (NON–EXCAVATABLE) TO THE ELEVATION SHOWN.

Add the following notes for splayed wingwalls only:

4. AFTER CONTROLLED DENSITY FILL (NON–EXCAVATABLE) HAS SET FILL THE GAPS BETWEEN GUARDRAIL TRANSITION AND BLOCK–OUT IN BACKWALL AND ABUTMENT WITH NON–SHRINK GROUT UP TO THE TOP OF BACKWALL.

5. THE REST OF REINFORCEMENT IS NOT SHOWN FOR CLARITY.

NOTES:

1. *The height of the transition top is 2'–10" for S3–TL4 railing at safety curb and 3'–6" for S3–TL4 railing, CT–TL2, and CP–PL2 barriers at sidewalk.*
2. *Modify the shape of the transition top as required for CF–PL2 barrier.*
3. *The height of the transition top is 2'–11" for CF–PL2 barrier and 3'–9" for CT–TL2, CP–PL2 and CF–PL3 barriers.*
4. *This dimension is equal to 3'–6$\frac{5}{8}$" for CT–TL2 and CP–PL2 barriers at safety curb and 3–6$\frac{3}{8}$" for CF barriers.*
5. *The chamfer is 2" for CT–TL2 and CP–PL2 barriers and 1" for CF barriers.*

Figure 3.8.3

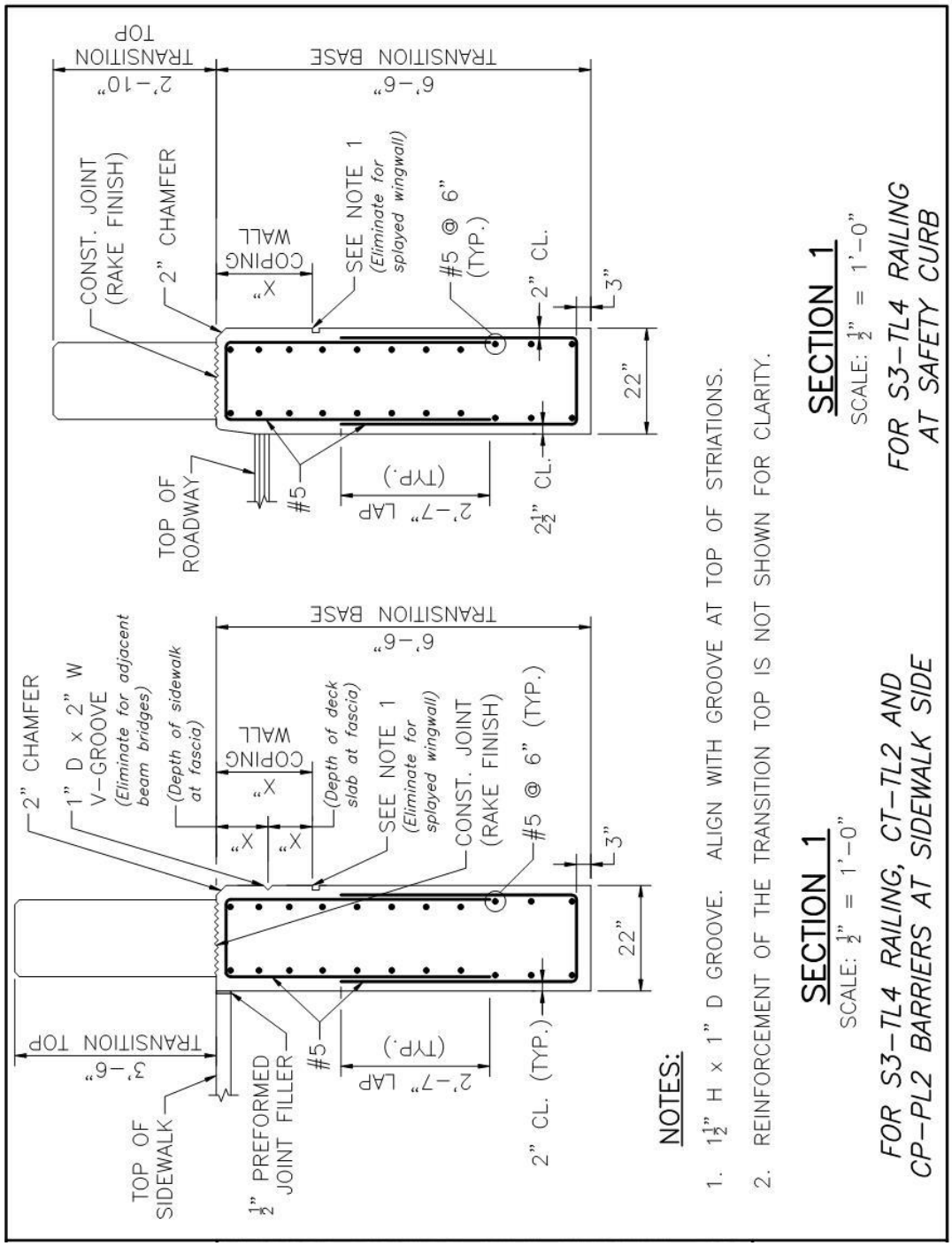
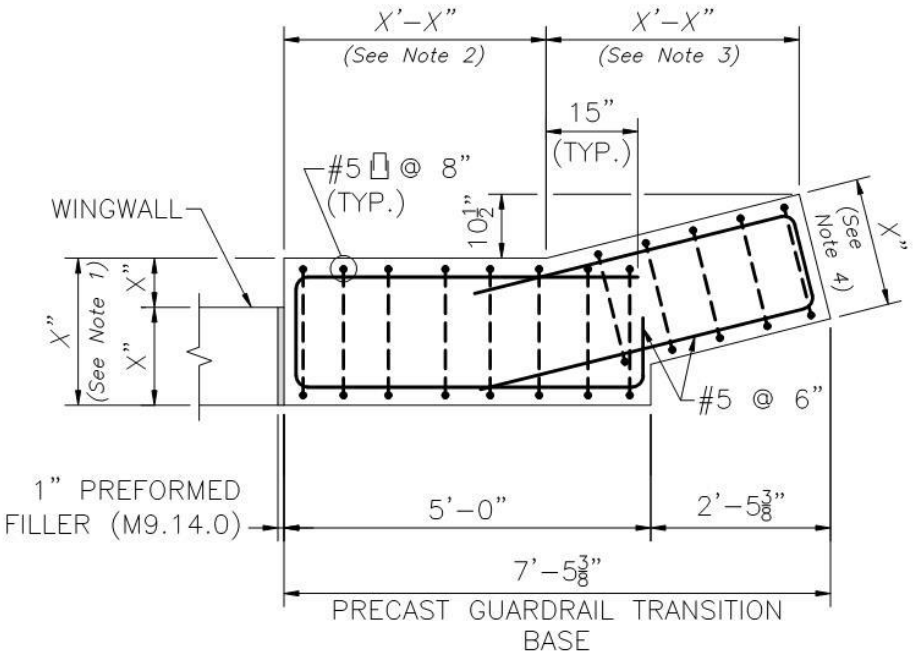

TRANSITION TOP
2'-10"
TRANSITION BASE
6'-6"
CONST. JOINT (RAKE FINISH)
2" CHAMFER
COPING WALL
X"
SEE NOTE 1 (Eliminate for splayed wingwall)
#5 @ 6" (TYP.)
2" CL.
3"
22"
TOP OF ROADWAY
#5
(TYP.)
2'-7" LAP
2½" CL.
2" CHAMFER
1" D x 2" W V-GROOVE (Eliminate for adjacent beam bridges)
(Depth of sidewalk at fascia)
(Depth of deck slab at fascia)
SEE NOTE 1 (Eliminate for splayed wingwall)
CONST. JOINT (RAKE FINISH)
#5 @ 6" (TYP.)
3"
22"
TRANSITION TOP
3'-6"
TOP OF SIDEWALK
½" PREFORMED JOINT FILLER
#5
(TYP.)
2'-7" LAP
2" CL. (TYP.)
NOTES:
1. 1½" H x 1" D GROOVE. ALIGN WITH GROOVE AT TOP OF STRIATIONS.
2. REINFORCEMENT OF THE TRANSITION TOP IS NOT SHOWN FOR CLARITY.
SECTION 1
SCALE: ½" = 1'-0"
FOR S3-TL4 RAILING, CT-TL2 AND CP-PL2 BARRIERS AT SIDEWALK SIDE
SECTION 1
SCALE: ½" = 1'-0"
FOR S3-TL4 RAILING AT SAFETY CURB

Figure 3.8.4



NOTE:

WINGWALL REINFORCEMENT AND STRIATIONS NOT SHOWN FOR CLARITY.

SECTION 2

SCALE: ½" = 1'–0"

NOTES:

1. *2'–0" for CF–PL3 Barrier and 22" for all other railing/barrier systems.*
2. *3'–6⅜" for CF–PL3 Barrier and 3'–6⅝" for all other railing/barrier systems.*
3. *3'–5⅞" for CF–PL3 Barrier and 3'–6⅛" for all other railing/barrier systems.*
4. *21" for CF–PL3 Barrier and 19" for all other railing/barrier systems.*

Figure 3.8.5

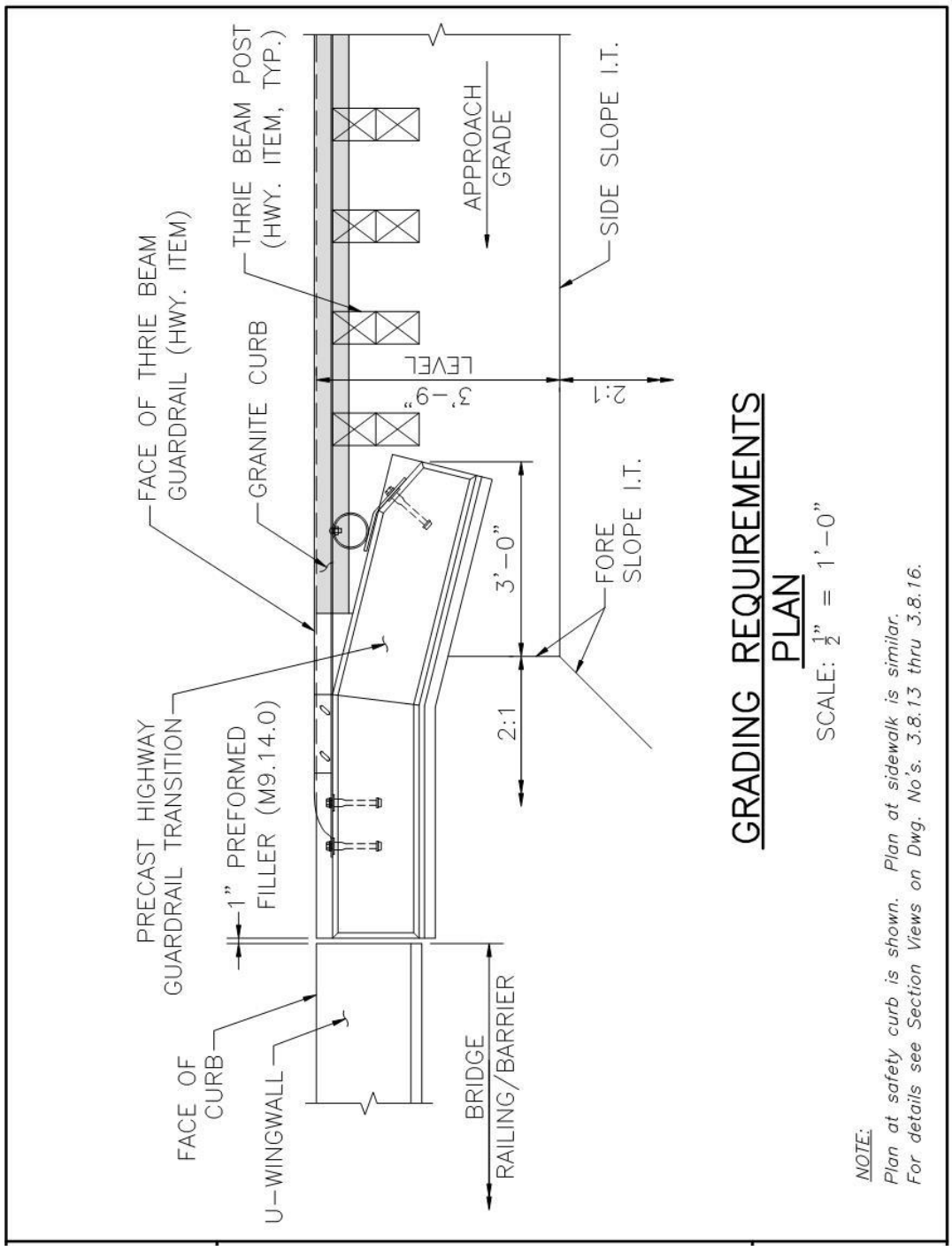

FACE OF THRIE BEAM GUARDRAIL (HWY. ITEM)
THRIE BEAM POST (HWY. ITEM, TYP.)
GRANITE CURB
APPROACH GRADE
SIDE SLOPE I.T.
LEVEL
3'-9"
2:1
3'-0"
2:1
FORE SLOPE I.T.
PRECAST HIGHWAY GUARDRAIL TRANSITION
1" PREFORMED FILLER (M9.14.0)
FACE OF CURB
U-WINGWALL
BRIDGE RAILING/BARRIER
GRADING REQUIREMENTS
PLAN
SCALE: 1/2" = 1'-0"
NOTE:
Plan at safety curb is shown. Plan at sidewalk is similar.
For details see Section Views on Dwg. No's. 3.8.13 thru 3.8.16.

Figure 3.8.11

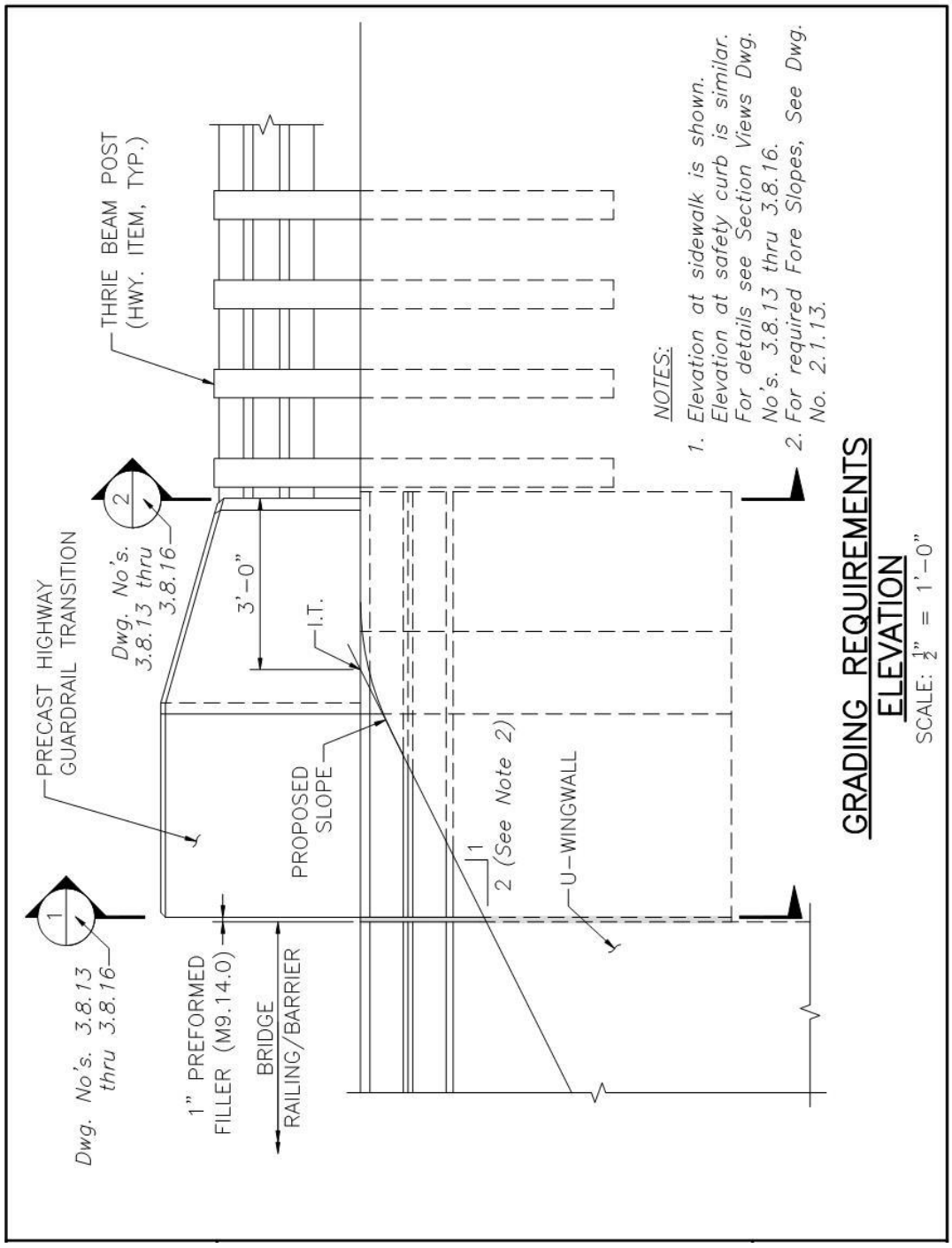

GRADING REQUIREMENTS
ELEVATION
SCALE: 1/2" = 1'-0"
NOTES:
1. Elevation at sidewalk is shown. Elevation at safety curb is similar. For details see Section Views Dwg. No's. 3.8.13 thru 3.8.16.
2. For required Fore Slopes, See Dwg. No. 2.1.13.
THRIE BEAM POST (HWY. ITEM, TYP.)
PRECAST HIGHWAY GUARDRAIL TRANSITION
Dwg. No's. 3.8.13 thru 3.8.16
Dwg. No's. 3.8.13 thru 3.8.16
3'-0"
I.T.
PROPOSED SLOPE
1
2 (See Note 2)
U-WINGWALL
1" PREFORMED FILLER (M9.14.0)
BRIDGE RAILING/BARRIER

Figure 3.8.12

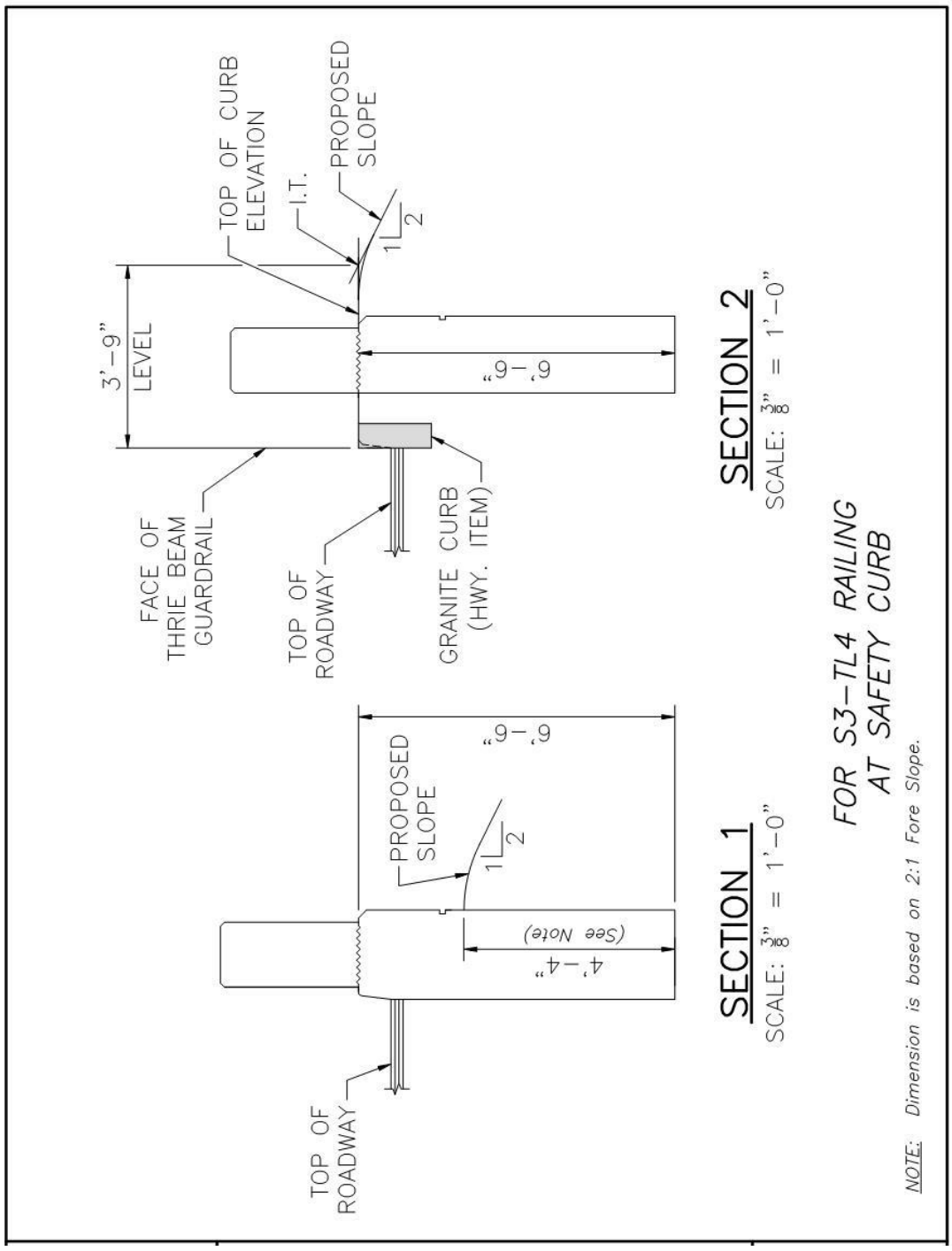

TOP OF CURB ELEVATION
I.T.
PROPOSED SLOPE
1
2
3'-9" LEVEL
6'-6"
FACE OF THRIE BEAM GUARDRAIL
TOP OF ROADWAY
GRANITE CURB (HWY. ITEM)
SECTION 2
SCALE: 3/8" = 1'-0"
PROPOSED SLOPE
4'-4" (See Note)
SECTION 1
SCALE: 3/8" = 1'-0"
FOR S3-TL4 RAILING AT SAFETY CURB
NOTE: Dimension is based on 2:1 Fore Slope.

Figure 3.8.14

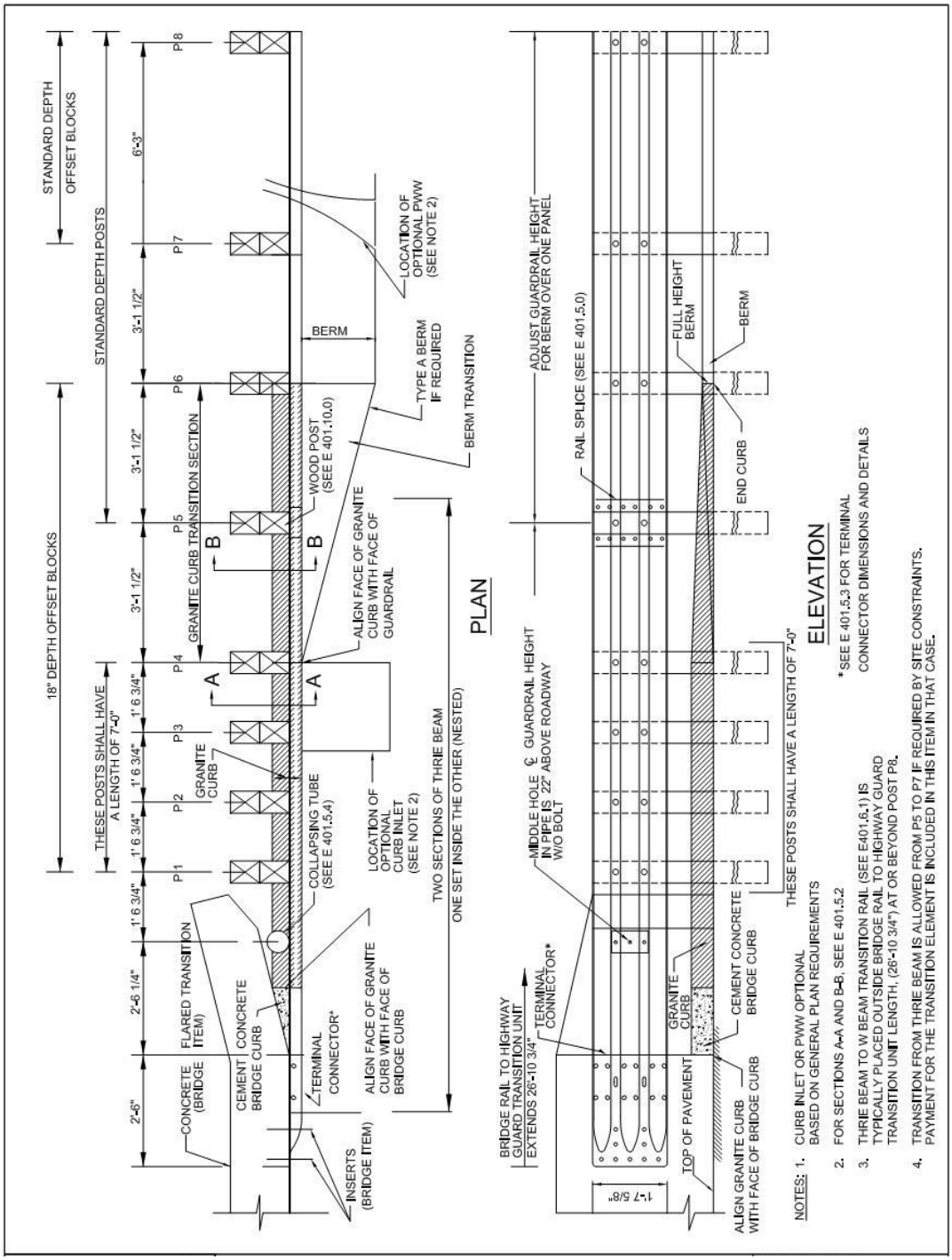


Figure E 401.5.1R

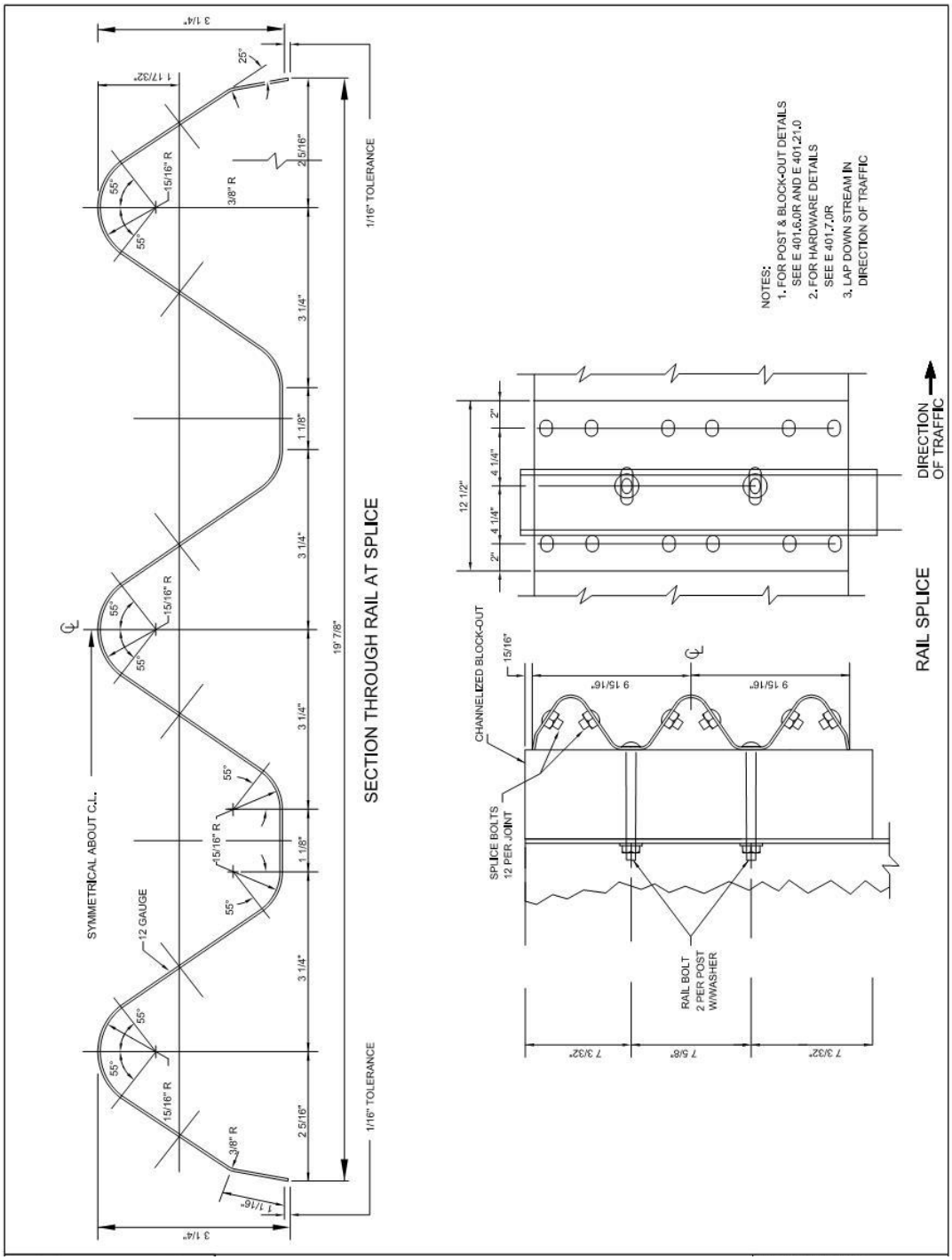


Figure E 401.5.0

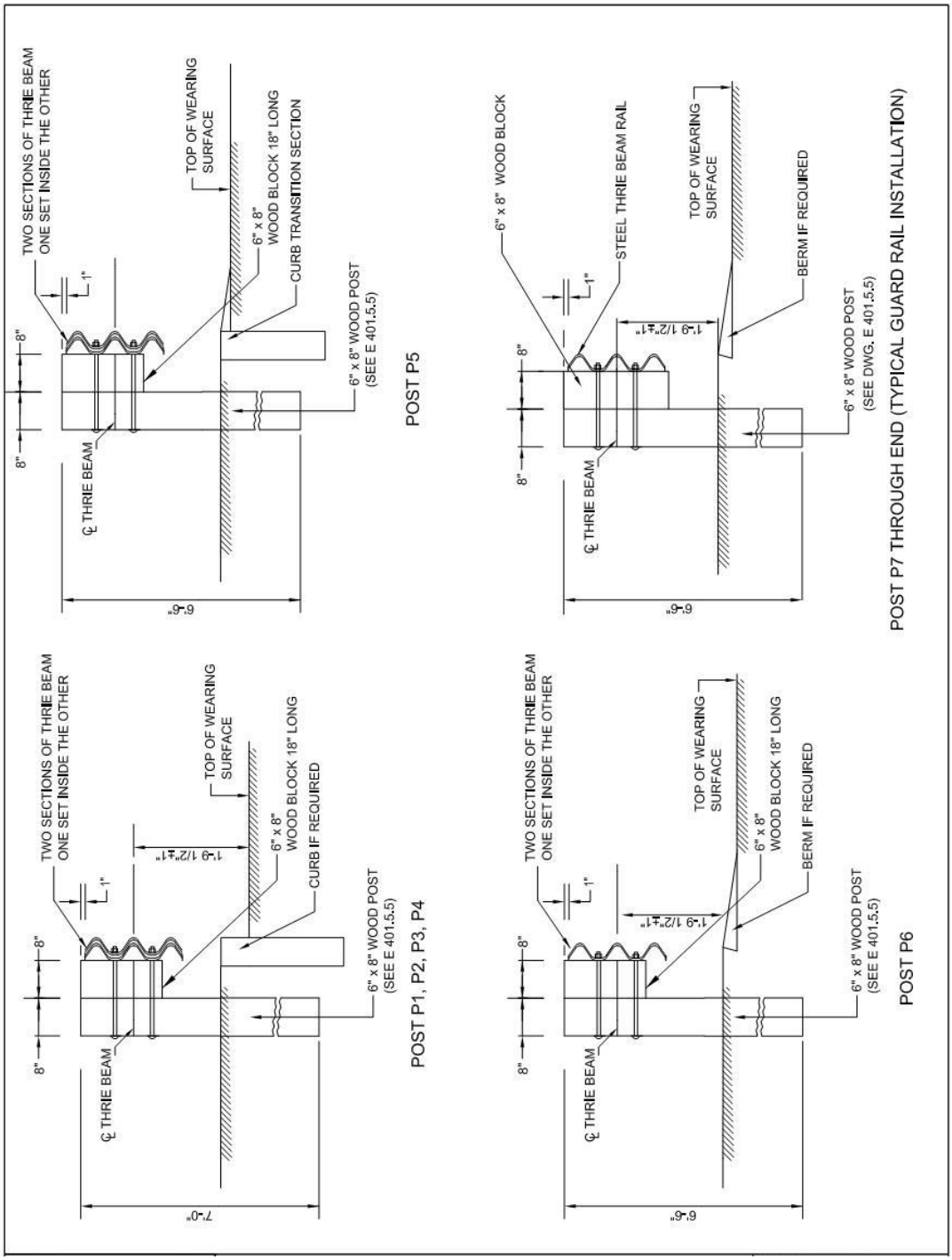


Figure E 401.5.2

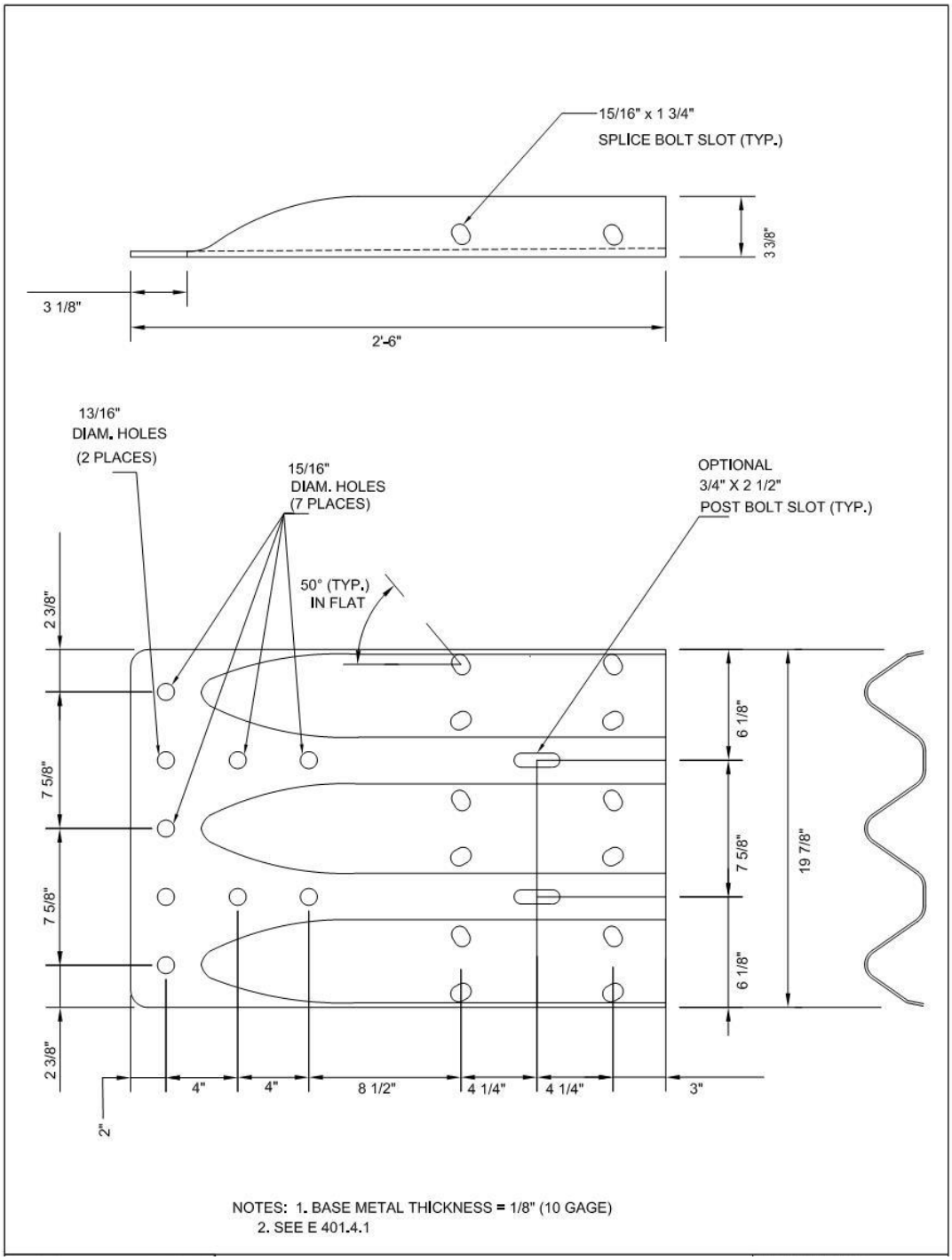


Figure E 401.5.3

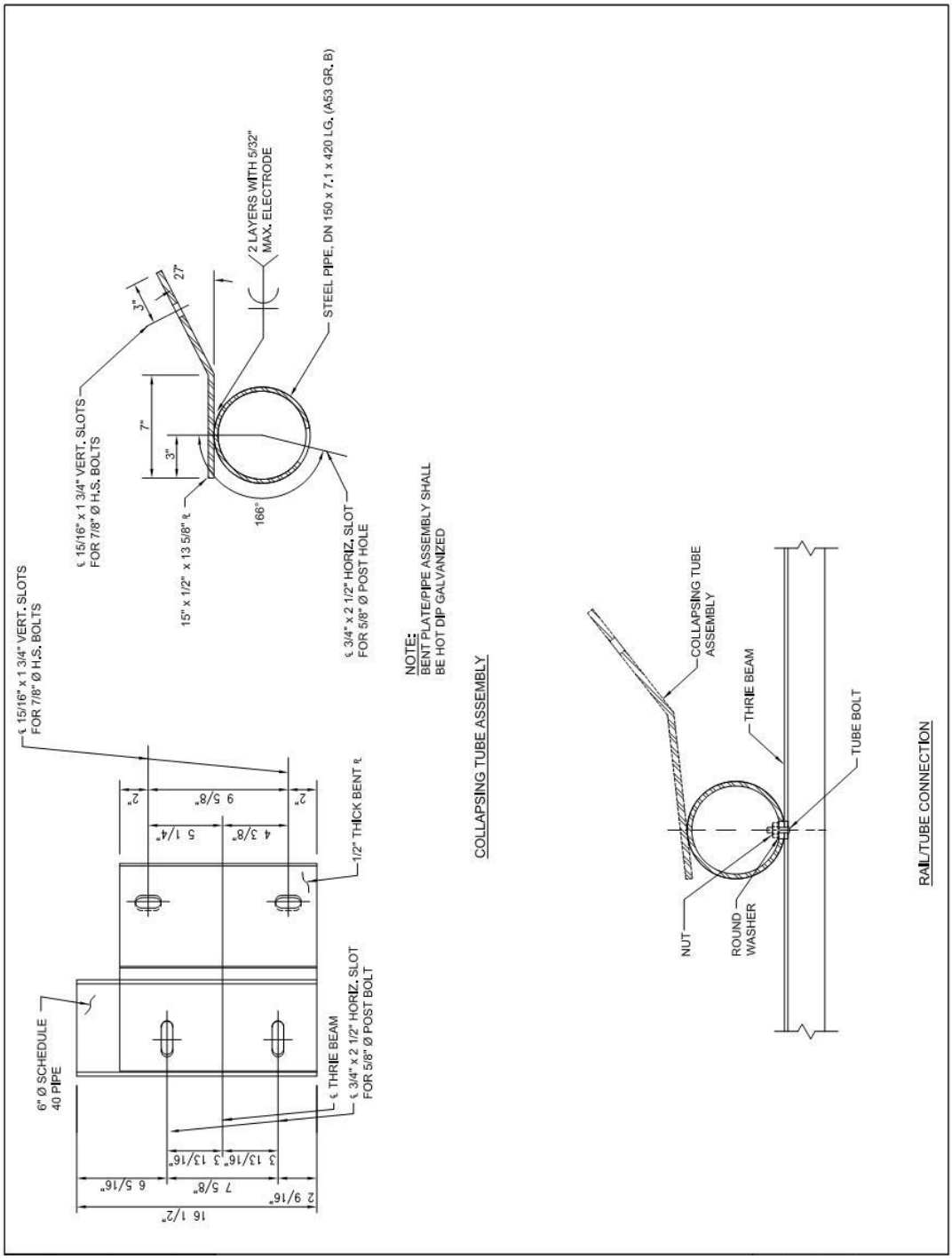


Figure E 401.5.4

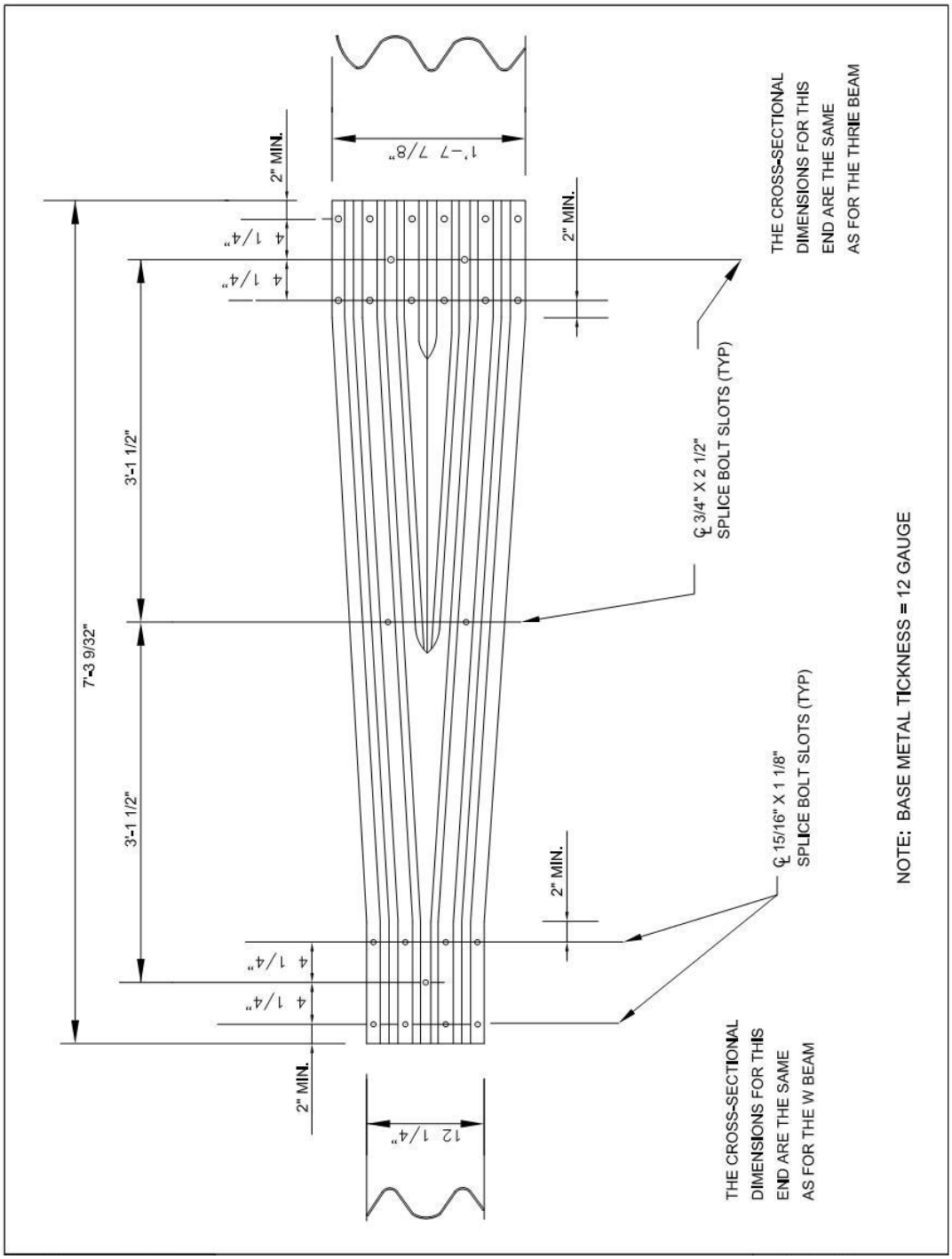


Figure E 401.6.1

BRIDGE RAILING, STEEL 3-BAR

xx. DESCRIPTION. This work shall consist of furnishing and erecting steel 3-bar bridge railing with vertical pickets as shown in the Plans and as directed by the Engineer.

The work under this Section shall be performed in accordance with these provisions, the Plans, and Sections 525 of the Standard Specifications.

xx. GENERAL REQUIREMENTS. Steel Bridge Railing shall be type S3-TL4 as shown in the Massachusetts Department of Transportation (MassDOT) LRFD Bridge Manual, 2013 Edition, Standard Details, or approved equal. Bridge Railing alternatives shall meet or exceed NCHRP Report 350 (1993) TL-4 crash rating, be of a similar unit weight, and fit within the geometric constraints detailed in the Plans.

xx. MATERIALS. Materials for Bridge Railing shall conform to Section 732 of the Standard Specification, except as required by the railing manufacturer to meet crash test requirements. Deviations from Section 732 shall be supplied to the Engineer for review and approval.

xx. CONSTRUCTION REQUIREMENTS. Bridge Railing shall be provided and erected to the configuration shown in the Plans.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Bridge Railing, Steel 3-Bar) to be measured for payment will be the number of linear feet of rail used in the complete and accepted work. Measurement will be made along the face of rail from end to end or between the pay limits specified.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Bridge Railing, Steel 3-Bar) will be paid for at the full contract unit price per linear foot. Payment will be full compensation for detailing, furnishing, delivering, handling, placing, and delineating the railing components, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
900.640	Special Provision (Bridge Railing, Steel 3-Bar)	Linear Foot

CRITICAL PATH METHOD (CPM) SCHEDULE

XX. DESCRIPTION. This work shall consist of developing and furnishing a CPM Schedule, including narratives, updates, and revisions for the duration of the Contract.

These provisions shall supersede Subsection 108.03(a) of the Standard Specifications.

XX. SUBMISSIONS.

(a) The Contractor is responsible for the scheduling of all Contract work, which shall include, but is not limited to subcontracted work, complete and acceptable submissions, work component fabrications, and delivery of materials. The schedule shall include allowance for time for all aspects of the work including sufficient time for VTrans to perform its functions as indicated in the Contract, including but not limited to acceptance inspection and/or testing, and review and acceptance/approval of any required Working Drawings as defined in Section 105 or otherwise in the Contract Documents.

(b) Provide the following items with each schedule submission. The schedule shall be prepared with MS Project.

(1) An electronic copy in MS Project format with run date and version of the schedule;

(2) A PDF illustrated in color, depicting no more than 50 activities on each 280 by 430 mm (11 by 17 in.) sheet, and with each sheet including title, project name and number, match data for diagram correlation, and a key;

(3) A four-week look-ahead narrative to provide a more detailed plan of upcoming work highlighting the near term priorities. Indicate the anticipated workdays per week, number of shifts per day, number of hours per shift, crew sizes, and assumed resources. If the project requires a road closure, identify any changes in anticipated resources, or work schedule during the closure period.

(c) The CPM schedule shall include the following:

(1) Activities that describe the essential features of the work, activities that might delay Contract completion, and which activities are on the critical path;

(2) The planned start and completion dates for each activity and the duration of each activity stated in work days (field activities of more than 15 work days in duration

shall be broken into two or more activities distinguished by location or some other logical feature); this estimated figure shall include considerations for permit limitations, seasonal limitations, and any other anticipated delays.

(3) When the project contains a defined Road or Bridge Closure Period impacting vehicular traffic of a minimum of 24 hours and up to a maximum of 28 days, the duration for work within the closure period shall be shown in hours instead of days. The maximum duration of each activity within the closure period shall be limited to twelve (12) hours;

(4) Finish-to-Start relationships among activities, without leads or lags unless justified in the narrative, and approved by the Engineer;

(5) Distinct columns showing Predecessors, Successors, Duration, Actual Start, and Actual Finish for each Activity;

(6) Project suspension or work inactivity that is three (3) days or longer;

(7) Dates related to the procurement of materials, equipment, and articles of special manufacture;

(8) Dates related to the submission of Working Drawings, plans, and other data specified for review or approval by the Agency;

(9) Key milestone dates specified in the Contract including but not limited to; Notice to Proceed, Interim Completion, Permit Restriction Dates, and Contract Completion Date. These shall be the only constraints in the schedule logic;

(10) Activities related to Agency or Third Party reviews and inspections.

(d) For contracts with an original Contract amount in excess of $8,000,000.00 the following additional information shall be shown on the CPM schedule:

(1) Each Contract bid item identified with at least one activity, except:

Lump Sum items, Lump Unit items, Contract items paid by the "Hour", Contract items paid by the "Dollar", Section 641 pay items, and Section 653 pay items.

(2) Each compensable activity shall identify the applicable Contract item(s), along with the total quantity intended to be placed during that activity.

XX. BASELINE SCHEDULE. The CPM Schedule submittal shall be received by the Engineer a minimum of seven (7) calendar days prior to the preconstruction meeting. The Engineer and Contractor may review the schedule at the preconstruction meeting. Any requested information and a revised schedule shall be submitted within seven (7) calendar days after receiving the Engineer's request. The Engineer shall be allowed twenty-one (21) calendar days to review the schedule and provide a response. The Engineer will review the schedule by assessing the schedule's compliance with these provisions and conformance with the Contract requirements. By accepting the schedule, the Engineer does not modify the Contract in any way. The Baseline Schedule shall be accepted before any field work begins. The accepted schedule will be used as the Baseline Schedule for the remainder of the project.

The schedule shall define and sequence activities so as to accurately describe the project and to meet Contract requirements for scope of work, phasing, accommodations for traffic, and interim, and project completion dates. Create the schedule, beginning with the date of the Notice to Proceed.

XX. SCHEDULE UPDATES. The schedule shall be updated during active construction at the end of every other bi-weekly estimate period (update period) and when directed by the Engineer. Projects with short duration road closures are of particular importance as the project float will be limited. The Contractor shall promptly inform the Engineer of any schedule delays or changes that occur during these periods. The Engineer shall be allowed ten (10) calendar days to review the update for compliance with these provisions and provide a response. Include the following with each update:

(1) Actual start dates of each activity started;

(2) Actual finish dates of each activity finished, or remaining durations of activities started but not yet completed;

(3) Narrative report describing progress during the update period, shifts in the critical activities from the previous update, sources of delay, potential problem areas, work planned for the next update period, and changes made to the schedule. Changes include additions, deletions, or revisions to activities due to the issuance of a Contract revision, changes to an activity duration, changes to relationships between activities, or changes to the planned sequence of work or the method and manner of its performance.

(4) The Original schedule shall be shown as a Baseline

XX. REVISIONS. Schedule revisions shall be submitted within ten (10) calendar days after any of the following:

(1) A written request to revise the schedule from the Engineer;

(2) A delay (actual or projected) to scheduled milestones or project completion dates;

(3) When actual progress falls behind the most recent schedule accepted by the Engineer, either by falling more than two (2) weeks behind schedule or by 5% of the total Contract time, the Contractor shall immediately inform the Engineer in writing. The Engineer may require the Contractor to submit a revised schedule. Neither the Engineer's acceptance of such revised schedule nor any Agency feedback regarding the revised schedule shall be construed as an approval of the revised schedule, nor should it be construed as the Agency's dictation of the Contractor's means and methods;

(4) Issuance of a Change Order/Supplemental Agreement(s) that by adding, deleting, or revising activities, changes the planned sequence of work or the method and manner of its performance;

(5) Issuance of a Change Order/Supplemental Agreement(s) that adds time to the Contract;

(6) The Contractor shall participate in progress meetings at the request of the Engineer to review and discuss the updated schedule information including any activity delay, coordination requirements, change orders, potential delays, and other relevant issues.

The Engineer shall review the revised schedule for compliance with these provisions, and provide a response within ten (10) calendar days.

XX. FLOAT. Any float in the schedule is to be credited to the project only.

XX. FAILURE TO SUBMIT SCHEDULE. Failure to submit a schedule (i.e. original baseline schedule, required updates, revisions, and when requested by the Engineer) in accordance with these provisions may be grounds for suspension of partial payments, as identified in Subsection 109.08, until a satisfactory schedule meeting the requirements of these provisions is received by the Engineer.

XX. METHOD OF MEASUREMENT. The quantity of Special Provision (CPM Schedule) to be measured for payment will be the number of each CPM Schedule (i.e. original baseline schedule, required updates, revisions, and when requested by the Engineer), accepted by the Engineer through the duration of the Contract.

XX. BASIS OF PAYMENT. The accepted quantity of Special Provision (CPM Schedule) will be paid for at the Contract unit price for each. Payment will be full compensation for preparing and submitting a schedule as specified, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
900.620	Special Provision (CPM Schedule)	Each

FENDER SYSTEM

xx. DESCRIPTION. This work shall consist of detailing, furnishing and installing an FRP Timber Fender System, Walkway and Railing as shown in the Plans and as directed by the Engineer.

xx. MATERIALS. Materials shall meet the following requirements:

(a) Structural Recycled Plastic Lumber. Shall be manufactured from a purified blend of post consumer, preconsumer and virgin High Density Polyethalene HDPE Resins. HDPE Lumber shall be UV resistant.

(b) Steel Hardware. Steel Hardware shall be constructed of ASTM A709 Grade 50 and shall be hot dipped galvanized in accordance with Subsection 726.08.

(c) Anchor Bolts. Anchor Bolts shall be ASTM A307 and shall be Hot Dipped Galvanized in accordance with Subsection 726.08. Anchor bolts shall be cast in concrete pier walls. No drilling and grouting of anchor bolts is allowed

.

(d) Structural Steel. Structural Steel shall meet the requirements of Subsection 714 for AASHTO M 270M/M 270, Grade 50 steel. Steel shall be hot dip galvanized following fabrication in accordance with Subsection 726.08.

xx. SUBMITTALS. The Contractor shall submit the following:

(a) Shop Drawings for the construction of the fenders, railings and walkway in accordance with Section 105.

(b) Color Samples of HDPE Timber shall be submitted to the engineer for approval.

xx. CONSTRUCTION REQUIREMENTS.

(c) Ensure FRP timber is cut, beveled, drilled, countersunk, and otherwise fabricated according to manufacturer's recommendations. Set material accurately to the required levels and lines, with members plumb and true and accurately cut and fitted. Securely attach FRP timber to substrate by anchoring and fastening as shown on Plans.

(a) Walkway and railings shall be level through out. Rail posts shall be installed plumb.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Fender System) to be measured for payment will be on a lump sum basis in the complete and accepted work

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Fender System) will be paid for at the Contract lump sum price. Payment will be full compensation for the detailing, fabricating, transporting, storing,

handling, and placing the materials necessary to complete the work. Hardware and labor necessary for installing anchor bolts used to attach the fender system shall be included in this item.

Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Fender System)	Lump Sum

HALF FILLED GRID DECK

xx. DESCRIPTION. This work shall consist of furnishing and installing half filled grid deck in accordance with the Plans and as directed by the Engineer.

xx. MATERIALS. Materials shall meet the following requirements:

(e) Steel. All steel for the component parts shall meet the requirements of Section 506 of the 2011 Standard Specifications for the Construction Book. The steel shall be ASTM A709 Grade 50 and shall be galvanized in accordance with ASTM A123. The section properties for the steel grid deck shall be as shown on the contract documents.

(f) Concrete. All concrete for the component parts shall meet the requirements of Section 501 of the 2011 Standard Specifications for the Construction Book. The density of Concrete shall be 120 pounds per cubic foot.

xxi. CONSTRUCTION REQUIREMENTS.

(a) Placement. Grid deck shall be placed true to line and grade and shall make full and even bearing on the underlying surface. The Sequence of concrete pours shall be as shown on the contract drawings. Temporary support of the grid deck shall be as shown in the contract documents the grid deck shall be placed such that a continuous 2 inch minimum haunch thickness will be provided.

(b) Banding Bars. Grid deck panels shall be provided with banding bars as shown in the contract documents

(c) Field Welding. Field welding of deck panels shall be used at splices in grid deck only. There shall be no welding between the grid deck and the bridge girders.

(d) Field Painting. Any damage to the galvanic coating shall be touched up with cold applied galvanic paint.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Half Filled Grid Deck) to be measured for payment will be the actual area, in square feet, of grid deck furnished and installed, including any portions that are filled with concrete in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Half Filled Grid Deck) will be paid for at the Contract unit price per square foot. Payment will be full compensation for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The cost of heating materials and protecting the concrete against cold weather, and any additional cost for cement, will not be paid for separately but will be considered incidental to this Special Provision.

Reinforcing Steel and Water Repellent, Silane used within the pay limits of this Special Provision will be paid for separately under their respective Contract items.

Payment will be made under:

Pay Item	Pay Unit
900.670 Special Provision (Half Filled Grid Deck)	Square Foot

INDIRECT COSTS

XX. DESCRIPTION. This items in this contract are not estimated to include indirect costs. In this contract indirect costs shall consist of payment of all costs for the Contractor's onsite management to support field construction.

These may include, but are not limited to, labor costs for project management, supervision, engineering, quality control, survey, safety, indirect equipment maintenance, temporary utilities for the Contractor's use, project-specific insurance, testing other than third-party laboratory testing, and field office administration.

The material and miscellaneous costs include project administration, along with any other labor and equipment costs necessary to maintain temporary facilities and temporary utilities

XX. WORK LIST. The following list indicated the categories of Work that are payable under this provision:

a) Field Engineers
b) Contractor Inspect/Expedite Trips
c) Project Manager
d) Super - Site General
e) Super - Structural
f) Superintendent Electrical
g) Senior Project Engineer
h) Project Engineer Electrical
i) Project Engineer Mechanical
j) Office Manager/Admin
k) Survey Party Chief
l) Construction QC Engineer
m) 10 Hour OSHA Training
n) Safety Specialist
o) Safety Related Training
p) Safety Orientations
q) Miscellaneous Temporary Design
r) Project Specific Insurance
s) Partnering Meetings
t) Show-Up Time
u) Yard Leases
v) Marina Leases
w) Snow & Ice Removal - On Site
x) Plow & Sand Construction Site
y) Monthly Construction Power Bills
z) Management Staff Office Rent
aa) Monthly Internet Access Fees
bb) Monthly Heating Bill - Management Office
cc) Radio/Marine Communications - Jobsite
dd) Portable Toilet Bills – Office
ee) Portable Toilet Bills – Crew
ff) Clean Field Offices
gg) Contractor Field Office Supplies
hh) Contractor Field Office Equipment (Printer-Electronics)

ii) Dumpster Disposal - Jobsite
jj) Maintenance of Temp Power

XX. METHOD OF MEASUREMENT. The quantity of Special Provision (Indirect Costs) to be measured for payment will be on a lump sum basis in the complete and accepted work.

XX. BASIS OF PAYMENT. The accepted quantity of Special Provision (Indirect Costs) will be paid in equal installments monthly over the number of months of scheduled construction.

Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Indirect Costs)	Lump Sum

MICROPILES

xx. DESCRIPTION. This work shall consist of furnishing and installing micropiles at the locations and to the required capacities indicated in the Contract Documents.

xx. MATERIALS. Materials shall meet the following requirements:

(a) Permanent Casing. Permanent casing shall be new, flush joint-type steel pipe of appropriate thickness to withstand the stresses associated with advancing it into the ground, in addition to the stresses due to hydrostatic and earth pressures. The permanent steel casing/pipe shall conform to the minimum requirements of ASTM A252 for Grade 3 pipe, or API 5CTN80. The casing/pipe shall have a minimum yield stress of 80 ksi.

(1) Certification. Certification for permanent casing pipe shall meet the following requirements.

a. A Type D Certification shall be furnished in accordance with Subsection 700.02.

(2) Additional Requirements. Additional requirements for permanent casing that is installed in coupled (spliced) sections shall meet the following requirements:

a. The casing shall be flush joint and the pipe joint shall be completely shouldered with no stripped threads.

b. Welds shall meet the requirements of Subsection 506.10. The welding plan and procedures shall be approved by the VTrans Fabrication Supervisor.

(b) Bar Reinforcement. Bar reinforcement shall be Grade 420 (Grade 60), continuously threaded bar, meeting the requirements of AASHTO M 31M/M 31 (ASTM A 615/A 615M) or continuously threaded Uncoated High-Strength Steel Bars conforming to AASHTO M 275M/M 275 (ASTM A 722/A 722M), as used in the design submittal.

Bar couplers, if required, shall develop the ultimate tensile strength of the bars without any evidence of failure.

(c) Cement. Cement shall meet the requirements of Subsection 701.02.

(d) Grout. Grout shall be a neat cement or sand/cement mixture with a minimum compressive strength of 5,000 psi at 28 days. Water for mixing grout shall be potable. The use of Grout Sand and Fly Ash in the mix is optional.

During production, micropile grout shall be tested by the Contractor for compressive strength at an approved laboratory in accordance with AASHTO T 106 (ASTM C 109) at a frequency of no less than one set of three 2 inch grout cubes from each grout plant each day of operation or per every 10 piles, whichever occurs more frequently. The compressive strength shall be the average of the 3 cubes tested.

Grout consistency as measured by grout density shall be determined by the Contractor per AASHTO T 133 (ASTM C 188) or API RP-13B-1 at a frequency of at least one test per pile, conducted just prior to start of pile grouting. The Baroid Mud Balance used in accordance with API RP-13B-1 is an approved device for determining the grout density of neat cement grout. The measured grout shall have a specific gravity of between 1.9 and 2.0, or as used in the mix design submittal.

Grout samples shall be taken directly from the grout plant. The grout cube compressive strength and grout density test results shall be provided to the Engineer within 24 hours of testing.

(e) Centralizers and Spacers. Centralizers and spacers shall be fabricated from Schedule 40 PVC pipe, tube, steel, or material non-detrimental to the reinforcing steel. Wood shall not be used.

(f) Structural Steel. Structural steel shall meet the requirements of Subsection 714.02 or 714.03 as used in the design submittal.

xx. SUBMITTALS. The Contractor shall submit the following:

(a) Qualifications. The micropile Contractor shall be fully experienced in all aspects of micropile and construction, and shall furnish all necessary plant, materials, skilled labor, and supervision to carry out the work under the Contract. The experience information outlined below shall be submitted to the Engineer for approval. This information shall be approved prior to any other work occurring under this specification. The Contractor shall allow 10 working days for the review of this material.

(1) Five projects in the past five years of similar scope and size to that indicated in the Contract Documents. A brief description of the scope of work and a reference shall be included for each project. As a minimum, the reference shall include an individual’s name and current contact information. The micropile contractor shall not sublet the whole or any part of the work under the Contract without the written approval of the Engineer.

(2) The proposed On-Site Supervisor for this work having supervised the successful installation of micropiles on at least five projects in the past five years.

(3) The proposed key personnel (Superintendent, Driller, and Project Engineer/Manager) who will be materially involved, with each having at least three years of relevant experience.

(b) Installation Procedure. Submit the installation procedure information outlined below to the Engineer for acceptance. The Contractor shall allow 20 working days for the review of this material. Work shall not begin prior to receiving acceptance by the Engineer. Acceptance of the installation method by the Engineer does not constitute a guarantee of acceptable pile installations. Acceptable installations are the responsibility of the Contractor.

The submitted installation procedure shall include the following information:

(1) Proposed steel drill casing/pipe

(2) Equipment for pile installation.

(3) Procedures for pile installation, including but not limited to installation sequence and the approximate time required for each sequence step.

(4) Procedures for advancing through boulders and other obstructions.

(5) Procedures for containment of drilling fluid and spoil, and disposal of spoil.

(6) Where applicable, drawings that show specific work can be performed under limited headroom conditions and as close to obstructions as site conditions warrant, to install the piles at the locations and pile batters indicated in the Contract Documents. Provide information on the length of the casing sections to be used, as dictated by the length of the drill mast and by the available overhead clearance, and the resulting location of joints. Welding procedures for all shop and/or field welds shall be submitted.

(7) Procedures and equipment for placing grout.

a. Prepare the mix design for the grout and obtain documentation from an AMRL accredited laboratory showing the following:

1. The mix design conforms to the submitted mix and meets the 28 day strength requirements.

2. The compressive strength of the mix, tested at 3, 7, 14, and 28 days.

3. The specific gravity of the mix.

b. Identify a method for monitoring quality control of the mix. At a minimum, the Contractor shall use a Baroid Mud Balance per American Petroleum Institute (API) Recommended Practice (RP) 13B-1: Standard Procedure for Testing Water-Based Drilling Fluids, to check the specific gravity of the mixed grout prior to placement of the grout into each micropile.

c. Provide pressure gages capable of measuring the actual grout pressures used and such that actual pressure readings are within the middle third of the gage.

(8) If applicable, post-grouting equipment and procedures, including the method, sequence of operations, and equipment required.

(9) Layout drawings showing the proposed sequence of pile installation. Coordinate this sequence with the proposed phasing and scheduling. Layout drawings should include micropile number, type and size of bar reinforcement, minimum total bond length, total micropile length, and the pile top attachment details.

(c) Record Information. Submit revisions to the installation procedure information outlined in part (b) of SUBMITTALS of this Section to the Engineer as required within 60 days from completion of micropile installation.

xx. CONSTRUCTION REQUIREMENTS.

(a) Drilling and Excavation. Progress all micropiles using steel drill casing. The hole shall be advanced using a duplex drilling method without drilling or flushing ahead of the drill casing by more than 1 foot. Drilling and excavation shall be performed in such a manner as to prevent collapse of the hole. Use of bentonite slurry is not permitted. Use of polymer slurry to

remove cuttings from the cased hole shall be approved by the Engineer.

An obstruction is defined as something encountered while advancing a micropile that is not expected based on boring log findings or known obstructions identified on the Plans. Boulders, cobbles, bedrock, and very dense till material are not considered obstructions. When obstructions are encountered during excavation for a pile, the hole shall be advanced by means of coring, a tricone roller bit, or other tooling approved by the Engineer. Use of drop-type impact hammers and blasting are not permitted. Use of down-the-hole hammers shall be approved by the Engineer.

The Contractor shall notify the Engineer in writing when a potential obstruction is encountered. Upon notification, the Engineer shall determine if an obstruction has been encountered that will cause an increase in the time required to accomplish the work. The Contractor will be notified of the Engineer's determination as to whether or not an adjustment of the Contract is warranted. If an adjustment is warranted, the Contract will be modified in writing accordingly. Any adjustment made will exclude loss of anticipated profits.

All tools and materials required to remove the obstruction shall be available at the site at all times during micropile installation and in sufficient quantities to avoid delays in the execution of this work.

Procedures and operations shall be controlled so as to prevent undermining, damage, or settlement to adjacent structures, tunnels, utilities, or adjacent ground. All drilling operations shall be discontinued at the first sign of undermining, damage, or settlement and a written plan shall be provided to the Engineer for review with procedures to avoid reoccurrence. Work shall be resumed only after the Engineer has approved the plan in writing. All damage and settlement shall be repaired at no additional cost to VTrans.

The rate of fluid flow used to progress the holes shall be monitored. Drilling fluid shall be controlled and spoils shall be disposed of in accordance with the approved procedures.

Holes shall not be progressed, pressure-grouted, or post-grouted, within a radius of 5 feet of a micropile until the grout for that micropile has set for 24 hours.

The drill hole shall be open along its full length to at least the design minimum diameter prior to grout placement.

(b) Reinforcement and Post Grout Tube Placement. Centralizers sized to position the reinforcement within 3/8 inch of plan location from the center of the pile shall be provided. The centralizers shall be sized to allow grout tremie pipe insertion to the bottom of the drill hole and to allow grout to freely flow up the drill hole and casing. The centralizers shall be securely attached to the reinforcement to withstand installation stresses. Centralizers shall be provided at centers not to exceed 10 foot spacing. Micropile reinforcement shall not be dropped into the hole. When a post grout tube is used, it shall be attached to the steel reinforcement prior to lowering it into the hole.

(c) Grout Placement and Casing Removal. The Contractor shall perform grout testing in accordance with part (d) of MATERIALS of this Section.

Grout shall be placed by means of a tremie pipe from the bottom of the pile upward. The initial volume of grout required to fill the hole shall be recorded along with the grouting pressure and volume of grout being pumped into the pile during pressure grouting. Upon completion, the grout level shall be maintained at or above the pile cut-off elevation until the grout has set.

The grout pressure and volume measuring gages at the pile installation site shall be accessible and legible to the inspector during the grouting operations.

(d) Construction Tolerances. Piles shall be installed to the tolerances shown in the plans.

(f) Pile Acceptance Criteria. Pile(s) shall be accepted if all of the following criteria are met:

(1) Pile meets Construction Tolerance criteria.

(2) Pile meets the MATERIALS requirements of this Section and was installed in accordance with the approved submittal.

(3) Pile is not damaged.

(g) Unacceptable Piles. Unacceptable piles are piles which do not meet the acceptance criteria identified in part (f) above.

A written plan shall be submitted to the Engineer for remedial action, indicating how to correct the problem and prevent its reoccurrence. Unacceptable piles shall be repaired, augmented, or replaced in accordance with the approved remedial plan at no additional cost to VTrans.

xx. METHOD OF MEASUREMENT. The quantities of Special Provision (Micropile, Cased) and Special Provison (Micropile, Uncased) of the size specified to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work.

The quantity of Special Provision (Furnishing Equipment for Installing Micropiles) to be measured for payment will be on a lump sum basis in the complete and accepted work.

The quantity of Unexpected Obstruction Drilling to be measured for payment will be the number of hours taken to advance the micropile through the obstruction.

xx. BASIS OF PAYMENT. The accepted quantities of Special Provision (Micropile, Cased) and Special Provision (Micropile, Uncased) of the size specified will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for providing all required submittals; for furnishing, transporting, storing, handling, and placing the materials specified, including but not limited to permanent casing, bar reinforcement, grout, centralizers, spacers, and pile top attachment; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The Contractor shall be responsible for estimating the grout take. There will be no extra compensation allowed for grout overruns.

The accepted quantity of Special Provision (Furnishing Equipment for Installing Micropiles) will be paid for at the Contract lump sum price. Payment will be full compensation for furnishing and mobilizing to the project site all equipment required for installing the micropiles, operating and maintaining the equipment while in service on the project, and demobilizing the equipment from the project site.

When the equipment for installing the micropiles has been set up and installation of production piles has started, a payment of 50 percent of the Contract lump sum price will be allowed. The remaining 50 percent of the Contract lump sum price will be paid when the micropile installations are complete and the equipment has been removed from the site to the satisfaction of the Engineer.

The accepted quantity of Unexpected Obstruction Drilling will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work of overcoming encountered obstructions and for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the task.

Payment will be made under:

Pay Item		Pay Unit
900.640	Special Provision (Micropile, Cased)(9.625”)	Linear Foot
900.640	Special Provision (Micropile, Uncased)(8”)	Linear Foot
900.645	Special Provision (Furnishing Equipment for Installing Micropiles)	Lump Sum
900.630	Special Provision (Unexpected Obstruction Drilling)	Hour

RELOCATION OF EXISTING CONTROL HOUSE

xx. DESCRIPTION. This work shall consist of Shoring the existing control house along the top of the existing bascule pier, lifting the control house off of the existing pier, and transporting the control house to a location to be designated by the Engineer.

xx. MATERIALS. Materials shall meet the following requirements:

(a) Bar Reinforcement. Bar reinforcement shall be Grade 75, fully threaded bar, meeting the requirements of AASHTO M 31M/M 31 (ASTM A 615/A615M).

(b) Cement. Cement shall meet the requirements of Subsection 701.02.

(c) Grout. Grout shall be a neat cement or sand/cement mixture with a minimum three-day compressive strength of 2500 psi and a minimum 28-day compressive strength of 5000 psi per AASHTO T 106. Water for mixing grout shall be potable. The use of Grout Sand and Fly Ash in the mix is optional. Field sampling and testing shall be performed in accordance with the VTrans Materials Sampling Manual on file with the VTrans Materials and Research Section.

(d) Structural Steel. Structural Steel shall meet the requirements of Subsection 714.02.

xx. SUBMITTALS. The Contractor shall submit the following:

(a) Qualifications. Submit the experience information outlined below to the Engineer for approval by the Engineer. This information shall be approved prior to any other work occurring under this specification. The Contractor shall allow 10 working days for the review of this material.

(1) Two projects in the past two years on which the Contractor has successfully moved an existing structure to a new location. A brief description of the scope of work and a reference shall be included for each project. As a minimum, the reference shall include an individual's name and current contact information.

(2) The proposed On-Site Supervisor for this work having supervised the successful structure relocation on at least two projects in the past two years.

(b) Shoring and Lifting Plans. Submit the Contractors shoring plan required to provide the structural stability of the existing

control house during lifting and relocation of the existing control house. The Contractor shall submit plans and procedures to cut the existing control house free from the bascule pier, lift the control house onto a flatbed truck and secure the control house for transportation. The plan sheets, procedures, and materials shall be included in the shoring and lifting plan which will be signed by an Engineer licensed in the State of Vermont. The information outlined shall be submitted to the Engineer for acceptance by the VTrans Project Manager (PM). The Contractor shall allow 20 working days for the review of this material. Work shall not begin prior to receiving approval by the PM.

The submitted shoring and lifting procedure shall include the following information:

(1) Proposed steel framing members used for stability and lifting.

(2) Equipment for lifting and transportation

(3) Provide drawings that show specific location of all equipment required to lift the existing control house. Provide catalogue cuts for lifting equipment that clearly shows equipment capacity at the required pick radius.

(4) Provide lifting calculations signed and sealed by an engineer licensed in the State of Vermont. Provide any calculations required by the state for transportation of the existing control house across any state or local roads and bridges. All calculations shall be signed and sealed by an engineer licensed in the State of Vermont.

xxii. CONSTRUCTION REQUIREMENTS.

(a) Any damage to windows and or doors shall be repaired or replaced as ordered by the Engineer.

(b) Any damage to existing masonry shall be repaired to match the existing construction as ordered by the Engineer.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Relocation of Existing Control House) will be on a lump sum basis.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Relocation of Existing Control House) will be paid for at the Contract lump sum price bid. Payment will be full compensation for the cost of equipment and labor required to remove the existing control house and transporting control house to the location identified by the Engineer.

Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Relocation of Existing Control House)	Lump Sum

REMOVE AND RESET ARMORED STONE

xx. DESCRIPTION. This work shall consist of removing and resetting armored stone at the locations and to the limits shown in the plans and as directed by the Engineer.

xx. MATERIALS. Materials shall meet the following requirements:

(a) Armored Stone. Armored Stone shall be hard, sound, and resistant to the action of water and weathering. Replaced Armored Stone shall consist only of sections removed.

xx. CONSTRUCTION REQUIREMENTS.

(a) Removal and Storage. Armored stone shall be protected from damage during removal and storage.

(b) Placement. Armored Stone shall be placed on a prepared slope, in a single lift, and in a manner that will result in a reasonably well graded surface. The stone shall be placed such that there is no accumulation of either larger or smaller sizes of stone.

All armored stone shall be replaced in kind, or at the direction of the Engineer. Placement shall reasonably match and tie into that of the existing undisturbed armored stone.

Excess armored stone due to encroachment of the new bridge piers into the removal limits shall be replaced within limits of Class IV stone fill. If the removed stone exceeds that replaced, the left over material may substitute Class IV stone fill at the discretion of the Engineer.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Remove and Reset Armored Stone) to be measured for payment will be the number of square feet removed in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Remove and Replace Armored Stone) will be paid for at the Contract unit price per square foot. Payment will be full compensation for providing all required submittals; for furnishing, transporting, storing, handling, and placing the materials specified; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
900.670 Special Provision (Remove and Reset Armored Stone)	Square Foot

STRUCTURAL STEEL

xx. DESCRIPTION. This work shall consist of furnishing and erecting structural steel for the bascule span and nonstructural steel as shown in the Plans and as directed by the Engineer.

The work under this Section shall be performed in accordance with these provisions, the Plans, and Sections 506 of the Standard Specifications.

xx. MATERIALS. Materials for the bascule span structural steel or nonstructural steel shall meet the requirements specified in the Plans.

xx. CONSTRUCTION REQUIREMENTS. Bascule span steel and nonstructural steel shall be installed as detailed on the Plans and as directed by the Engineer.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Bascule Span Structural Steel – XXX,XXX LB) to be measured for payment will be on a lump sum basis in the complete and accepted work

The quantity of Special Provision (Nonstructural Steel) to be measured for payment will be on a lump sum basis in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Bascule Span Structural Steel – XXX,XXX LB) will be paid for at the Contract lump sum price. Payment will be full compensation for the detailing, fabricating, transporting, storing, handling, and placing the materials necessary to complete the work.

The accepted quantity of Special Provision (Nonstructural Steel) will be paid for at the Contract lump sum price. Payment will be full compensation for the detailing, fabricating, transporting, storing, handling, and placing the materials necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Bascule Span Structural Steel – XXX,XXX LB)	Lump Sum
900.645	Special Provision (Nonstructural Steel)	Lump Sum

TEMPORARY MOVABLE BRIDGE

xx. DESCRIPTION. This work shall consist of the design, construction, maintenance, and removal of a temporary bridge, its substructures and approaches.

Work under this item includes; approach spans, movable bascule span, bascule span tower, bridge bearings, fender system, all mechanical components required to operate the bascule span, control panel, temporary warning gates, temporary barrier gates, temporary traffic signals, limit switches, instrumentation devices, all electrical work, and bridge testing.

The Contractor is responsible for the operation, in conformance with the existing Coast Guard navigation requirements, and preventative maintenance of the temporary bridge throughout the construction duration.

xx. MATERIALS. The Contractor may use any material or combination of materials that will conform to the requirements of this Subsection and meet the approval of the Engineer. The Engineer reserves the right to reject materials and details that are structurally unsafe for the use proposed. Used materials will be acceptable, provided appropriate allowances are made for their condition.

All main structural members shall be Grade 50 steel or greater, in conformance with ASTM A709. Steel conforming to alternate specifications may be used, provided it is demonstrated that characteristics are adequate to ensure that the system will successfully function under the design criteria. No field welding will be allowed on the superstructure unless approved as an element in the installation procedure which has been signed by a licensed Engineer in the State of Vermont.

Unless otherwise authorized on the approved drawings, all main load carrying members shall be continuous between supports. Splices will only be approved for:

(e) A fully bolted connection, with high-strength bolts, designed for its location in accordance with the AASHTO LRFD Bridge Design Specifications.

(f) A fully welded connection designed, welded, inspected, and tested in accordance with the AASHTO LRFD Bridge Design Specifications and AWS requirements. Any welded connection performed in the absence of and without the approval of the Agency’s Welding Inspector will not be approved.

Any welding done for work under this Section must be detailed on the Working Drawings and performed in conformance with Section 506.

xx. CALCULATIONS. The Contractor shall submit basic design calculations in accordance with Section 105. The basic design calculations shall include substructure design loads, superstructure elements including all trusses, towers, floorbeams, stringers, secondary members, and machinery calculations for operating forces and motor horsepower.

xx. DRAWINGS. Working Drawings shall be prepared by the Contractor for the proposed work under this item in accordance with Section 105. Drawings for the bridge approaches shall include plan, profile, typical section, and specific cross-sections for the temporary roadway and channel (when applicable) with complete details and identification of materials to be used.

Plan, elevation, and section views of the structure shall include size and spacing of all members or components for:

(a) Abutments
(b) Piers
(c) Main supporting members or stringers
(d) Floor system
(e) Diaphragms and lateral bracing
(f) Railing (bridge and approach)
(g) Curbs
(h) Bearings
(i) Barrier Gates
(j) Warning Gates
(k) Temporary Traffic Signals
(l) Other applicable information

Electrical working drawings shall be submitted to the Engineer for review and approval. Drawings shall include all power and control, Schematic. A complete set of catalog cuts for materials furnished shall be included for review at the time of schematic submittal.

xx. DESIGN AND CONSTRUCTION DETAILS. The design and structural details of the movable bascule span shall be signed, stamped, and dated by a Professional Engineer (Structural) with proven design experience with movable bridges.

The substructures and approach spans shall be designed, stamped and dated by a Professional Engineer (Structural).

In designing and constructing a temporary bridge, the Contractor shall provide for the waterway and clearances shown on the Plans. A 40 ft navigational channel shall be maintained at all time during construction in accordance with the Coast Guard Permit.

Fill placed in or adjacent to Lake Champlain shall be clean granular or rock material meeting the requirements of Subsection 703.04 or 703.05 and protected with sufficient stone to prevent erosion to a Q 10 headwater elevation (based on the new structure). Any fill placed in Lake Champlain to protect the temporary bridge and approaches shall be removed to the satisfaction of the Engineer upon completion of the project. Questions regarding hydraulic information not furnished shall be addressed to the Engineer.

(a) Roadway. Approach embankments shall be constructed of acceptable fill material, compacted to adequately support design loading requirements. A minimum of 18 inches of approved gravel or other acceptable surfacing material shall be provided for the full width of the typical section.

The approaches shall be paved as shown on the plans and the approaches and bridge shall have temporary pavement markings applied as per Section 646. Bituminous concrete pavement shall conform to the requirements of Section 406 or 490, except the mix design submittal and plant inspection requirements set forth in Section 406 or 490 will not be required. The Engineer may also waive weather limitations. The temporary pavement shall extend for the full length of the approaches and the full clearance width described below.

(b) Bridge.

(1) Bascule Span. The bascule span and tower shall be designed in accordance with the latest edition of the AASHTO Standard Specifications for Movable Highway Bridges. The bascule span shall meet the clearance requirements shown on the Plans. Electrical, mechanical, and structural components shall be sized and configured so that under normal operations, the span can be fully opened in under one hundred twenty (120) seconds. The span shall also fully close in under one hundred twenty (120) seconds.

There shall be positive speed monitoring throughout all span travel for opening and closing to prevent overspeed/overhauling conditions. Safety features and the interlocking of steps in the operational sequence of the lift span shall include locks, traffic signals, warning gates, and barrier gates.

The system shall be designed so that a completely non-electrical means of operating the span is also available, either by an aux motor or hand crank. Proper interlocking for this system shall be provided. This system shall be capable of either raising or lowering the moveable span within five (5) minutes.

Tower deflections due to wind loads shall be included when detailing bridge components. Tower deflection shall be limited so that there is no interference between moving and stationary components under such loading at any point during span travel or when span is seated.

The Contractor shall employ a manufacturer's technical representative to advise and assist the Contractor during the transport, assembly, and erection phases of the bascule span.

(2) Loading. Unless otherwise specified, all temporary bridge structures shall be designed for an HS-20 or HL-93 live load, and for all other applicable forces, in accordance with the AASHTO Standard Specifications for

Highway Bridges or LRFD Bridge Design Specifications. Sidewalks and pedestrian structures shall be designed for a minimum live load of 60 pounds per square foot.

(2) Clearances. The Contractor shall provide the minimum clear width and vertical clearances required by VTrans for the existing roadway.

(3) Erection. As part of the Working Drawings submittal, the Contractor shall, dependent upon the type of structure being erected, include the information required under Section 506 or 510 pertaining to erection or installation. Submittal of the computations indicating magnitude of stresses in the segments is not required. Erection of the bascule span shall occur outside of the normal operational season (May 15th to October 15th) for the bridge in accordance with the Coast Guard Permit. The Contractor shall notify the Engineer and Coast Guard a minimum of 30 days prior to the start of the bascule span erection.

(c) Railing. Approach railing and temporary barrier rail shall conform to Subsection 621.07.

Details for either rail system or combination thereof shall conform to applicable AASHTO requirements. Rail sections shall be continuous from the approaches across the structure. Approach railing shall be provided for a minimum of 25 feet off the ends of any structure and shall be provided for all approach fill slopes steeper than 1:3 (vertical:horizontal).

The free end of any steel beam rail shall be protected with a W-beam end section RE-6 (rounded) as defined in the Guide to Standardized Highway Barrier Rail Hardware, flared to a 4 foot offset. The free end of any concrete barrier rail shall be flared horizontally to a 4 foot offset for a minimum panel length 10 feet and project a maximum of 6 inches above the adjacent roadway surface. The top of the steel beam railing shall be 30 ± 1 inch above the adjacent surface and the concrete barrier railing shall be 31 ± 1 inch above the adjacent surface.

Vehicular bridge rail posts and anchorage shall be designed to withstand a horizontal loading of 600 pounds per foot applied 1 foot, 9 inches above the deck surface. Pedestrian railing and posts shall provide protection for a height of 42 inches above the walkway surface and be designed to withstand a horizontal loading of 50 pounds per foot applied 42 inches above the walkway surface.

When a pedestrian walkway is specified or used in conjunction with vehicular traffic, a 12 × 12 inch curb separation shall be provided. Curbs shall be anchored to withstand a horizontal loading of 250 pounds per foot. The outside pedestrian railing shall be a combination of vehicular and pedestrian railing. The pedestrian railing shall be constructed to limit clearance between horizontal rail components to 6 inches.

When temporary barrier rail is specified or used as a movable rail system (e.g., adjusting traffic flow patterns), the "concrete median barrier" specified herein shall be used. An

adequate connection shall be provided when concrete median barrier is used in combination with standard steel beam rail.

(d) Walkways and Approaches. Temporary bridges with walkways, and approaches to walkways shall be designed and constructed to provide width, grade, surface, etc. in conformance with the requirements set forth in the current ADA standards for sidewalks.

(e) Electrical Work. The Contractor shall provide a control panel capable of bridge operation in accordance with AASHTO's Standard Specification for Movable Highway Bridges. Bridge power is limited to 100 Amps at 480V, 3 phase service.

Provide all bridge control wiring. Coordinate control wire requirements with submarine cable configuration requirements. Temporary bridge control panel shall control operation of the bascule span, barrier gates, warning gates, traffic signals, locks, and navigation lights.

xx. MAINTENANCE AND LIABILITY. The Contractor shall maintain the temporary bridge and its approaches in conformance with Contract requirements and to the satisfaction of the Engineer. The Contractor shall assume all liability for the installation, maintenance, and removal of the temporary bridge and its approaches. Unless otherwise specified, all rights-of-way on private property required for the performance of this work shall be provided by the Contractor.

Costs for replacing the loss of any part of the temporary bridge or its approaches shall be included in the unit price for the temporary bridge item except as provided in Subsection 107.18.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Temporary Movable Bridge) measured for payment will be on a lump sum basis, in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Temporary Movable Bridge will be paid for at the Contract lump sum price as specified. Payment will be full compensation for designing, detailing, constructing, operating, maintaining, and removing the bridge and its approaches, including placing and removing pavement and pavement markings.

When Working Drawings have been submitted and approved in accordance with Section 105, a payment of 10 percent of the lump sum price will be allowed.

When all the materials for the bascule span arrive on-site, a payment of 10 percent of the lump sum price will be allowed.

While the temporary bridge, its substructures, and roadway approaches are constructed, a payment of 45 percent of the lump sum price will be allowed spread out monthly for 10 months (i.e. 4.5 percent per month).

When the temporary bridge and its approaches have been removed, a further payment of 35 percent of the lump sum price will be allowed.

Unless otherwise specified as a separate Contract item, the costs of all approach and bridge railing associated with the temporary bridge will be considered to be included in the Contract lump sum price for Temporary Movable Bridge.

Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Temporary Movable Bridge)	Lump Sum

TRAFFIC CONTROL EQUIPMENT

XXX.1 DESCRIPTION. This work shall consist of furnishing and installing a traffic control system for Movable Bridge operations, including the traffic signals, barrier gates, warning gates, and their respective foundations.

All electrical work performed under the Contract and all materials installed shall be subject to inspection and approval of the State or Municipal Electrical Inspector, whichever position is applicable. As a minimum, all work must meet the requirements of the following:

(a) AASHTO Standard Specifications for Movable Highway Bridges.

(b) Manual on Uniform Traffic Control Devices (MUTCD)

(c) National Electrical Manufacturer Association (NEMA)

(d) NFPA 70, National Electric Code

XXX.2 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV	707.03
Paint for Traffic Control Signals	708.07
Anchor Bolts	714.09
Preformed Fabric Bearing Pads	731.01
Metal Hand Railing	732.01
Traffic Signal Poles with Mast Arms or Bracket Arms..	752.03
Traffic Signal Heads	752.05
Traffic Signal Conductor Cable	752.09
Grounding Electrodes	753.05

Prior to ordering any traffic control components of the signal system, the Contractor shall submit Fabrication Drawings in accordance with Section 105. The submittal shall contain, as a minimum, the following information:

(a) Traffic Signal Heads. Size, manufacturer, model, lamp wattage, wiring, housing (material and color), visors, and back plates. The signal heads shall conform to the requirements of ITE standards and the Traffic Control Equipment Special Provision.

(b) Auxiliary Equipment. Flasher(s), conflict monitor or malfunction management unit, manufacturer, model, functions, and assurance of conformance to NEMA standards, where applicable.

(c) Mast Arm Poles.

(1) Dimensions for pole/post height, mast arm attachment height, mast arm length, pole/arm diameter (top and bottom), pole/arm gauge, handhole (size and location), baseplate, bolt circle, and anchor bolt size.

(2) Material specifications for each component.

(3) Welding information for all welded connections.

(4) Special features as shown on the Plans, such as finish or color.

(5) Pole/baseplate stamping detail.

(d) Warning and Barrier Gates.

(1) Dimension for all gate equipment, including and not limited to the gate housing, arm length.
(2) Platform dimensions and details.
(3) Point to point interconnection wiring for all gate components, including but not limited to the gate motor, limit switches, warning gong, enclosure heater, receptacles, door interlock and flasher unit.
(4) Loads to be transmitted to the gate foundation, in accordance with the latest version of the AASHTO LRFD Bridge Design Specifications.

(e) Warning and Barrier Gate Foundations

(1) Reinforcing Steel Schedule

(2) Submittal requirements for micropile construction in the barrier gate foundations in accordance with 900.640 Special Provision (Micropile, Cased) and 900.640 Special Provision (Micropile, Uncased).

(3) Working Drawings for platform railing.

(4) Working Drawings for each gate foundation with bottom of footing elevation, top of footing elevation, micropile cutoff elevation, and dimensions to all cast-in items including electrical conduits, gate anchorage, and railing anchorage.

In the above, all information supplied shall match or be equivalent to the details shown on the Plans. If equivalent, the Contractor may be asked to supply proof of equivalency. Copies of catalogue sheets are acceptable if all the appropriate information is included.

Submitted Fabrication Drawings shall indicate by either text in the transmittal letter or by text and signature on the Fabrication Drawings, that the Contractor has reviewed the Fabrication Drawings and that the Fabrication Drawings are in conformance with the Contractor's proposed installation procedures.

Mast arm pole styles other than that shown on the Plans will be permitted. The poles must be able to carry the design loads with a maximum dead load (span wire and signal head) deflection of 150 mm (6 inches). Bending stress (f_b) is limited to 66 percent of the minimum yield stress (f_y). All design details, quality of work, procedures, materials, etc., shall be in accordance with the latest edition of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Foundations shall be designed in accordance with VTrans' MREI 10-01 guidelines. The contractor shall be responsible for the foundation design. Soil boring information can be found on the Boring Information Sheet and the Boring Logs Sheets within the plan set. In addition to fabrication drawings, the boring logs, design criteria, and design calculations shall be submitted as working drawings in accordance with Subsection 105.03.

All signal heads shall be 12" Polycarbonate. The signal heads shall have flat back housings and visors.

All signal heads shall have flat black louvered backplates.

All signal heads shall have red, yellow, and green L.E.D. signals with a visible beam spread of 80 degrees off axis.

Schedule 80 conduit shall be used for all applications.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Steel bar reinforcement shall conform to the requirements of Section 507.

XXX.3 EXCAVATION AND BACKFILL.

(a) General. Unless otherwise shown in the Contract Documents, the Contractor shall perform all excavation, backfilling, and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces, and any other materials necessary to complete the work in accordance with the Contract Documents or as directed by the Engineer.

In making excavations in paved surfaces, cuts shall be made with a concrete saw to a minimum depth of 2 inches along the neat lines of the area to be removed.

All landscaping and underground utility systems that have been disturbed by the construction shall be restored to their original condition at the Contractor's expense upon completion of the work.

(b) Excavation. Excavation shall be at the locations and to the dimensions shown on the Plans.

(c) Backfill. Backfill of suitable material shall be placed and compacted in layers not exceeding 6 inches. The bottom of pull boxes shall be filled with granular materials approved by the Engineer to within 6 inches of the bottom of conduit.

XXX.4 ERECTION OF POLES. All poles shall be erected on concrete bases at the locations shown on the Plans.

In the erection of posts and poles, leveling nuts shall be provided for installation between the bases and the concrete foundation to aid in plumbing.

The space between the top of the concrete footing and metal base of the support shall be filled with Type IV mortar.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 1/8 inch in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

XXX.5 ELECTRIC POWER SERVICE. The new Drawbridge ahead sign with flashing beacons shall utilize the existing utility power source as indicated on the plans.

XXX.6 WIRING. See section 678.09 and Bridge Electrical Equipment under the Special Provision.

XXX.7 GROUNDING AND TESTING. See section 678.10 and Bridge Electrical Equipment under the Special Provision.

All new traffic signal heads that have been installed but not placed in either flashing or full operation shall be covered. Existing signal heads which are placed out of service in order to perform work on the signal system shall also be covered, except when such work can be completed in a relatively short period of time (several hours) and traffic control has been provided for.

The signal covers shall consist of a one-piece plastic bag having a minimum thickness of 4 mils. The bag shall be black or dark brown in color and shall be opaque. The cover shall slip over the entire signal head and shall be securely tied at the opening to secure the cover. An intermediate tie of the same material shall be drawn around the center of the cover to prevent excess flapping in the wind.

A drain hole shall be made at the bottom of the bag to allow the escape of moisture. No tape or adhesive will be allowed to be attached to any surface of the signal housing or lenses. All covers shall be placed in a neat professional manner. Any cover that is torn or missing shall be immediately replaced. Payment for the covers, their placement and removal, and all incidentals for completion of the work will be considered incidental to the installation of the traffic signal.

XXX.8 WARNING GATES. The warning gates shall meet the following requirements.

(a) The warning gates shall be designed and manufactured for use as a warning, traffic control and access control device.

(b) It shall be explicitly designed for traffic control on movable bridges as required by AASHTO.

(d) Manufacturer. The warning gate manufacturer shall be regularly engaged in the production/fabrication of traffic gates with a minimum of ten (10) years documented experience.

(e) Housing. The operating mechanism and control components shall be contained within a weatherproof housing as indicated on the plans. The housing shall be construction of minimum 0.188 inches carbon steel, hot deep galvanized after fabrication. Exterior surfaces shall be painted aluminum (factory painted). All fasteners shall be corrosion resistant, all external fasteners shall be stainless steel.

1. The gates shall be have front and rear access doors, doors shall be mounted on full cross bronze straps. Door handles shall be provided on each door. The door handles shall use vise action to compress a neoprene bulb-gasket to seal the door openings. A padlock-able strap shall be provided on each door for heavy duty padlocks.
2. The warning gate manufacturer shall provide and install a 120 VAC/1Ø/60HZ, 150 Watt heater inside each warning gate housing.
3. The manufacturer shall also provide a GFCI receptacle inside each warning gate housing.

(f) Mounting. The gates shall be mounted onto the gate platform as indication on the plans.

(g) Gate Arm/Arm Base.

1. The gate arm shall be 4 inch square, 6005-T5 aluminum extruded tubing. The front and rear of the arm surface shall be covered with alternating red and white high intensity reflecting sheeting. Stripes shall be 16” wide and vertical per MUTCD. The remaining exposed surface shall be painted white.
2. The arm base shall be designed with a shear pin mechanism to minimize damage to the gate and vehicle in the event of vehicular impact. In the event of an impact, the shear pin shall break away, allowing the arm to swing approximately 75 to 80 degrees. When the gate is in the fully raised (open) position, a spring-loaded latch shall engage preventing the arm from swing back into traffic (closing). The arm shall be easily reset by manually releasing the latch, rotating the arm back into position and replacing the shear pin.

3. A roadway type bumper rod shall be furnished at the discretion of the manufacturer.

(h) Arm Mounting Channel/Counterweight and Arm Shaft.

1. A pair of carbon steel channels, hot dipped galvanized, painted aluminum, shall be rigidly affixed to the ends of the main arm shaft. The channels and steel cross member shall provide a sturdy mount for the arm, arm base assembly and counterweights.
2. A counterweight shall be mounted at the rear end of each side arm channel. The counterweight shall be hot dip galvanized. The counter weight shall be sectional and shall permit at least 10% adjustment.
3. The main arm shaft shall be a minimum of 2" diameter AISI 4150 with a minimum tensile strength of 140,000 psi. The shaft shall be mounted in heavy duty re-lubricable ball bearings.

(i) Arm Lights/Flasher Unit

1. Each warning gate shall be equipped with four (4), red 4 inch fresnel plastic, 12 VDC, LED, double-faced assembly.
2. Warning light flashers shall be spaced as shown on plans and recommended by the manufacturer.
3. The light housing shall be of high impact plastic. Light assembly shall be mounted to the warning gate arm using an aluminum adapter plate. All terminals shall be clearly labeled and shall be compression type screw terminals.
4. The flasher shall be moisture and corrosion resistant and shall be capable of dissipating heat sufficient for continuous duty.
5. The flasher shall have two alternately flashing circuits, and one steady burn circuit. Each flashing circuit shall flash .5 seconds on and .5 seconds off.
6. Standard input voltage shall be 120VAC. The 120V/12V transformer shall provide 12V for the flasher and the arm lights. The flasher shall operate properly for input voltages within 10% of nominal.
7. The output circuits shall be rated at 10 amps at 12VAC each (10 amps total load). A voltage drop of up to 0.5 volts to the output terminals shall be acceptable.

(j) Operating Mechanism

1. The warning arm shall pivot in the vertical plane via a mechanical 4-bar linkage.
2. The linkage shall utilize cranks keyed to the main arm shaft and transmission shaft and an adjustable connecting rod between a pair of self-aligning spherical rod ends. The connecting rod shall be of AISI 4150.
3. The linkage shall be driven by a fully enclosed, double reduction, worm gear speed reducer. Gear ratio used shall produce an operation time of 11 seconds.
4. An auxiliary crank shall be used, paired with the transmission crank, to reduce the load on the transmission and to better balance and stabilize the load on the housing and mounting structure.
5. The auxiliary crank shall be mounted in a permanently lubricated bronze bearing. The velocity of the arm shall follow a sinusoidal pattern to provide smooth operation.
6. The arm shall begin and end its full motion path with zero velocity and accelerate smoothly to maximum velocity at mid-travel

(k) Motor.

1. The motor voltage shall be 480VAC/3-phase/60HZ as indicated on the plans. The motor horse power shall be 1HP or as recommended by the gate manufacturer and approved by the engineer.
2. The motor shall be equipped with a solenoid-release, automatic brake. The brake shall have a manual release lever to permit manual operation of the gate during emergencies or setup.
3. Provisions shall be made for hand operation and a hand crank shall be furnished for each gate.

(l) Limit Switch

1. Each gate housing shall have a self-contained limit switch assembly.
2. Gate limit switch assembly shall be a rotary cam type assembly with multiple switches directly driven from the transmission.
3. The warning gate limit switch assembly shall provide 8 independent single pole double throw (SPDT) control switches.
4. Switches shall be rated for 15 amps, 480 VAC. Contacts shall be quick – break with silver alloy buttons. Switches shall be controlled by individually adjustable cams.

5. The limit switch assembly design shall permit adjustment of all cams with the warning gate arm in any position. Cams shall be secured with set screws. The limit switch shaft shall be stainless steel.
6. The limit switch assembly shall have a removable cover to help prevent accidental contact with switch terminals. Cams, bushings and housing pieces shall be of non-ferrous, corrosion resistant materials.

(m) Safety Switches, Terminal Blocks and Wiring

1. A manual disconnect switch shall be provided prewired at the factory to break the main motor leads and protect personnel during service. The manual disconnect switches shall be furnished with auxiliary contacts as indicated in the control schematics.
2. A hand crank safety switch shall be provided to prevent automatic actuation of the barrier during manual operation. Additionally, safety switches shall be installed and set at the factory to break the control circuit when either access door is opened. Door safety switches shall have a pull-to-override feature for test operation and shall automatically reset when doors are closed.
3. Control components and terminal blocks shall be mounted inside electrical enclosure mounted facing the rear access door. Roadway side access (front door) shall not enclose any live electrical or control components and shall be used for inspection only.
4. Pressure-type, modular terminal blocks shall be fully labeled and clearly coded and shall match the labels used on the wiring diagrams. Connections to screw-type terminals shall have lugs.

(n) Traffic Warning Gong

1. Warning gongs shall be supplied with the warning gates on the oncoming side only.
2. The warning gong shall be used as an audible traffic signaling device to draw attention to the traffic gates and bridge status.
3. A 12 inch gong shall be supplied with the warning gate on the oncoming traffic side.
4. The warning gongs housing shall be of heavy duty, cast aluminum construction.
5. The gong shall be equipped with an aluminum mounting adapter for mounting to

the top of the warning gate housing. Mounting shall be designed to enclose all wiring.

6. A hinged and gasketed rear door shall provide service access. A cast aluminum guard shall be installed above the shell to provide weather protection.
7. The warning gong shall be capable of producing a sound level of 90dB at 10ft.
8. The operation gong shall operate on 120V power.

XXX.9 BARRIER GATES. The barrier gates shall meet the following requirements.

(a) The barrier gates shall be designed and manufactured for use as a warning barrier and shall be suitable for use as a penetration resistance barrier.

(b) It shall be explicitly designed for traffic control on movable bridges as required by AASHTO.

(c) Manufacturer. The warning gate manufacturer shall be regularly engaged in the production/fabrication of traffic gates with a minimum of ten (10) years documented experience.

(d) Housing. The operating mechanism and control components shall be contained within a weatherproof housing as indicated on the plans. The housing shall be construction of minimum 0.375 inches carbon steel, hot deep galvanized after fabrication. Exterior surfaces shall be painted aluminum (factory painted). All fasteners shall be corrosion resistant, all external fasteners shall be stainless steel.

1. The gates shall have front and rear access doors, doors shall be mounted on strap hinges. Hinges shall be of the slip-off type and shall have stainless steel pins. Door handles shall be provided on each door. The door handles shall use vise action to compress a neoprene bulb-gasket to seal the door openings. A padlock-able strap shall be provided on each door for heavy duty padlocks.
2. The warning gate manufacturer shall provide and install a 120 VAC/1Ø/60HZ, 150 Watt heater inside each warning gate housing.
3. The manufacturer shall also provide a GFCI receptacle inside each warning gate housing.

(e) Mounting. The gates shall be mounted onto the gate platform as indicated on the plans and as

required by the gate manufacturer. Use eight 1 inch diameter anchor bolts.

(f) Gate Arm/Arm Shaft.

1. The barrier arm design shall be double rail aluminum tube.
2. Arm length shall be measured from the centerline of the housing.
3. Stainless steel truss cables and a roadway type bumper rod shall be furnished at the discretion of the manufacturer.
4. The front and rear surfaces of the arm shall be covered with pre-striped alternating red and white high intensity reflective sheeting. Striping shall be 16 inches wide and vertical according to MUTCD. Remaining exposed surfaces shall be painted white.
5. The main arm shaft shall be 2.5 inches diameter AISI 4140 high strength alloy steel with a minimum tensile strength of 140,000 psi. The shaft shall be mounted in heavy duty sealed ball bearings with lubrication fittings.

(g) Energy Absorption Cables

1. The barrier shall utilize 6x19 classification, 300-series stainless steel, and annealed energy absorption cables to assist in diffusing the kinetic energy of an impacting vehicle.
2. Cables shall be annealed in a coil not less than 42 inches diameter.
3. Double rail aluminum tube arms shall use three 0.5 inches cables, one inside each tube, and one along the center of the arm.

(h) Arm End Lock.

1. The energy absorption cables shall be anchored at the tip end of the arm in the closed to traffic position.
2. A passive end lock mounted on the arm tip shall engage a rigidly mounted and anchored socket on or in a wall or post for independent barriers.
3. For paired barriers, on-coming barrier shall be fitted with a bar and anchor nut while off-going barrier shall be fitted with a yoke.
4. On-coming barriers shall be sequenced to close first and open last.
5. The yoke on the off-going traffic barrier shall fit over the anchor nut in the closed to traffic position. The end lock system shall be designed so that the yoke will engage the anchor nut in a collision

to connect the two barriers into a continuous unit. End locks shall not require powered actuation for proper engagement.

(i) Arm Mounting Tubes/Counterweights.

1. Hot dip galvanized steel counterweight plates shall be mounted onto carriers inside the vertical tubes to balance the arm.
2. Counterweights shall be sectional and shall be balanced at the factory.
3. The opening in the vertical tubes shall be closed with a removable cover to prevent ingress of water and debris and to provide access for service.
4. A pair of carbon steel rectangular tubes, hot dip galvanized after fabrication, painted aluminum, shall be rigidly affixed to the ends of the main arm shaft.
5. The tubes shall locate the arm centerline at 24 inches above the housing base. The tubes and a steel cross-member shall provide a sturdy mount for the arm.

(j) Arm Lights/Flasher Unit

1. Each warning gate shall be equipped with two (2), red 4 inch Fresnel plastic, 12 VDC, LED, double-faced assembly.
2. Warning light flashers shall be spaced as shown on plans and recommended by the manufacturer.
   The light housing shall be of high impact plastic. Light assembly shall be mounted to the warning gate arm using an aluminum adapter plate. All terminals shall be clearly labeled and shall be compression type screw terminals.
3. The flasher shall be moisture and corrosion resistant and shall be capable of dissipating heat sufficient for continuous duty.
4. The flasher shall have two alternately flashing circuits, and one steady burn circuit. Each flashing circuit shall flash .5 seconds on and .5 seconds off.
5. Standard input voltage shall be 120VAC. The 120V/12V transformer shall provide 12V for the flasher and the arm lights. The flasher shall operate properly for input voltages within 10% of nominal.
6. The output circuits shall be rated at 10 amps at 12VAC each (10 amps total load). A voltage drop of up to 0.5 volts to the output terminals shall be acceptable.

(k) Operating Mechanism

1. The barrier arm shall pivot in the vertical plane via a mechanical 4-bar linkage.
2. The linkage shall utilize cranks keyed to the main arm shaft and transmission shaft and an adjustable connecting rod between a pair of self-aligning spherical rod ends. The connecting rod shall be 1.25 inches diameter AISI 4140 alloy steel.
3. An auxiliary crank shall be used, paired with the transmission crank, to reduce the load on the transmission and to better balance and stabilize the load on the housing and mounting structure.
4. The auxiliary crank shall be mounted in a permanently lubricated bronze bearing.
5. The velocity of the arm shall follow a sinusoidal pattern to provide smooth operation.
6. The arm shall begin and end its full motion path with zero velocity and accelerate smoothly to maximum velocity at mid-travel.

(l) Transmission

1. The mechanism linkage shall be driven by a fully enclosed, heavy duty worm gear, double reduction speed reducer.
2. The transmission shall have an occasional momentary peak load rating of not less than 37,000 inch-pounds. The output shaft shall be 2 inches diameter.
3. Gear ratio used shall produce an operation time of approximately 16 seconds.

(m) Torque Limiter

1. A heavy duty torque limiter shall be provided to limit torque transmitted to the operating mechanism in the event of excessive winds or a physical obstruction to the arm that could damage the mechanism during operation.
2. The torque limiter shall be capable of being set anywhere within a range of 10,000 to 75,000 inch-pounds torque.
3. Each torque limiter shall be factory set for the load recommended by the manufacturer, based on installation requirements.
4. Each torque limiter shall be adjusted and tested at the factory, under over-load condition, for a minimum of 5 minutes to verify the setting.

5. The gate limit switch assembly shall be driven from the output side of the torque limiter so that slippage of the torque limiter will have no effect upon the limit settings.

(n) Motor.

1. The motor voltage shall be 480VAC/3-phase/60HZ as indicated on the plans. The motor horse power shall be 2HP or as recommended by the gate manufacturer and approved by the engineer.
2. The motor shall be a C-face design and shall be mounted directly to the transmission. The motor shall be instantly reversing and overload protected.
3. The motor shall be equipped with a solenoid-release, automatic brake. The brake shall have a manual release lever to permit manual operation of the barrier during setup or emergencies.

(o) Limit Switch

1. Each barrier gate housing shall have a self-contained limit switch assembly.
2. Gate limit switch assembly shall be a rotary cam type assembly with multiple switches directly driven from the transmission.
3. The warning gate limit switch assembly shall provide 8 independent single pole double throw (SPDT) control switches.
4. Switches shall be rated for 15 amps, 480 VAC. Contacts shall be quick – break with silver alloy buttons. Switches shall be controlled by individually adjustable cams.
5. The limit switch assembly design shall permit adjustment of all cams with the warning gate arm in any position. Cams shall be secured with set screws. The limit switch shaft shall be stainless steel.
6. The limit switch assembly shall have a removable cover to help prevent accidental contact with switch terminals. Cams, bushings and housing pieces shall be of non–ferrous, corrosion resistant materials.

(p) Safety Switches, Terminal Blocks and Wiring

1. A manual disconnect switch shall be provided, pre-wired at the factory to break the main motor leads, to protect personnel during service.

2. A handcrank safety switch shall be provided to prevent automatic actuation of the barrier during manual operation.
3. Safety switches shall be installed and set at the factory to break the control circuit when either access door is opened.
4. Door safety switches shall have a pull-to-override feature for test operation and shall automatically reset when doors are closed.
5. Control components and terminal blocks shall be mounted inside an electrical enclosure, which shall be mounted inside the operator housing, with roadway side access, except where customer requirements prevent this arrangement.
6. Pressure-type, modular terminal blocks shall be fully labeled and clearly coded to wiring diagrams.
7. All control wiring shall be clearly coded to wiring diagrams and shall terminate at the terminal block.
8. Connections to screw-type terminals shall have lugs.
9. Both a handcrank and a drill crank shall be provided with each barrier to facilitate manual operation.

XXX.10 Warning Gate and Barrier Gate Foundations. The Warning Gate and Barrier Gate Foundations shall meet the requirements shown on the plans, and the following:

(a) Micropiles.
Micropile construction shall be in accordance with the requirements of Items 900.640 Special Provision (Micropile, Cased) and 900.640 Special Provision (Micropile, Uncased).

(b) Concrete.
Concrete in Warning Gate and Barrier Gate Foundations shall be High Performance Class B in accordance with Section 501 with a minimum 28-day strength of 3500 psi.

(c) Reinforcing Steel.
Reinforcing Steel shall be Grade 60 reinforcing with a level 1 corrosion resistance in accordance with Section 507.

(d) Platform Railing Anchorage.
Anchor Bolts cast in for attachment of the platform railing shall meet the applicable requirements of Section 525. The combination of anchor plate, base plate, anchor bolt, nut, and washer shall be mechanically galvanized in accordance with AASHTO M298, Class 50, Type 1.

(e) Gate Housing Anchorage.

Gate Housing Anchorage shall be supplied by the gate manufacturer and installed according to manufacturer specifications. The combination of anchor bolt, nut, and washer shall be mechanically galvanized in accordance with AASHTO M298, Class 50, Type 1.

(f) Platform Railing.
Platform Railing shall conform to the applicable requirements of Section 525.

XXX.11 INSTALLATION AND COMPLETION. The signals and equipment shall be properly installed, and operating sequences set as shown on the Plans by a competent factory-trained representative of the manufacturer or by workers under the manufacturer's supervision.

All span wire mounted signals shall have disconnect hangers. All fixed mounted signals shall have terminal components.

Traffic signals installed at locations that were previously unsignalized shall be operated in the flash mode for a minimum of 48 hours prior to being put into full operation. Full operation for new installations or switch over for replacement signals shall not be initiated except in the presence of the Highway Safety and Design Program Manager or a designated representative.

The traffic signals shall not operate without the pavement markings, signal related signing in place, and warning and barrier gate systems in place and operational.

All work shall conform to the requirements of the National Electrical Code.

After the signal control system has been completely installed, any signal fixtures with damaged factory applied paint shall be corrected by applying one coat of enamel meeting the requirements of VT 6.01 (Flat Black Enamel) or VT 6.02 (Yellow Enamel) applied to the complete sectional area that is damaged after being lightly sanded to remove gloss. The visors (hoods) and the entire surface of louvers, fins, and the front surface of back plates shall have a dull black finish.

The Contractor shall submit in duplicate to the Engineer the wiring diagrams, signal sequence chart, signal terminal connection diagram, service manual, programming manual (if applicable), and parts list for each signal controller. The foregoing and manufacturer's warranties and guarantees furnished for materials used in the work shall be delivered to the Engineer

prior to acceptance of the work. The warranties shall be the manufacturer's customary trade warranties.

There will be a minimum 30-day test control period to adjust and establish timing sequences for the installation. If, during the last 14 days of the control period, the system does not operate correctly, the test period will be extended until the system operates correctly for 14 calendar days.

The Contractor shall correct all deficiencies found in the traffic control system as a result of the test control period, and shall repair or replace defective equipment at no additional cost to the Agency. The traffic control system shall not be accepted until successful completion of the test control period.

The Contractor shall make every reasonable effort to have the installation complete and operating, including the test control period, prior to the date specified in the Contract. However, if all other work under the Contract has been completed, any portion of the test control period which extends beyond the completion date may not be considered time charged for liquidated damages.

For new traffic signals or flashing beacons, the Contractor shall be responsible for all utility costs until acceptance of the signal or beacon system. For upgrading of existing signals or beacons, the State or Municipality, whichever is applicable, shall continue to pay for normal monthly power usage while the Contractor shall be responsible for all other utility costs.

The required 30-day test control period for the signal installation shall not begin until all construction of the signal control system installation is complete and the Engineer has received notice from the responsible Agency parties that all paperwork, including Fabrication Drawings, materials certifications, bench test reports, etc., related to the signal control equipment and installation have been completed to the satisfaction of the responsible parties. Once the 30-day test period has been completed, and the project has been declared substantially complete by the Engineer, the Engineer will send a memorandum or an e-mail to the Highway Safety and Design Program Manager, with a copy to the Traffic Signal Maintenance Technician and the appropriate Agency DTA stating that the above criteria have been met and that the Agency is now responsible for the maintenance of the traffic signal system. The name of the power company and the account number on the power bill shall be included for the DTA's records. If a memorandum is sent, a telephone call will also be made by the Engineer to ensure the transfer of responsibility.

For projects where several signal systems are coordinated, all the individual signal systems must have successfully completed the 30-day test control period before the signal systems can be accepted.

The Contractor shall notify the Engineer at least 48 hours prior to turning off the existing traffic control signal system, or when the Contractor is ready to install the traffic control signal system. Notice is required so that a representative may be provided to observe the installation of the equipment in preparation for maintenance and repair of the system and to have a uniformed traffic officer present to maintain traffic, if required.

Removal of existing or reuse of salvaged equipment:

(a) Unwanted equipment must be disposed of by the Contractor. Removal of equipment shall include removal of concrete bases and backfill of the holes, where applicable. Any equipment that is damaged or lost by the Contractor during removal shall be repaired or replaced to the satisfaction of the Engineer, at the Contractor's expense.

(b) All salvaged and reused equipment shall be thoroughly cleaned and painted as required, before reuse.

(c) All reused traffic signal, flashing beacon, or street lighting lenses and reflectors shall be cleaned and all lamps shall be replaced using lamps conforming to the applicable requirements of Subsection 752.05.

XXX.12 METHOD OF MEASUREMENT. The quantity of Traffic Control Equipment to be measured for payment will be the system installed in the complete and accepted work.

BASIS OF PAYMENT. The accepted quantity of Traffic Control Equipment will be paid for at the Contract lump sum price. Payment will include mast arm poles, signal heads, warning gate, barrier gates, platforms, all wiring not included in the Bridge Electrical Equipment, and all other materials necessary for a fully operational Traffic Control System not otherwise

paid for under Contract items in this Section or Contract items in Section 678 – Traffic Control Signals. The Contractor shall be responsible for all maintenance costs for new or existing traffic control systems until project acceptance. This period shall include any winter shut downs during the Contract period. Replacement of poles and cabinet/controllers will not be considered maintenance costs unless the loss is due to the Contractor's negligence. At the discretion of the Engineer, the Contractor may be required to replace poles and cabinet/controllers that are lost or damaged due to an accident. If required, such work will be considered Extra Work under Subsection 109.06 and additional payment will be allowed. Any equipment that is defective or damaged prior to the beginning of the Contract shall be maintained in at least as good condition, until it is replaced as part of the Contract.

Payment for Traffic Control Equipment will be made as follows:

(a) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(b) The second Payment of 50 percent of the lump sum price will be made upon delivery of the traffic control equipment to the job site.

(c) The third payment of 40 percent shall be made when the traffic control equipment has been installed at the project site and field tested.

(d) Payment of the remaining amount will be made after acceptance testing and punch list items have be resolved

Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Traffic Control Equipment)	Lump Sum

HVAC

XX. DESCRIPTION

(a) Included in this section are the requirements for furnishing all labor, materials, tools, and equipment, and performing all operations necessary to install, field test and place in satisfactory condition, the HVAC system as indicated on the contract drawings and specified herein.

XX. REFERENCES AND STANDARDS

(a) Air Movement and Control Association (AMCA).

(1) AMCA Publication 203 "Field Performance Measurement of Fan Systems"

(2) ANSI/AMCA 210 "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating".

(b) Air Conditioning and Refrigeration Institute (ARI).

(c) American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):

(1) HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."

(2) 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.

(3) 52, Method of Testing Air Conditioning Devices Used in General Ventilation for Removing Particulate Matter.

(4) 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

(d) National Electrical Manufacturers Association (NEMA):

(1) 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

(e) National Fire Protection Association (NFPA).

(1) 70, National Electrical Code (NEC).

(f) National Roofing Contractors Association (NRCA).

(g) Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

(1) Ducted Electric Heat Guide for Air Handling Systems.

(2) HVAC Duct Construction Standards - Metal and Flexible.

(h) Underwriters Laboratory, Inc. (UL):

(1) 555, Standard for Safety Fire Damper and Ceiling Fire Damper.

(2) 555S, Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems.

(2) 507, Standard for Electric Fans.

(3) Building Materials Directory.

(i) Building code:

(1) International Code Council (ICC):
International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

XX. SUBMITTALS

(a) Ductwork

(1) For shop drawings, submit product technical data including: Acknowledgement that products submitted meet requirements of standards referenced, copies of manufacturer's written directions regarding material handling, delivery, storage and installation, separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components, attach technical product data on gaskets, fittings, and other components, and proof of experience.

(b) Exhaust Fans

(1) For shop drawings, submit product technical data including: Acknowledgement that products submitted meet requirements of standards referenced, manufacturer's installation instructions, wiring diagrams, control diagrams, manufacturer's catalog cuts and technical data, corrosion-protection information, fan curves, sound data, vibration isolation, performance data on all equipment. Provide certification of thickness of corrosion-protection coating and that fan systems have been tested in accordance with AMCA Standard 210 or 260, and are licensed to bear the AMCA Certified Ratings Seal.

(2) Submit factory performance test for any fan having a flow rate greater than 1,000 cfm and/or a total static pressure rating equal to or greater than 1.5 inches WC. Pursuant to AMCA Publication 203 or 210 with no plus tolerances on Power and no minus tolerances on flow or pressure.

(3) For contract closeout information, submit operation and maintenance Data. Draft and final operations and maintenance data shall be submitted

electronically. Two final operations and maintenance data paper copies shall be submitted.

Provide a cover page as the first page of each manual with the following information: manufacturer(s) name and contact information, vendor’s name and contact information, date (month, year), project owner and project name, specification section, project equipment tag numbers, model numbers, engineer’s name, and contractor’s name.

Operations and Maintenance data shall contain but is not limited to: product data, with catalog number, size, composition and color and texture designations, product MSDS for each approved product, any precautionary application, storage guidelines, include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance, recommendations for inspections, maintenance and repair, and additional requirements as specified in individual product specifications.

(c) HVAC: Equipment

(1) For shop drawings, submit fabrication and/or layout drawings.

(2) For product technical data submit the following: acknowledgement that products submitted meet requirements of standards referenced, manufacturer's installation instructions, wiring diagrams, control diagrams, manufacturer's catalog cuts and technical data, corrosion-protection information, fan curves, sound data, vibration isolation, control description, and performance data on all equipment. Provide certification of thickness of corrosion-protection coating.

(3) For contract closeout information, submit operation and maintenance Data. Draft and final operations and maintenance data shall be submitted electronically. Two final operations and maintenance data paper copies shall be submitted.

Provide a cover page as the first page of each manual with the following information: manufacturer(s) name and contact information, vendor’s name and contact information, date (month, year), project owner and project name, specification section, project equipment tag numbers, model numbers, engineer’s name, and contractor’s name.

Operations and Maintenance data shall contain but is not limited to: product data, with catalog number, size, composition and color and texture designations, product MSDS for each approved product, any precautionary application, storage guidelines, include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance, recommendations for inspections, maintenance and repair, and additional requirements as specified in individual product specifications.

XX. MATERIALS All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating. Corrosion-resistant materials include aluminum, stainless steel and FRP. Corrosion-resistant coating shall be phenolic-based: 3 mil minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 DegF. 5 mil baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 DegF. Corrosion-resistant coasting shall be factory applied. Provide factory certification of application.

(a) UNIT HEATERS

Unit heaters shall be as scheduled on Contract Drawings. The Contractor will submit all the necessary shop drawings, product data and any other relevant information to the Engineer for approval. See XX. Submittals section HVAC: Equipment for submittal process.

(b) HEAT PUMPS

Heat pumps shall be as scheduled on Contract Drawings. The Contractor will submit all the necessary shop drawings, product data and any other relevant information to the Engineer for approval. See XX. Submittals section HVAC: Equipment for submittal process.

(c) FAN COILS

Fan coils shall be as scheduled on Contract Drawings. The Contractor will submit all the necessary shop drawings, product data and any other relevant information to the Engineer for approval. See XX. Submittals section HVAC: Equipment for submittal process.

(d) EXHAUST FANS

Exhaust fans shall be as scheduled on Contract Drawings. Manufacturer substitutions can be made for an approved equal. See XX. Submittals section Exhaust Fans for submittal process.

(e) LOUVERS

Louvers shall be as scheduled with specified dampers as shown on Contract Drawings. The Contractor will submit all the necessary shop drawings, product data and any other relevant information to the Engineer for approval.

(f) GENERATOR EXHAUST KIT

The generator exhaust kit shall be as recommended by the manufacturer and specified on Contract Drawings. The Contractor will submit all the necessary shop drawings, product data and any other relevant information to the Engineer for approval.

(g) DUCTWORK

Acceptable transverse joint manufacturers: Ductmate Industries, Inc. or approved equal.

Acceptable flexible duct manufacturers: Thermaflex, Condu-flex, Glass-flex, or approved equal.

Acceptable turning vane manufacturers: Ductmate Industries, Inc., Duro Dyne, SEMCO Incorporated, Ward Industries, Inc., or approved equal.

Acceptable flexible duct connection manufacturers: Vent Fabrics, Duro Dyne, or approved equal.

Acceptable flexible connector thrust restraint manufacturers: Mason WB, or approved equal.

Acceptable access doors in ductwork manufacturers: Vent Fabrics, American Warming, or approved equal.

Acceptable backdraft damper manufacturers: Air Balance, Ruskin, American Warming, or approved equal.

Acceptable ceiling diffuser manufacturers: Anemostat, Carnes, Titus, or approved equal.

Acceptable air filter manufacturers: American Air Filter, Farr, Continental, or approved equal.

Acceptable manual (volume) damper manufacturers: Air Balance, Ruskin, American Warming, or approved equal.

Acceptable motorized damper manufacturers: Ruskin, or approved equal.

Acceptable duct sealer manufacturers: Durkee-Atwood, Unitec McGill, Benjamin Foster, Design Polymerics, or approved equal.

Acceptable louver manufacturers: Ruskin, Air Balance, American Warming, or approved equal.

Duct and fittings shall be fabricated from 003 H-14 aluminum alloy and comply with ASTM B209.

Ducts with largest side or diameter to 30 IN shall have a thickness of 0.05 IN thick. Ducts with largest side or diameter greater than 30 IN shave have a minimum thickness of 0.08 IN thick.

Utilize SMACNA HVAC Duct Construction Standards for minimum of 2 IN water gage static pressure for the minimum sheet material thickness specified herein. Heavier gage sheet material may be used with associated reinforcement as an alternate to minimum thickness specified. Lighter gage sheet material with associated reinforcement shall not be used as an alternate to minimum thickness specified.

Longitudinal seams fabricated from 0.050 material shall be Pittsburgh seam or continuously welded. Longitudinal seams fabricated from 0.080 material shall be continuously welded. Seams on factory assembled units shall be continuously welds.

Transverse joints (Alternate A) shall be SMACNA T-22 companion flange and gasketed. Ducts with largest side or diameter to 30 IN shall be rigidity SMACNA Class D (1-1/2 x 1-1/2 x 1/8 IN angles). Ducts with largest side or diameter greater than 30 to 54 IN shall be SMACNA Class H (2-1/2 x 2-1/2 x 3/16 IN angles).

Transverse joints (Alternate B) shall have aluminum angles and corners fabricated from ductmate 35. Snap cleats shall be aluminized or stainless steel. Gaskets shall be closed cell neoprene. Bolts shall be stainless steel and 3/8 IN DIA x 1 IN bolts. Sheet metal screws shall be self-drilling stainless steel with unthreaded section under head. Transverse joints (Alternate B) shall be rigidity SMACNA Class H.

Supports and hangers shall be trapeze type units. Strap hangers are not allowed.

Supports and hangers for aluminum duct shall have support angles fabricated from aluminum or stainless steel, minimum 1-1/2 by 1-1/2 by 1/4 angle. Hanger rods shall be stainless steel. Anchors shall be stainless steel wedge type.

Supports and hangers for galvanized duct shall have support angles fabricated from galvanized or stainless steel, minimum 1-1/2 by 1-1/2 by 1/4 angle. Hanger rods shall be galvanized or stainless steel. Anchors shall be stainless steel wedge type.

Turning vanes shall be the same as duct. Fabricate double vane units. Pressure drop through elbows shall be maximum 20 percent of velocity pressure.

Flexible Connections shall be hypalon, double coated closely woven glass fabric and must withstand 4.5 IN water column, positive and negative pressure.

Access Door inner and outer panels and frame shall be the same material as duct. Gaskets shall be closed cell neoprene. Insulation shall be 1 LB density fiberglass. Hinges shall be stainless steel. Latches shall be aluminum-zinc alloy with outside lever handle, adjustable spacer, and beveled inside flange. Minimum 3/8 IN DIA stud for doors up to 24 IN wide x 48 IN high. Minimum 1/2 IN DIA stud for doors larger than 24 x 48 IN.

Provide four-side continuous gaskets. Utilize continuous piano hinges. One (1) latch required for doors 12 IN in any direction. Two (2) latches required for doors up to 18 x 18 IN and up to 24 x 48 IN. Three (3) latches required for doors up to 24 x 72 IN. Minimum door size is 12 x 12 IN.

Drain Pans shall be 0.080 IN aluminum.

Acoustical Liners shall be 1 IN 3 LBS/CF density fiberglass. UL listed, Class 1, non-combustible.

Backdraft Dampers shall be 6063 T5 aluminum, with extruded vinyl blade edge seals. 0.125 thick frames shall be a 16 gage minimum. Blade thickness of 0.070 IN shall be 18 gage minimum. Linkage shall be 1/2 IN tie bars. Bearings shall be synthetic.

Fire damper frames, blades, and enclosures shall be galvanized steel. Frame and enclosure thickness shall be 20 GA, G60. Blades shall be curtain type and 24 GA, G60 thickness. Fusible link shall be 212 DegF, UL listed. Fire dampers shall have a 1-1/2 HR per UL 555 fire rating, can be mounted vertically or horizontally, and designed with blade package out of air stream.

Combination fire and smoke dampers shall be factory installed, 120 V, 60 HZ and UL listed. Combination fire and smoke damper frames, blades, and enclosures shall be galvanized. Frames shall be 5 IN x 16 GA. Blades shall be 6 IN wide and 16 GA. Bearings shall be stainless steel sleeve pressed into frame. Jamb seals shall be either flexible metal, compression type or stainless steel. Sleeve shall be factory-supplied 20 GA. Fusible link shall be 212 DegF, UL listed. Combination fire and smoke dampers shall be fired rated per UL 555. Leakage rate shall conform to Class III per UL 555S. Combination fire and smoke dampers can be mounted vertically or horizontally. Operator/Actuator is normally closed (NC).

Diffusers shall be square or rectangular with removable core and have extruded aluminum bodies. Ceiling diffuser gaskets shall be sponge rubber. Key operated opposed blade damper mounted in neck except where indicated on Drawings to be omitted. Dampers are to be housed in round to square adapters. Interior of perforated supply and return diffusers shall have a flat black paint finish.

Volume dampers and flow equalizers for round neck diffusers shall be aluminum and designed for a neck velocity of 2500 FT/MIN. Center rod operator shall be accessible through diffuser without removing diffuser. Furnish with screws, duct collars, transitions and air pattern deflectors as required.

Duct sealer shall have a NFPA rating of "Non-Combustible". Flame spread rating of 25 or lower, in dry condition. Smoke developed rating of 50 or lower, in dry condition. Resistant to water and water vapors. Comply with UL 181. Pressure rupture rating of 16 IN WG, minimum.

See architecture specifications for louvers.

Furnish Owner with twelve complete filter media changes for each filter unit. Filter media used during construction is in addition to this requirement.

XX. QUALIFICATIONS/QUATLITY ASSURANCE

(a) Fabricator firms regularly engaged in the manufacture of the specific product, of type, size required, whose products have been in use in similar service for not less than three (3) years.
(b) Installer firms shall have at least five (5) years installation experience on products similar to that required for this Project.

XX. CONSTRUCTION

(a) UNIT HEATER

Unit heaters shall be installed and furnished vertically per manufacturer's instructions and recommendations. See Contract Drawings for locations. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report. Install new filters on units which have been running prior to acceptance of Project.

(b) HEAT PUMPS

Heat pumps shall be installed floor mounted per manufacturer's instructions and recommendations. See Contract Drawings for locations. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report. Install new filters on units which have been running prior to acceptance of Project.

(c) FAN COILS

Fan coils shall be installed in the ceiling and be installed per the manufacturer's instructions and recommendations. See Contract Drawings for locations. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report. Install new filters on units which have been running prior to acceptance of Project.

(d) EXHAUST FANS

Exhaust Fans shall be mounted as shown in Contract Drawings and installed per the manufacturer's instructions and recommendations. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report. Install new filters on units which have been running prior to acceptance of Project.

(e) LOUVERS

Install per the manufacturer's instructions and recommendations. See Contract Drawings for locations.

(f) DUCTWORK

Install metal ductwork with longitudinal seams sealed for zero leakage. For welded seams, submit sample for approval by Engineer. Install gaskets at each transverse joint and fasten sections together with bolts. Tighten for zero leakage. Install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards. Install turning vanes in square elbows. Unsupported vane length not to exceed 48 IN. Position vanes at proper angle to meet specified pressure drop. Install flexible connections as close as possible to fans. Allow 1 IN of slack to prevent vibration transmission. Install thrust restraints across connectors. Install access doors where indicated on Drawings and at smoke and fire damper in accordance with NFPA requirements. Install volume extractors at supply registers, grilles, diffusers and supply branch connections from ducts. Provide branch duct extensions into main duct above and below extractor when branch duct is narrower than main duct.

Install drain pans at fan coil cooling coils, control valves above finished ceilings and at other sources of moisture. Install metal tubing at drain and terminate above floor drain, equipment drain and as shown on Drawings.

Install acoustical liners for a minimum length of 30 FT from equipment or mechanical room walls, whichever is greater.

Install dampers where indicated on Drawings of sizes shown. Install fire and smoke dampers in ductwork passing through 1 HR or higher fire-rated construction. Install in wall and floor openings utilizing steel sleeves, angles and other materials following practices required to provide installation in accordance with local Building Codes.

Install diffusers where shown on Drawings of size and capacities scheduled on Drawings. Install painted lay-in type in lay-in ceilings. Install prime painted diffusers in areas where duct work is concealed. Install anodized diffusers in exposed duct work.

XX. METHOD OF MEASUREMENT Contract Drawings are conceptual only. The Contractor is responsible for all quantities.

XX. MEASUREMENT AND PAYMENT

(1) METHOD OF MEASUREMENT

(a) Payment shall be made on a lump sum basis.

(2) BASIS OF PAYMENT

(a) This item will be measured as a lump sum subject to the payment schedule below:

(1) Shop drawing approval: 5% (of total bid item).

(2) Purchase of raw material including forgings: (Payment amount for purchase of raw material shall be the amount supported by a copy of a receipted bill for same.)

(3) Fabrication/shop testing/storage (onsite or at fabricator): (75% minus % paid for raw material.)

(4) Installation: 15%.

(5) Acceptance Testing: 5%.

(b) Payment will be made under:

Pay Item	**Pay Unit**
900.645 Special Provision (HVAC Control House and HVAC Tender House)	Lump Sum

PLUMBING

XX. DESCRIPTION Included in this section are the requirements for furnishing all labor, materials, tools, and equipment, and performing all operations necessary to install, field test and place in satisfactory condition, the Plumbing system as indicated on the contract drawings and specified herein.

XX. REFERENCES AND STANDARDS

(a) Americans with Disabilities Act (ADA):
(1) Accessibility Guidelines for Buildings and Facilities (ADAAG).

(b) American Society of Mechanical Engineers (ASME):

(1)B1.2, Gages and Gaging for Unified Screw Threads.

(2) B31.1, Power Piping.

(3) B31.3, Process Piping.

(4) B31.5, Refrigeration Piping.

(4) B31.9, Building Services Piping.

(5) B40.100, Pressure Gauges and Gauge Attachments.

(6) A112.19.3, Stainless Steel Plumbing Fixtures (Designed for Residential Use).

(c) ASTM International (ASTM):

(1) A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

(2) A74, Standard Specification for Cast Iron Soil Pipe and Fittings.

(3) A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

(4) A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

(5) B32, Standard Specification for Solder Metal.

(6) B88, Standard Specification for Seamless Copper Water Tube.

(7) C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

(8) E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

(9) E119, Standard Test Methods for Fire Tests of Building Construction and Materials.

(10) E814, Standard Test Method for Fire Tests of Through Penetration Fire Stops.

(11) F708, Standard Practice for Design and Installation of Rigid Pipe Hangers.

(12) E1966, Standard Test Method for Fire-Resistive Joint Systems.

(d) American National Standards Institute (ANSI/ASTM):

(1) B16.3, Malleable Iron Threaded Fittings.

(2) B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.

(3) B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.

(4) B16.23, Cast Copper Alloy Solder Joint Drainage Fittings (DWV).

(5) B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.

(6) Z21.10.1/ 4.1, Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less.

(7) Z21.10.3/CSA 4.3, Gas Water Heaters Vol. III, Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous.

(8) Z21.22/CSA 4.4, Relief Valves for Hot Water Supply Systems.

(9) Z358.1, Emergency Eyewash and Shower Equipment.

(e) American Society of Heating, Refrigerating and Air Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):

(1) 90.1 SI, Energy Standard for Buildings Except Low-Rise Residential Buildings.

(f) American Society of Sanitation Engineers (ASSE):

(1) 1011, Performance Requirements for Hose Connection Vacuum Breaker.

(g) American Water Works Association (AWWA):

(1) B300-10, Standard for Hypochlorites.

(2) C110, Standard for Ductile-Iron and Gray-Iron Fittings.

(3) C150, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

(4) C151, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

(5) C203, Coal-Tar Protective Linings for Steel.

(6) C206, Field Welding of Steel Water Pipe.

(7) C207, Steel Pipe Flanges for Waterworks Service.

(8) C606, Grooved and Shouldered Joints.

(9) C651, Disinfecting Water Mains.

(10) M11, Steel Pipe- A Guide for Design and Installation.

(h) American Welding Society (AWS):

(1) A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.

(2) D1.1 - Structural Welding Code - Steel.

(i) Chlorine Institute, Inc. (CI):

(1) Pamphlet 6, Piping Systems for Dry Chlorine.

(j) Cast Iron Soil Pipe Institute (CISPI):

(1) 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

(l) Building code:

(1) International Code Council (ICC):

a. International Plumbing Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

(m) FM Global:

(1) FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

(n) Intertek Testing Services (Warnock Hersey Listed):

(1) WH - Certification Listings.

(o) International Code Council (ICC):

(1) IPC, International Plumbing Code.

(p) International Organization for Standardization (ISO):

(1) 9001, Quality Management Systems- Requirements.

(q) National Fire Protection Association (NFPA):

(1) 54, National Fuel Gas Code.

(2) 70, National Electrical Code.

(r) NSF International (NSF).

(s) Manufacturers Standardization Society of the Valve and Fittings Industry:

(1) MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.

(2) MSS SP 67 - Butterfly Valves.

(3) MSS SP 69 - Pipe Hangers and Supports - Selection and Application.

(4) MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.

(5) MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.

(6) MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.

(7) MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

(8) MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

(t) Underwriters Laboratories Inc:

(1) UL 263 - Fire Tests of Building Construction and Materials.

(2) UL 723 - Tests for Surface Burning Characteristics of Building Materials.

(3) UL 1479 - Fire Tests of Through-Penetration Firestops.

(4) UL 2079 - Tests for Fire Resistance of Building Joint Systems.

(5) UL 2215, Outline of Investigation for Oil/Water Separators.

(6) UL - Fire Resistance Directory.

XX. QUALIFICATIONS/QUALITY ASSURANCE Use only certified welders meeting procedures and performance outlined in ASME Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local building and utility requirements.

For drinking water service, provide valves complying with NSF 61.

Instantaneous Domestic Water Heaters: design heaters to limit the maximum temperature to avoid scalding possibilities at low flow rates and provide constant set hot water temperatures whether one or multiple faucets are open simultaneously.

Company shall have minimum three (3) years documented experience specializing in manufacturing the products specified in this Specification Section. Water heaters shall be manufactured by a company that has achieved certification to the ISO 9001. Provide equipment with manufacturer's name, model number, and rating/capacity permanently identified.

Company shall have minimum three (3) years documented experience specializing in performing the Work of this Specification Section. Installation of plumbing systems shall be performed by individuals licensed as a Journeyman or Master Plumber by the state in which the work is performed. Installation may be performed by Apprentice Plumbers provided they are registered with the state and under direct

supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.

Provide full written description of manufacturer's warranty. Water heaters shall be warranted in writing against failure due to leaks of heater body and element assembly under normal use and service for a minimum period of five years after date of substantial completion. Electric heating element shall be warranted for a minimum period of one year, gas heat exchanger shall be warranted for a minimum of five years.

Oil Water Separator: Manufacturer shall have at least 10 years experience in manufacturing similar units for identical applications. No subcontracting of tank fabrication shall be permitted.

XX. DELIVERY, STORAGE, AND HANDLING

(a) Instantaneous Domestic Water Heaters: Accept products on site in factory packaging. Inspect for damage. Maintain products in factory packaging until installation. Provide temporary inlet and outlet caps when not factory provided. Maintain caps in place until installation. Protect components from damage after installation. Do not allow use of heater for any reason, other than testing, during the construction phase of this project.

XX. SYSTEM DISCRIPTION Firestopping Materials in accordance with ASTM E119 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

XX. PERFORMANCE REQUIREMENTS

Firestopping shall conform to applicable code for fire resistance ratings and surface burning characteristics. Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

Oil Water Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation.

XX. SUBMITTALS

(a) Pipe and Pipe Fittings: Plumbing Systems

(1) For shop drawings, submit product technical data including: Acknowledgement that products submitted meet requirements of standards referenced, copies of manufacturer's written directions regarding material handling, delivery, storage and installation, separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components, attach technical product data on gaskets, pipe, fittings, and other components, and welders' certificates.

(2) For informational submittals submit qualifications of lab performing disinfection analysis on water systems. For test reports submit copies of pressure test results on all piping systems, reports defining results of dielectric testing and corrective action taken, disinfection test reports, and notification of time and date of piping pressure tests.

(b) General-Duty Valves for Plumbing Piping

(1) For product data, submit manufacturers catalog information with valve data and ratings for each service.

(2) For manufacturer's installation instructions, submit hanging and support methods, joining procedures.

(c) Hangers and Supports for Plumbing Piping and Equipment

(1) For shop drawings, indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

(2) Product Data:

Hangers and Supports: Submit manufacturers catalog data including load capacity.

Firestopping: Submit data on product characteristics, performance and limitation criteria.

(3) For firestopping schedule, submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

(4) For design data, indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods and calculations sealed by a registered professional engineer.

(5) Manufacturer's Installation Instructions:

Hangers and Supports: Submit special procedures and assembly of components.

Firestopping: Submit preparation and installation instructions.

(5) Submit manufacturer's certificate to certify products meet or exceed specified requirements.

(6) Firestopping Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

(d) Plumbing Fixtures and Equipment

(1) For shop drawings, submit color selection charts for Owner color selection, fabrication and/or layout drawings showing the layout plans showing dimensions, elevations, and details showing connections, installation, rough-in locations, etc.

(2) For product technical data, submit acknowledgement that products submitted meet requirements of standards referenced, manufacturer's installation instructions, and chemical-resistance data.

(e) Instantaneous Domestic Water Heaters

(1) For shop drawings, submit product technical data including dimension drawings of water heaters indicating piping, components and required connections, manufacturer's data sheets and installation instructions, and wiring diagrams, electrical characteristics, minimum water pressure requirements and connection types.

(2) For contract closeout information, submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

(f) Oil Water Separator

(1) For shop drawings, submit shop drawings for oil/water separators shall show principal dimensions and location of all fittings.

(2) Submit three complete sets of installation, operation, and maintenance instructions with separator. Quality control, inspection procedures, and reports shall be considered part of the submittal package.

XX. MATERIALS

(a) TOILETS

Toilets shall be as scheduled on Contract Drawings. Manufacturer substitutions can be made for an approved equal. See XX. Submittals section Plumbing Fixtures and Equipment for submittal process.

(b) SINKS

Sinks shall be as scheduled on Contract Drawings. Manufacturer substitutions can be made for an approved equal. See XX. Submittals section Plumbing Fixtures and Equipment for submittal process.

(c) WATER HEATERS

Water heaters shall be as scheduled on Contract Drawings. Manufacturer substitutions can be made for an approved equal. See XX. Submittals section Plumbing Fixtures and Equipment for submittal process.

(d) SUMP PUMPS

Sump pumps shall be as scheduled on Contract Drawings. Manufacturer substitutions can be made for an approved equal. See XX. Submittals section Plumbing Fixtures and Equipment for submittal process.

(e) OIL/WATER SEPARATORS

Oil/Water separators shall be Highland Tank Model R-HTC-600 UL-SU2215 Aboveground Parallel Corrugated Plate Gravity Displacement Oil/Water Separator. Manufacturer substitutions can be made for an approved equal.

Oil/Water separator shall be furnished with oil level alarm system. Oil/Water separator shall be 9’0” long X 3’0” wide X 3”0” high, having a total volume of 600 gallons to comply with Spill Prevention Control and Countermeasures (SPCC) plan requirements at the facility. The sizing of this oil/water separator is consistent with industry protocols for complying with the minimum federal spill and discharge regulations therefore a separator of smaller volume is not permissible.

Sump Separator shall be the standard patented product of a steel tank manufacturer regularly engaged in the production of such equipment.

Separator shall be rectangular, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions.

Separator shall have an oil storage capacity equal to about 30% of the total vessel volume and an emergency oil spill capacity equal to 60% of the total vessel volume.

Separator shall be standard prefabricated, inclined parallel-corrugated plate, gravity displacement type unit with removable top cover(s).

The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:

An influent connection 4 inch, flanged. An internal influent nozzle at the inlet end of the separator. Nozzle discharge to be located at the furthest diagonal point from the effluent discharge opening.

A velocity head diffusion baffle at the inlet to reduce horizontal velocity and flow turbulence, distribute the flow equally over the separators cross sectional area, direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume, completely isolate all inlet turbulence from the separation chamber.

A sediment chamber to disperse flow and collect oily solids and sediments.

A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.

An Oil/Water Separation Chamber containing a removable, inclined parallel corrugated plate coalescer, with removable corrugated plates sloped downward toward the sediment chamber, to:

(1) Shorten the vertical distance than an oil globule has to rise for effective removal. Minimum plate gap to be 3/4".

(2) Enhance coalescence by generating a slight sinusoidal (wave like) flow pattern thereby causing smaller, slow rising, oil globules to coalesce together on the undersides of the plates forming larger, rapidly rising sheets of oil.

(3) Direct the paths of the separated oil to the surface of the separator.

A sectionalized removable "Petro-Screen" polypropylene impingement coalescer designed to intercept oil globules of less than 20 microns in diameter. Heavy, one-piece impingement coalescers are not permissible.

An oil dam with two (2) effluent transfer pipes.

An effluent clearwell.

An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the effluent clearwell only.

An effluent connection 4 inch, flanged.

Fittings for vent, interface/level sensor, waste oil pump-out, sampling, drain, and gauge.

Removable vapor-tight top cover(s), gasket, and bolts with large wing nuts for easy access.

Lifting lugs at balancing points for handling and installation.

Identification plates: Plates to be affixed in prominent location and be durable and legible throughout equipment life.

Internal surfaces commercial grit blast and coated with heavy duty Polyurethane.

External surfaces commercial grit blast and coated with heavy duty Polyurethane.

Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi hi oil level (audible and visual) of oil storage in the oil/water separator will be provided. A silence control shall be provided for the audible alarms. Level sensor(s) to be intrinsically safe. Level sensor floats to be made of stainless steel. The control panel shall be NEMA 4. Power to the control panel is to be 120V, 1 phase.

(f) PIPE AND PIPE FITTINGS: PLUMBING SYSTEMS

Acceptable couplings manufacturers: Dresser, Rockwell, or approved equal.

Acceptable mechanical couplings manufacturers: Vitaulic, Tyler, or approved equal.

Acceptable expansion fittings manufacturers: Flexicraft, Mason, Metraflex, or approved equal.

All exterior piping shall be heat traced with 2 IN of insulation and sheathing.

Copper pipe shall be either type K, L, or M per ASTM B88. Utilize only annealed (soft) type tubing where flared joints are used and drawn temper (hard) type tubing where soldered or brazed joints are used. Provide unions, valves and equipment. Unions shall be Class 150, bronze.

Fittings, per System Type:

(1) Cast copper or bronze (pressure): Per ASTM B16.18.

(2) Wrought copper or bronze (pressure, solder): ASTM B16.22.

(3) Cast copper or bronze (DWV): Per ASTM B16.23.

(4) Wrought copper or bronze (pressure, flared): Per ASTM B16.26.

Joints shall be flared or soldered or brazed. If the joints are soldered or brazed:

(1) Above ground below 180 DegF: ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux.

(2) Above ground 180 DegF and above: use brazing alloy with melting temperature above 1000 DegF and suitable flux.

(3) Buried: Silver solder per AWS A5.8M/A5.8.

Steel pipe shall be schedule 10, 40, or 80 and be black or hot dipped galvanized per ASTM A53.

Fittings: Per System Type:

(1) Malleable iron: Per ASTM B16.3.

(2) Forged Steel: Per ASTM A234.

(3) Cast Iron: Per ASTM A126.

Joints shall be threaded with unions, valves and equipment, flanged with rubber gaskets, or socket or butt welded. Unions shall be either Class 150, 250, or 350, depending on the system. Unions shall be constructed malleable iron and threaded.

Ductile Iron shall be pressure class per system type per AWWA C150, or AWWA C151. Fittings shall be ductile or gray iron per AWWA C110, standard thickness.

Joints, per System Type:

(1) Flanged with rubber gasket.

(2) Grooved coupling per AWWA C606.ckness.

Cast Iron Soil Pipe shall be service weight, ASTM A74.

Fittings, per System Type:

(1) Hubless per CISPI 310.

(2) Hub and spigot per ASTM A74.

Joints, per System Type:

(1) Neoprene gaskets and stainless steel clamp and shield assemblies per CISPI 310.

(2) Rubber gasket joint devices per ASTM C564.

(3) Lead and oakum per ASTM C564.

(4) Coatings: Bituminous.

Unions for copper pipes 2 IN and smaller shall be copper ground joint unions. Unions for copper pipes larger than 2IN shall be brass flanged unions.

Ductile iron pipe flanged couplings shall be steel sleeve flange and followers with grade 30 rubber gasket. Flanges to meet standards of adjoining flanges. Ductile iron pope compression sleeve couplings shall be steel sleeve and followers. Flanges to meet standards of adjoining flanges. Provide field coating for buried couplings per AWWA C203. Ductile iron pipe mechanical couplings shall be in accordance with AWWA C606.

For steel heating lines, provide braided, flanged stainless steel connectors for connection to equipment. Provide pump connectors with stainless steel construction, rubber filled bellows and flanged end connections.

Natural Gas Equipment Isolator shall be 316L stainless steel, T-321 stainless steel braid with connections compatible with joints in piping system.

Bellows-type Expansion Fitting shall be single sphere style stainless steel construction with a pressure rating of 125 psig, temperature rating of 250 DegF, maximum compression of 3 IN and maximum extension 1/4 IN. Joints shall be as specified for individual piping system.

(g) GENERAL-DUTY VALVES FOR PLUMBING PIPING

Acceptable valve manufacturers: Apollo, Crane, DeZurik, Milwaukee Valve Co., Nibco, Inc, Stockham, or approved equal.

Gate valves 2 IN and smaller shall be MSS SP 80, Class 150 bronze body, bronze trim, union bonnet, rising stem, hand-wheel, inside screw, solid wedge disc, alloy seat rings, threaded ends.

Gate valves 2-1/2 IN and larger shall be MSS SP 70, Class 150, cast iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 IN and larger mounted over 8 FT above floor.

Ball valves 2 IN and smaller shall be MSS SP 110, 400 psiWOG, two piece bronze body, chrome plated brass ball, full port, teflon seats, blow-out proof stem, threaded ends with union, lever handle with balancing stops.

Ball valves 2 IN and smaller shall be MSS SP 110, Class 150, bronze, two piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, threaded ends with union, lever handle with balancing stops.

Butterfly valves 2-1/2 IN and larger shall be MSS SP 67, Class 150. The body shall be cast or ductile iron, grooved ends, stainless steel stem, extended neck. Disc shall be nickel-plated ductile iron. Seat shall be resilient replaceable neoprene Viton. Handle and operator shall be 10 position lever handle.

Horizontal Swing Check Valves 2 IN and smaller shall be MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc, threaded ends.

Horizontal Swing Check Valves 2-1/2 IN and larger shall be MSS SP 71, Class 150, cast iron body, bolted cap, bronze or cast iron disc, flanged ends, outside lever and spring.

Spring Loaded Check Valves 2 IN and smaller shall be MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, threaded ends.

Spring Loaded Check Valves 2-1/2 IN and larger shall be MSS SP 71, Class 150, globe style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

(h) HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

Acceptable pipe hangers and supports manufacturers: Anvil International, PHD Manufacturing, Cooper B-Line, Erico International, Tolco Inc., or approved equal.

Acceptable insert manufacturers: Hilti, Simpson, Tolco, Cooper B-Line, Grinnell, approved equal.

Acceptable mechanical sleeve seals manufacturers: GPT Industries, Proco Products, Inc., Flexicraft Industries, approved equal.

Acceptable formed steel channel manufacturers: Unistrut Corporation, Cooper B-Line Erico, or approved equal.

Acceptable firestopping manufacturers: Dow Corning, 3M Company, US Gypsum Co., or approved equal.

Plumbing Piping – DWV shall conform to ASME B31.9.

Hangers for pipe sizes 1/2 to 1-1/2 inch shall be malleable iron, adjustable swivel, split ring.

Hangers for pipe sizes 2 inches and larger shall be carbon steel, adjustable, clevis.

Multiple or trapeze hangers shall be steel channels with welded spacers and hanger rods.

Wall support for pipe sizes 3 inches and smaller shall be cast iron hook.

Wall support for pipe sizes 4 inches and larger shall be welded steel bracket and wrought steel clamp.

Vertical support shall be steel riser clamps.

Floor support shall be comprised of cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

Copper Pipe Support shall be comprised of copper-plated, carbon-steel adjustable, ring.

Plumbing Piping – Water shall conform to ASME B31.9.

Hangers for pipe sizes 1/2 to 1-1/2 inch shall be malleable iron, adjustable swivel, split ring.

Hangers for cold pipe sizes 2 inches and larger shall be carbon steel, adjustable, clevis.

Hangers for hot pipe sizes 2 to 4 inches shall be carbon steel, adjustable, clevis.

Hangers for hot pipe sizes 6 inches and larger shall be adjustable steel yoke, cast iron roll, double hanger.

Multiple or trapeze hangers shall be steel channels with welded spacers and hanger rods.

Multiple or trapeze hangers for hot pipe sizes 6 inches and larger shall be steel channels with welded spacers and hanger rods, cast iron roll.

Wall Support for Pipe Sizes 3 inches and Smaller shall be cast iron hook.

Wall support for pipe sizes 4 inches and larger shall be welded steel bracket and wrought steel clamp.

Wall support for hot pipe sizes 6 inches and larger shall be welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

Vertical supports shall be steel riser clamps.

Floor support for cold pipe shall be cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

Floor support for hot pipe sizes 4 inches and smaller shall be cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

Floor support for hot pipe sizes 6 inches and larger shall be adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

Copper pipe support shall be copper-plated, carbon-steel ring.

Hanger rods shall be mild steel threaded both ends, threaded on one end, or continuous threaded and electro-galvanized or cadmium plated after threads are cut.

Inserts shall be malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

Flashing

Metal flashing shall be 26 gage thick galvanized steel.

Metal counterflashing shall be 22 gage thick galvanized steel.

Lead flashing waterproofing shall be 5 lb./sq. ft sheet lead, soundproofing shall be 1 lb./sq. ft sheet lead.

Flexible flashing shall be 47 mil thick sheet butyl; compatible with roofing.

Caps shall be steel, 22 gage minimum; 16 gage at fire resistant elements.

Sleeves

Sleeves for pipes through non-fire rated floors shall be 18 gage thick galvanized steel with acrylic sealant.

Sleeves for pipes through non-fire rated beams, walls, footings, and potentially wet floors shall be steel pipe or 18 gage thick galvanized steel with acrylic sealant.

Firestopping can be comprised of different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application. All fire stopping colors shall be as selected from manufacturer's full range of colors.

Silicone firestopping elastomeric firestopping shall be single component silicone elastomeric compound and compatible silicone sealant.

Foam firestopping compounds shall be single component foam compound.

Formulated firestopping compound of incombustible fibers shall be formulated compound mixed with incombustible non-asbestos fibers.

Fiber stuffing and sealant firestopping shall be composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.

Mechanical firestopping device with fillers shall be mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.

Intumescent firestopping shall be intumescent putty compound which expands on exposure to surface heat gain.

Firestop pillows shall be formed mineral fiber pillows.

(i) PLUMBING FIXTURES AND EQUIPMENT

Acceptable drains, roof drains, carriers and shock absorbers manufacturers: Wade, Josam, Zurn, Smith, or approved equal.

Acceptable trap primer manufacturers: Precision Plumbing Products, or approved equal.

Floor drains (FD) shall be bottom outlet, clamping seepage flange, seepage openings. Size as shown on drawings. Cast iron body. For FD-1 (unfinished area) sediment bucket, bucket shall support grate: Wade W-1200-TD. For FD-2 (finished area) adjustable satin nickel bronze strainer: Wade W-1100. For FD-3 (finished area with tile floor) adjustable satin nickel bronze square strainer: Wade W-1100-G.

Traps for floor and equipment drains shall be same material and coating as the piping system. 3 IN minimum seal.

Fixture drains shall be 2 IN minimum seal, cast brass, chrome plated. Size as required.

Ventilation housing drains shall be extra-deep seal sufficient to maintain seal against static pressure maintained in fan housing.

Trap Primers shall be all brass construction. 1/2 IN male NPT inlet. 1/2 IN female NPT outlet. Stainless steel debris screen. Brass piston. Trap primer distribution shall be up to 4 traps, 2 IN copper body, brass outlet.

Cleanouts (CO)

Cleanouts for cast iron pipe shall be tapped extra heavy cast iron ferrule. Calked into cast iron fittings. Extra heavy brass neoprene seal screw plug with solid hexagonal nut.

Cleanouts for steel pipe shall be extra heavy brass screw plug in drainage fittings.

Access housing with adjustable anchor flange and secured scoriated cast: Wade W-3800-MF. Cleanouts turning out through walls and up through floor shall be made by long sweep ells or "y" and 1/8 bends with plugs and face or deck plates to conform to architectural finish in room. Where definite finish is not indicated, wall plates shall be chrome-plated cast-brass and floor plates polished brass.

Provide cleanouts of same size as pipe up to 4 IN and not less than 4 IN for larger pipes. Close access openings for concealed cleanouts with flush floor or flush wall cover plates or flush ceiling access panels. Provide wall plates with chrome plated cast-brass round cleanout cover with flanged ring. Provide screws which match cover plate material.

Cleanouts installed in floor with a resilient tile finish: Wade W-6000-TS. Cleanouts installed in floor with ceramic tile, concrete, or Terrazzo finish: Wade W-6000-U. Cleanouts installed in finished rooms flush with wall: Wade W-8480-S stainless steel. Cleanouts installed in completely accessible pipe chases or where piping is exposed do not require special covers. Cleanouts in floating floors: Wade 8300-MF housing and cover with 8550 cleanout body and closure plug or Smith 4250 or 4260 Series housing and cover with 4280 or 4290 Series cleanout body and closure plug.

Trench sections shall be pre-cast fiberglass modular channel sections. Nominal dimensions shall be 8 IN interior width, 1.0 percent slope built into the bottom, 6 FT length. Vertical side walls and a radiused bottom. 2 IN bolted lap joint. End caps shall be same material as channel, design that allows the caps to interlock with channel sections and either close off the end of the channel or provide for drain pipe connection.

XX. CONSTRUCTION

(a) TOILET

Toilets shall be installed and furnished vertically per manufacturer’s instructions and recommendations. See Contract Drawings for locations.

(b) SINKS

Sinks shall be installed and furnished vertically per manufacturer’s instructions and recommendations. See Contract Drawings for locations.

(c) WATER HEATERS

Water heaters shall be installed and furnished vertically per manufacturer’s instructions and recommendations. See Contract Drawings for locations.

(d) SUMP PUMPS

Sump pumps shall be installed and furnished vertically per manufacturer's instructions and recommendations. See Contract Drawings for locations.

(e) PIPE AND PIPE FITTINGS: PLUMBING SYSTEMS

(1) Preparation: Ream pipe and tube ends. Remove all burrs, scale and dirt on inside and outside before assembly. Prepare piping connections to equipment with flanges and unions. Deep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

(2) Exterior Buried Piping Installation: Unless otherwise shown on the Drawings, provide a minimum of 4 FT and maximum of 8 FT earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals as shown on Drawings. When entering or leaving structures with buried mechanical joint piping, install joint within 2 FT of point where pipe enters or leaves structure. Install second joint not more than 6 FT or less than 4 FT from first joint.

Install expansion devices as necessary to allow expansion and contraction movement. Install underground hazard warning tape. Install insulating components where dissimilar metals are joined together.

Excavate and backfill trench in accordance with Drawings. Clean each pipe length thoroughly and inspect for compliance to specifications. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined. Except for first two (2) joints, before making final connections of joints, install two (2) full sections of pipe with earth tamped along side of pipe or final with bedding material placed. Lay pipe in only suitable weather with good trench conditions. Never lay pipe in water except where approved by Engineer. Seal open end of line with watertight plug if pipe laying stopped. Remove water in trench before removal of plug.

Lay piping on route lines shown on Drawings. Deflect from straight alignments or grades by vertical or horizontal curves or offsets. Observe maximum deflection values stated in manufacturer's written literature. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.

Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall. Concrete blocks shall not cover pipe joints. Provide bearing area of concrete in accordance with drawing detail.

(3) Interior and Exposed Exterior Piping Installation: Install piping in vertical and horizontal alignment as shown on Drawings. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for the following: Expansion and contraction. Operation and access to equipment, doors, windows, hoists, moving equipment. Headroom and walking space for working areas and aisles. System drainage and air removal. Provide insulating components where dissimilar metals are joined together.

Enter and exit through structure walls, floor and ceilings using penetrations and seals as shown on the Drawings. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

Use methods of piping support as shown on Drawings and as required. Size pipe supports with consideration to specific gravity of liquid being piped. Locate and size sleeves and castings required for piping system. Arrange for chases, recesses, inserts or anchors at proper elevation and location. Use reducing fittings throughout piping systems. Bushings will not be allowed unless specifically approved.

Provide drip pans and piping at equipment where condensation may occur. Avoid piping over electrical components such as motor control centers, panelboards, etc. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment. Hard pipe drainage to nearest floor drain.

If system is not otherwise specified, provide stainless steel tubing. Size to handle application with 3/4 IN being minimum size provided.

Install in position which will permit valve or equipment to be removed without dismantling adjacent piping. Mechanical type couplings may serve as unions. Additional flange unions are not required at flanged connections.

Install expansion devices as necessary to allow expansion/contraction movement. Provide full face gaskets on all systems.

Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or as integral part of equipment. For each water supply piping connection to equipment, furnish and install union and gate or angle valve. Provide wheel handle stop valve at each laboratory sink

water supply. Minimum size: 1/2 IN. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system. Size trap as required by IPC. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed.

(4) Connections with Existing Pipe: Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation. Undertake connections in fashion which will disturb system as little as possible. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

(5) Access Provisions: Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping and piping appurtenances requiring service. Size of access panels to allow inspection and removal of items served, minimum 10 x 14 IN size. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type. Provide with key locks, keyed alike, in public use areas. Furnish panels with prime coat of paint. Style and type as required for material in which door installed. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

(6) Cathodic Protection: Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal. Make all connections from wire or cable by Thermit Cad welding accomplished by operators experienced in this process. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50 percent of the straight line length. After cad welding, coat all exposed metallic surfaces with hot applied tape.

(7) Installation – Pipe Specific

Soil and Waste Piping Installation: Install horizontal soil or waste lines less than 4 IN diameter with a slope of not less than 1/4 IN/FT or 2 percent toward the point of disposal. Install 4 IN and larger piping at 1/8 IN/FT. Install as close to construction as possible to maintain maximum head room. Make changes of direction with 1/8 bends and junctions with wye fittings. Use short wye fittings in vertical pipe only. Install handhole test tee at base of each stack. Install

cleanouts at dead ends, at changes of direction and at 50 FT intervals on horizontal runs. Where cleanouts occur in concealed spaces, provide with extensions to floors above or to walls as required.

Install piping true to grade and alignment. Begin at the system low point. Locate vertical extensions of underground piping below partition walls for concealment in wall. In locations where hubs are wider than partition, set hubs 1 IN below final floor. Install concealed, in finished structures such as administration and office facilities and at locations shown on Drawings. For hub and spigot joints, install hub facing flow.

Vent Piping Installation: Run vent stack parallel to each soil or waste stack to receive branch vents from fixtures. Originate each vent stack from soil or waste pipe at its base. Where possible, combine soil, waste or vent stacks before passing through roof so as to minimize roof openings. Offset pipes running close to exterior walls away from such walls before passing through roof to permit proper flashing. Provide pipes passing through roofs with cast iron increaser’s minimum of 12 IN below roof one size larger than pipe but in no case less than 4 IN. Terminate each vent with approved frost proof jacket. Carry vent stacks 4 IN and larger full size through roof. Extend vent stacks at least 12 IN above roofing. Pipe vents from pressure regulating devices in compliance with local codes. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.

(8) Joining: Install products in accordance with manufacturer's instructions.

Joining Methods - Flanges:

Facing method:

Insert slip-on flange on pipe. Assure maximum tolerances for flange faces, from normal with respect to axis of pipe, is 0.005 IN per foot of flange diameter. Test flanges after welding to pipe for true to face condition and reface, if necessary, to bring to specified tolerance.

Joining method:

Leave 1/8 to 3/8 IN of flange bolts projecting beyond face of nut after tightening. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, equipment, tank, and other interconnecting piping systems. When bolting flange joints, exercise extreme care to assure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or cause unnecessary stress, bending or torsional strains being applied to cast flanges or flanged fittings. Allow one (1) flange free movement in any direction while bolts are being tightened. Do not assemble adjoining flexible coupled, mechanical coupled or welded joints until flanged joints in piping system have been tightened. Gradually tighten flange

bolts uniformly to permit even gasket compression. Do not overstress bolts to compensate for poor installation.

Joining Method - Welded Joints:

Perform welding in accordance with AWWA C206 and this Section. For flange attachment perform in accordance with AWWA C207. Have each welding operator affix an assigned symbol to all his welds. Mark each longitudinal joint at the extent of each operator's welding. Mark each circumferential joint, nozzle, or other weld into places 180 degrees apart. Welding for all process piping shall conform to ASME B31.3. Welding of utility piping 125 psi and less shall be welded per ASME B31.9. Utility piping above 125 psi shall conform to ASME B31.1. Provide caps, tees, elbows, reducers, etc., manufactured for welded applications. Weldolets may be used for 5 IN and larger pipe provided all slag is removed from inside the pipe. Weld-in nozzles may be used for branch connections to mains and where approved by Engineer. Use all long radius welding elbows for expansion loops and bends. Use long radius reducing welding elbows 90 degree bends and size changes are required.

Joining Method - Couplings:

Compression sleeve: Install coupling to allow space of not less than 1/4 IN but not more than 1 IN. Provide harnessed joint. Use joint harness arrangements detailed in AWWA M11. Design harness assembly with adequate number of tie rods for test pressures indicated in Section 40 05 00 and allow for expansion of pipe. Provide ends to be joined or fitted with compression sleeve couplings of the plain end type. Grind smooth welds the length of one (1) coupling on either side of joint to be fitted with any coupling. Assure that outside diameter and out-of-round tolerances are within limits required by coupling manufacturer.

Mechanical coupling: Arrange piping so that pipe ends are in full contact. Groove and shoulder ends of piping in accordance with manufacturer's recommendations. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

Joining Method - Threaded and Coupled (T/C):

Provide T/C end conditions that meet ASME B1.2 requirements. Furnish pipe with factory-made T/C ends. Field cut additional threads full and clean with sharp dies. Leave not more than three (3) pipe threads exposed at each branch connection. Ream ends of pipe after threading and before assembly to remove burrs. Use Teflon thread tape on male thread in mating joints.

(9) Field Quality Control: Test piping systems as follows: Test exposed, non-insulated piping systems upon completion of system. Test exposed, insulated piping systems upon completion of system but prior to application of insulation. Test concealed interior piping systems

prior to concealment and, if system is insulated, prior to application of insulation. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.

Isolate equipment which may be damaged by the specified pressure test conditions. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates. Select each gage so that the specified test pressure falls within the upper half of the gage's range. Notify the Engineer 24 HRS prior to each test. Completely assemble and test new piping systems prior to connection to existing pipe systems. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

For water systems, waste and drain systems, the testing medium shall be water.

The testing pressure for pumped systems shall be no less than 125 percent of pump head plus the system fill pressure. Test pressurized systems at 150 psig.

Natural gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5 percent of the specified test pressure throughout the duration of the test.

Hydrostatic pressure testing methodology: All joints, including welds, are to be left exposed for examination during the test. Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water. Provide temporary restraints for expansion joints for additional pressure load under test. Isolate equipment in piping system with rated pressure lower than pipe test pressure. Do not paint or insulate exposed piping until successful performance of pressure test.

Soil, waste, drain and vent systems shall test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks. Eliminate leaks before proceeding with work or concealing piping. Minimum test heights shall be 10 FT above highest stack inlet.

Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

(10) Cleaning, Disinfection, and Purging: Clean interior of piping systems thoroughly before installing. Maintain pipe in clean condition

during installation. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner. Clean chlorine piping in accordance with CI Pamphlet 6.

(f) GENERAL-DUTY VALVES FOR PLUMBING PIPING

(1) Installation: Install valves with stems upright or horizontal, not inverted. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe. Install 3/4 IN gate valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Install valves with clearance for installation of insulation and allowing access. Provide access where valves and fittings are not accessible.

(2) Valve Applications: Install ball or gate valves for drain service at locations indicated on Drawings in accordance with this Section. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers. Install ball valves for throttling, bypass, or manual flow control services. Install spring loaded check valves on discharge of water pumps. Install lever and spring check valves on discharge of pumps in pumped sanitary and pumped storm water piping. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment. Install gate valves in domestic water systems for shut-off service. Install ball valves in domestic water systems for throttling service.

(g) HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

(1) Examination and Preparation: Verify openings are ready to receive sleeves. Verify openings are ready to receive firestopping. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material. Remove incompatible materials affecting bond. Obtain permission from Architect/Engineer before using powder-actuated anchors. Do not drill or cut structural members.

(2) Installation – Inserts: Install inserts for placement in concrete forms. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger. Where concrete slabs form finished ceiling, locate inserts flush with slab surface. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

(3) Installation – Pipe Hangers and Supports: Install in accordance with {{ASME B31.1} {ASME B31.5} {ASME 31.9}} {ASTM F708} {MSS SP 58} {MSS SP 69} {MSS SP 89}. Support horizontal piping as scheduled. Install hangers with minimum 1/2 inch space between finished covering and adjacent work. Place hangers within 12 inches of each horizontal elbow. Use hangers with 1-1/2 inch minimum vertical adjustment. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers. Support vertical piping at every {other} floor. Support vertical cast iron pipe at each floor at hub. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers. Support riser piping independently of connected horizontal piping. Provide copper plated hangers and supports for copper piping. Design hangers for pipe movement without disengagement of supported pipe. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed. Provide clearance in hangers and from structure and other equipment for installation of insulation.

(4) Installation – Flashing: Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and seal, metal counter-flash, and seal. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device. Seal floor drains watertight to adjacent materials. Adjust storm collars tight to pipe with bolts; seal around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

(5) Installation – Sleeves: Exterior watertight entries: Seal with mechanical sleeve seals. Set sleeves in position in forms. Provide reinforcing around sleeves. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping. Extend sleeves through floors 1 IN above finished floor level. Seal sleeves. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and sealant. Provide close fitting metal collar or escutcheon covers at both sides of penetration. Install stainless steel escutcheons at finished surfaces.

(6) Installation – Firestopping: Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

(h) PLUMBING FIXTURES AND EQUIPMENT

(1) Installation: Do not install any plumbing components that will provide a cross connection between potable and non-potable or drainage systems.

Install fixtures at locations indicated on Drawings and in compliance with local Codes. Connect plumbing supply, drain and vent line sizes as shown on Drawings. Set proper grounds to form secure base for each fixture and rigid setting. Install fixtures except water closets with water supply above rim. Seal fixture joints abutting walls and floors with silicone sealant. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified. Install emergency fixtures in accordance with ANSI Z358.1.

Install drains at locations indicated on Drawings and in compliance with local Codes. In quarry tile floors: 24 x 24 IN 6 LB lead sheet clamped to drain. Set 1-1/2 IN above structural slab for mortar set and 1/2 IN for thin set.

In uncovered concrete slabs install at the low points of surface areas to be drained or as indicated. Set tops of drains flush with the finished floor. Install drain flashing collar or a flange so that no leakage occurs between the drain and the adjoining surfaces. Maintain the integrity of waterproof membranes, where penetrated.

Install trench drains in accordance with manufacturer's instructions and approved Shop Drawings. Install trench sections with the top edges level and straight at elevations indicated. Support channel sections in place while concrete is placed under and around sections as indicated.

Install cleanouts above floor in each vertical riser that connects to horizontal branch below floor. At test tee to receive proper test plugs in each vertical riser at least every other floor. Install as required by local Code.

Test piping and fixtures for leaks.

(i) INSTANTANEOUS DOMESTIC WATER HEATERS

(1) Installation: All installation shall be in accordance with IPC, International Plumbing Code, 70, National Electrical Code, and 54, National Fuel Gas Code.

All installation shall be in accordance with manufacturer's manufacturer's installation instructions. Furnish all supports required by the equipment included in this Contract in accordance with the manufacturer's published instructions.

Furnish and install all necessary valves, strainers, unions, etc. to facilitate proper functioning and servicing of equipment. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment.

Install heater in a vertical position as close as possible to the hot water outlets with a minimum of 6 IN" of clearance on all sides for servicing or as shown on the Contract Drawings. Coordinate location of unit to avoid conflicts with piping, electrical outlets, casework and handicap access to plumbing fixture. Do not install unit where it would routinely be splashed with water.

Install a line size shutoff valve in cold water inlet close to each heater. Flush water supply line to remove all air, scale and dirt prior to connecting heater. Take precautions to prevent heat generated by soldering procedures from being transmitted to heater components. Verify and insure that flow control outlets on faucets being served by water heater correspond with the flow requirements of the installed heater.

Coordinate with Electrical Contractor for power and wiring required. Verify that electrical power is connected to a properly grounded dedicated branch circuit of proper voltage rating and equipped with ground fault interrupter. Each electric heater shall be provided with an independent circuit. Insure that the correct wire and circuit breaker sizes are provided. Provide acid neutralizer on condensate drainage of condensing heaters.

When all plumbing installation is completed, check for leaks and take corrective action before proceeding. Flow hot water until temperature has stabilized. Verify that the water meets scheduled temperature at all outlets. Clean heater water inlet line strainer prior to final inspection of installation.

XX. METHOD OF MEASUREMENT Contract Drawings are conceptual only. The Contractor is responsible for all quantities.

XX. MEASUREMENT AND PAYMENT

(1) METHOD OF MEASUREMENT

(a) Payment shall be made on a lump sum basis.

(2) BASIS OF PAYMENT

(a) This item will be measured as a lump sum subject to the payment schedule below:

(1) Shop drawing approval: 5 percent (of total bid item).

(2) Purchase of raw material including forgings: (Payment amount for purchase of raw material shall be the amount supported by a copy of a receipted bill for same.)

(3) Fabrication/shop testing/storage (onsite or at fabricator): (75 percent minus % paid for raw material.)

(4) Installation: 15 percent.

(5) Acceptance Testing: 5 percent.

(b) Payment will be made under:

Pay Item	**Pay Unit**
900.645 Special Provision (Plumbing)	Lump Sum

MACHINERY GENERAL REQUIREMENTS

1. DESCRIPTION. This Section specifies the general requirements for the fabrication, furnishing and installation of the mechanical systems for the erection of the North Hero Grand Isle Bascule Bridge.

2. SCOPE OF WORK. The following is a list of work items to be paid for under this specification:

(a) Provide and install of the Hydraulic Power Units
(b) Provide and install of the Hydraulic Cylinder Assemblies
(c) Provide and install of Hydraulic Hoses, Tubes, Ball Valves, Clamps, and Fittings
(d) Provide and install of the Trunnion Assemblies
(e) Provide and install of the Live Load Shoes
(f) Provide and install of the Span Locks
(g) Provide and install of the Control Instruments and the Instrument Drive Components

Installation work shall consist of furnishing all labor, equipment and materials (including spare parts and Operation and Maintenance Manuals) as shown on the Plans and specified herein. The work also includes installing, adjusting, painting, lubricating and testing to place in correct, satisfactory operating condition the new operating and span lock machinery and hydraulics for the double-leaf bascule bridge.

This specification also specifies general requirements for the fabrication and procurement of machinery. For reference purposes, the payment for the fabrication and procurement of the machinery shall be as follows:

(a) HYDRAULIC POWER UNITS
(b) HYDRAULIC CYLINDERS
(c) HYDRAULIC POWER UNITS
(d) TRUNNION ASSEMBLIES
(e) LIVE LOAD SHOES
(f) SPAN LOCKS
(g) ELECTRICAL GENERAL REQUIREMENTS

The work to furnishing and install new span control equipment shall be furnished under 900.645. The span control equipment shall include all apparatus for controlling the operation of the bascule span, and all conduits, boxes, wiring, cables and other equipment required to extend the necessary circuits from the control house to the respective components.

3. REFERENCES. The following is a listing of the publications referenced in this Section:

(a) American Association of State Highway and Transportation Officials(AASHTO)
(b) American Gear Manufacturers Association (AGMA)
(c) American Iron and Steel Institute (AISI)
(d) American National Standards Institute (ANSI)
(e) American Society for Testing and Materials (ASTM)
(f) American Welding Society (AWS)
(g) Anti-Friction Bearing Manufacturers Association (AFBMA)
(h) National Lubricating Grease Institute (NLGI)
(i) Society of Automotive Engineers (SAE)
(j) Steel Structures Painting Council (SSPC)
(k) American Society of Mechanical Engineers (ASME)
(l) Deutsches Institut fur Normung (DIN)
(m) International Organization for Standardization (ISO)
(n) Joint Industrial Council (JIC)
(o) National Fluid Power Association (NFPA)
(p) National Electrical Manufacturers Association (NEMA)
(q) Occupational Safety and Health Administration (OSHA)

4. QUALITY ASSURANCE.

(a) Qualifications, Personnel and Facilities. Products used in the work under this specification shall be produced by manufacturers regularly engaged in the manufacture of the specified products.

For the fabrication, installation, cleaning, aligning, testing and all other work required by this specification, the Contractor shall use adequate numbers of skilled, trained and experienced mechanics and millwrights who are thoroughly familiar with the requirements and methods specified for the proper execution of movable bridge work. The Contractor shall provide supervisory personnel with a minimum of two heavy movable structure jobs with experience in the installation of machinery. The entire installation of the machinery shall be directly supervised by a representative of the machinery manufacturer and supplier having at least ten years of prior similar experience.

The Contractor shall provide adequate plant and all necessary tools and instruments required for the proper performance of the personnel engaged in the execution of the specified work

(b) Hydraulic Work Qualifications. Hydraulic system fabrication, installation and startup shall be performed by a qualified Hydraulic Vendor. The Hydraulic Vendor shall have had at least ten years experience in the design, fabrication, and installation of hydraulic systems of this size and type.

Piping/tubing and flushing shall be done under the direction of a certified fluid power technician with proper experience on similar systems.

At least one member of the installation crew shall be a certified fluid power technician. His certification number and experience shall be submitted for review and approval.

Installation and adjustment of hydraulic components shall be by personnel with demonstrated skill in this type of work.

(c) Hydraulic System Supplier. As part of this item, the Contractor shall be required to have the Hydraulic System Supplier/Vendor be present on the site during system installation and train the maintenance personnel.

(d) Rules, Regulations and Ordinances. Work shall comply with all applicable Local rules, regulations and ordinances.

In the event of a conflict between these Specifications and the above-mentioned codes, standards, rules, regulations and ordinances, the most stringent requirement shall apply.

(e) Measurements and Verification. Dimensions indicated on the Contract Drawings are nominal and are intended for guidance only. All variations from the nominal dimensions on the Contract Drawings shall be noted on the shop drawings.

(f) Substitutions. The terms "approved equal", "of equal quality" and "or equal" which appear on the Contract Drawings and in these Specifications are intended to allow the Contractor to substitute other manufacturers and model numbers of products of equal quality and rating for those specified.

Prior to the Contractor's ordering of any substitute product, the Engineer's approval of the equivalence of the substitute product shall be obtained in writing. The acceptance of the substitute products is at the sole discretion of the Engineer who will establish the basis for equivalence and will review the quality of the materials and products described in detail on the submitted shop drawings and product data.

The Engineer will review and stamp substitute material either "Approved" or "Revise and Resubmit". Upon return of a shop drawings

showing rejection, the Contractor shall resubmit the shop drawing showing the specified product. Rejection shall not in any way result in any extra cost.

Approval by the Engineer of any substitute products submitted by the Contractor shall not relieve the Contractor of responsibility for the proper operation, performance, or functioning of that product.

Where a particular product is specified by a manufacturer's name and catalog or part number in this Specification or on the Contract Drawings, it is so specified to establish quality, configuration and arrangement of parts. An equivalent product manufactured by another manufacturer may be substituted for the specified product subject to the approval of the Engineer; however, all necessary changes required by the substitution in related machinery, structural, architectural and electrical parts, shall be made by the Contractor at no additional cost.

If any departures from the Contract Drawings or these Specifications are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted as soon as practicable for approval. No such departures shall be made without approval by the Engineer.

(g) Inspection and Testing. The Contractor shall give no less than ten (10) working days notice to the Engineer of the beginning of work at foundries, forge and machine shops so that inspection may be provided if required. No materials shall be cast, forged, or machined before the Engineer has been notified where the orders have been placed.

The Contractor shall furnish all facilities for the inspection of material and workmanship in the foundries, forge and machine shops and the Inspector designated by the Engineer shall be allowed free access to necessary parts of the premises. Work done while the Inspector has been refused access or presented in a manner that prevents adequate inspection will automatically be rejected.

The Inspector shall have the authority to reject materials or workmanship, which do not fulfill the requirements of these Specifications.

Inspection at the foundries, forges and machine shops is intended as a means of facilitating the work and shall not relieve the Contractor of their responsibility in regard to imperfect material or workmanship and the necessity for replacing defective materials or workmanship which are delivered to the job site.

The Contractor shall furnish the Engineer with a copy of all orders covering work performed by subcontractors or suppliers.

Unless otherwise provided, the Contractor shall furnish without additional charge test specimens as required and all labor, testing machines, tools and equipment necessary to prepare the specimens and to make the physical tests and chemical analyses required by material specifications. A copy of all test reports and chemical analyses shall be furnished to the Engineer.

The acceptance of any material or finished parts by the Engineer shall not be a bar to their subsequent rejection if found defective. Rejected material and workmanship shall be replaced or made acceptable by the Contractor at no additional cost.

(h) Defective Materials and Workmanship. All machinery rejected during inspection and testing shall be removed from the work site and replaced without additional cost.

Delays resulting from the rejection of material, equipment or work shall not be the basis of any claim.

All defects found during the guarantee period resulting from faulty material, components, workmanship, or installation shall be corrected by the Contractor without cost. The owner reserves the right to make necessary correction with its own forces and charge the resulting costs to the Contractor.

(i) Training. The Contractor shall provide five (5) days of instruction to the owner Maintenance personnel. The instruction shall include but not be limited to the following with respect to all machinery components:

(1) Normal Maintenance
(2) Checking and Adding Lubricants
(3) Purging and Replacing Lubricants
(4) Normal Operation
(5) Emergency Operation
(6) Hydraulic Cylinder Maintenance
(7) Instrument Drive Adjustments
(8) Bearing Disassembly
(9) Coupling Disassembly

5. CODES AND STANDARDS. Work under machinery pay items shall comply with, but not be limited to, all applicable requirements of the following codes and standards and their abbreviations used in this Specification shall be as shown:

(a) American Association of State Highway and Transportation Officials (AASHTO)
(b) American Gear Manufacturers Association (AGMA)
(c) American Iron and Steel Institute (AISI)
(d) American National Standards Institute (ANSI)
(e) American Society for Testing and Materials (ASTM)
(f) American Welding Society (AWS)
(g) Anti-Friction Bearing Manufacturers Association (AFBMA)
(h) National Lubricating Grease Institute (NLGI)
(i) Society of Automotive Engineers (SAE)
(j) Steel Structures Painting Council (SSPC)
(k) American Society of Mechanical Engineers (ASME)

The work shall meet the requirements of all other codes and standards as specified elsewhere in these Specifications. Where codes and standards are mentioned for any pay item, it is intended to call particular attention to them; it is not intended that any other codes and standards shall be assumed to be omitted if not mentioned.

Particular attention is directed to the AASHTO Standard, which requires tests of the span operating machinery. Include all such tests of the span operating machinery. In some cases, for emphasis, specific requirements are repeated in these Specifications.

6. DELIVERY, STORAGE, AND HANDLING.

(a) Protection for Shipment. Machinery parts shall be cleaned of dirt, chips, grit and all other injurious materials prior to shipping and shall be given a coat of corrosion-inhibiting preservative.

Finished metal surfaces and unpainted metal surfaces that would be damaged by corrosion shall be coated as soon as practicable after finishing with a rust-inhibiting preservative. With the exception of the unfinished metal surfaces inside of gear reducers, this coating shall be removed from operation and from all surfaces prior to painting after erection.

Any interface between stainless steel or aluminum and Structural Steel shall receive an Engineer approval coat of zinc-chromate primer prior to assembly.

Shims shall be coated prior to shipment with a rust-inhibiting preservative and before erection; this coating shall be removed from the shims that are used.

Machinery parts shall be completely protected from weather, dirt and all other injurious conditions during manufacture, shipment and storage.

Shaft journals that are shipped disassembled from their bearings shall be protected during shipment and before erection by a packing of oil-soaked cloth material secured in place by burlap and covered with heavy metal thimbles or heavy timber lagging securely attached. Every precaution shall be taken to ensure that the bearing surfaces are not damaged and that all parts arrive at their destination in satisfactory condition

Assembled units shall be mounted on skids or otherwise crated for protection during handling and shipment.

(b) Guarantee and Warranties. Manufacturer's warranties or guarantees on equipment, materials or products purchased for use on the Contract which are consistent with those provided as customary trade practice, shall be obtained by the Contractor and, upon acceptance of the Contract, the Contractor shall assign to the owner, all manufacturer's warranties or guarantees on all such equipment, material or products furnished for, or installed as part of the Work.

All manufacturers shall warrant all products and associated hardware to be free of defects in material and workmanship for a minimum period of five (5) years from the date of Substantial Completion. Any defect within this period shall be repaired or replaced by the Manufacturer or Vendor, at total cost to the Manufacturer or Vendor, including labor, parts, equipment, and transportation. The Contractor shall provide letters to the suppliers with copies to the Engineer, identifying the scheduled date of Substantial Completion of the bridge and therefore the date the warranty shall begin. If the date of Substantial Completion is extended, it shall be the Contractors responsibility to extend the commencement of the warranties from the suppliers at no cost to the Buyer.

The Buyer reserves the right to receive on demand a test report from an independent laboratory certifying that the equipment furnished meets these specifications, at no cost to the Buyer.

The Buyer reserves the right to reject an entire shipment of material covered by this specification if an item or items are found to be defective within a 30-day period following receipt of materials.

The specific mechanical items which are subject to the five-year warranty are:
(a) Hydraulic cylinders
(b) HPU pumps, motors, control valves, and tank
(c) All hydraulic piping

7. SUBMITTALS. The Contractor shall submit the required assembly drawings showing all components mounted to supports, erection drawings, shop drawings, catalog cuts for machinery items, and construction procedures to the Engineer for review. In case of correction or rejection, the Contractor shall resubmit prints of assembly drawings, erection drawings, shop drawings, catalog cuts, and construction procedures until they are approved. The Contractor shall bear all costs for damages, which may result from the ordering of any materials prior to the approval of the shop drawings; and no work shall be done until the shop drawings have been approved. After approval of the shop drawings, the Contractor shall supply the Engineer prints of the approved shop drawings as may be ordered.

The Contractor shall submit the Operation and Maintenance Manuals to the Engineer for Approval. The Operation and Maintenance Manual shall include the following:

(a) As Built Drawings of all of the Mechanical Systems on 11”x17” paper
(b) As Built Drawings of all Fabricated Machinery Components on 11”x17” paper
(c) Cut Sheets of Purchased Components which shall include the manufacturer’s recommended maintenance.
(d) Maintenance procedures for all components that are described within this specification.
(e) Machinery Maintenance Schedule with, at minimum, 10 years of entries. The schedule shall be legible when printed on an 11”x17” sheet of paper and include all Machinery Components that require maintenance.
(f) The Contractor shall furnish maintenance and operation manuals giving complete instructions relative to assembly, installation, operation, adjustment, alignment, lubrication, maintenance, disassembly and carrying complete parts lists and assembly drawings for the new hydraulic system installed. The manuals, under a separate section, shall be part of a general maintenance and operation manual as specified elsewhere in these Special Provisions. Manuals shall be furnished concurrently with working drawings for review and approval by the Engineer.

Upon approval of the Operation and Maintenance Manual, the contractor shall produce four hard copies and one electronic copy of the Operation and Maintenance Manual to the owner. The hard copy shall be bound in an appropriately sized three ring "D" binder.

Upon Approval, the contractor shall supply a Machinery Maintenance Schedule to the owner which shall be printed on 11"x17" card stock.

8. HYDRAULIC SPAN DRIVE MACHINERY. The work in this section consists of furnishing and installing a permanent hydraulically operated drive system for each leaf of the bascule span.

The movable span shall be powered by a two-pump hydraulic power unit. The hydraulic power system shall have two electric motors and two hydraulic pumps as shown in the plans. Hydraulic cylinders shall be provided as specified in the plans and these specifications. The system shall be redundant such that if any one of the motors or pumps is out of service, the system can be operated at a reduced speed using the remaining components of the system. Normal operation of the bridge under all load conditions is with all pumps on the power unit operating.

Corrosion resistant nameplates shall be provided for each hydraulic component including cylinders, reservoir, pumps, motors, heaters, pressure gauges, test ports, valves, piping, etc. Nameplates shall clearly indicate the function of each device and, in the case of manually operated valves or controls, shall indicate the condition established for each position of the valves or control. Lettering on the nameplates shall be machine-engraved on plastic laminate with white characters on a black background. The nameplates shall be mounted to their respective locations that are easily visible to bridge personnel.

(a) Speed, Torque and Directional Control.
The span speed, torque limit and direction of motion of the hydraulic system for each leaf under normal operation shall be provided by a directional control valve (with slow shift feature), a proportional pressure relief valve, a proportional throttle valve and variable displacement, pressure-compensated pumps with torque limiters. The pumps shall be started under no-load conditions. Command value modules, associated relays and 24 VDC power supply are installed in HPU Control Panel (HPUCP). The command modules provide ramped signals (0 to 10 VDC) for the proportional valves. The proportional valves incorporate on-board electronic amplifiers. HPUCP shall be furnished and installed by the Hydraulic Vendor. The HPU shall interface with the bridge control system.

(b) Control System.

When the bridge control system provides a raise signal, it shall start two (2) pumps sequentially without load, with a two to five second delay between starts, by closing the motor control output contacts. For a lower signal only (1) pump is working.

When the control system provides the raise signal, the directional control valve shall shift and the bridge shall begin moving in creep speed (20% of full speed). Speed shall be increased after a acceleration period approximately 5 seconds until full speed is achieved.

When the near open span position is achieved on a limit switch, one (1) electric motor shall be de-energized, the control system shall then gradually reduce the opening of the proportional throttle valve. Flow (speed) shall be decreased for a deceleration period approximately 8 seconds until 20% of full flow (speed) is achieved.

When the control system indicates the span is fully open, the valves and the electric motor are being de-energized. The flow to the cylinders shall be ramped to zero by closing the proportional throttle valve and de-energizing the directional control valve. Span position will primarily be held by piloted check valves installed in cylinder manifolds.

The bridge structure has been designed with sufficient stiffness and strength to mechanically couple the cylinder rods. Additional means of synchronization between the cylinder rods is not required.

The lower cycle shall be similar to the raise cycle except in reverse and only one (1) pump of two is used for lower and seating.

(1) Seating: When the control system indicates span position to be at the nearly closed position, angle as shown on the plans, the span shall continue to lower at 20% speed until the seated limit switches are actuated. A torque developed by the hydraulic cylinders shall be reduced to 15%-20% of the max lowering torque. After 5 second off-delay, the control system shall de-energize the electric motor and the valves.

(2) Stopping: If at any time during operation, the raise or lower signal becomes open, the control system shall gradually reduce span speed down to creep speed at a normal deceleration rate. After 10 seconds, all valves and electric motors shall be de-energized.

(3) Changing Direction: If at any time during operation, inputs are reversed (from raise to lower or from lower to raise), the

control system shall perform stopping as described above (during 10 seconds). Then ramp up to correct speed in the opposite direction.

(4) Emergency Stop: If the emergency stop circuit (E-Stop) is activated, the electric motors and all valves shall be de-energized immediately. The control system shall bring the span to a "hard" but controlled stop to avoid slam-shut. The 24 VDC power supply should provide power (ca. 48 VA) during 15 sec from E-Stop is activated. The control system shall not operate until the emergency stop circuit is released.

(5) Overrunning/Overhauling Conditions: If at any time during a raise/lower cycle the pressure switches on the supply lines to hydraulic cylinders measure a pressure below 250 psi (raise)/375 psi (lower), the control system shall gradually reduce the opening of the proportional throttle valve to restrict the flow on the return side of the cylinders to the reservoir. The ramp time for the proportional throttle valves shall be field re-adjusted such that the bridge spans run smoothly.

In the event of complete loss of power to the system, a controlled stop shall be initiated as an Emergency Stop (E-Stop).

9. MACHINERY SHOP ASSEMBLY. The span lock machinery and trunnion assemblies installation shall include alignment of all components, shop inspection, and shop testing. The assembly alignments shall be rechecked and adjusted as necessary at erection.

Visual inspection of the shop-assembled machinery shall be made by, and shop tests shall be witnessed by, a designated representative of the Engineer. If any malfunctions are observed, they shall be corrected and such units shall pass all shop tests before release from the machinery manufacturer's shop.

After each unit has passed all shop tests, the manufacturer shall prepare Certificates of Compliance with the specified tests and shall submit them to the Engineer.

PRODUCTS

1. STANDARDS PRODUCTS. Materials and equipment shall be essentially the standard catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's recommended design that complies with the specification requirements.

Materials and equipment shall essentially duplicate items that have been in commercial or industrial use at least two years prior to bid opening. Where two units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer. Each major component of equipment shall have the manufacturer's name and address and the model and serial number on a nameplate, securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

2. MANUFACTURER'S RECOMMENDATIONS. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material. The Contractor shall provide all special machining and installation required by the manufacturer.

3. GENERAL HYDRAULIC EQUIPMENT. The materials shall meet the minimum requirements specified herein or as specified on the plans. The plans show equipment schedules listing the minimum design requirements for the new equipment.

All equipment and materials furnished under the items specified herein shall be brand-new. All new equipment, materials and workmanship shall be first class in every particular, and shall be manufactured and installed to the satisfaction of the Engineer.

The design, workmanship and erection of all machinery and hydraulic components, including materials for mounting, shall meet the applicable requirements of AASHTO Standard Specifications for Movable Highway Bridges, hereinafter referred to as the AASHTO Specifications, except as otherwise specified herein or as shown on the plans.

Portions or all of certain recognized industry or association standards or specifications referred to herein as being a requirement of these Special Provisions be considered as binding as though reproduced in full herein unless supplemented and/or modified by more stringent requirements of the Contract Documents. Unless otherwise stated the reference standard or specification which is current as of the date of issuance of these Special Provisions shall apply.

Hydraulic equipment shall be designed and assembled in accordance with standard Joint Industrial Council (JIC) and National Fluid Power Association (NFPA) hydraulic practices.

4. CASTINGS AND FORGINGS. All necessary precautions shall be taken to fabricate the castings free of cracks, cold shuts, shrink holes, blowholes, and porosity.

All castings shall be cleaned free of loose scale and sand; all fins, seams, gates, risers, and other irregularities shall be removed. All unfinished edges of castings shall be neatly cast with rounded corners, and all inside angles shall have ample fillets.

All castings shall be ultrasonically tested in accordance with ASTM A609, Method A, Quality Level 3. Castings that do not pass this test may be rejected. Test results, whether positive or negative, shall be submitted to the Engineer. Test records meeting Quality Level 4 may be considered for weld repaired, provided the fabricator submits a procedure to the Engineer 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 Contractor providing a new casting meeting the acceptance criteria, at no additional cost to the owner.

All castings shall be visually inspected in accordance with ASTM A 802, Level II. Castings that do not pass this test may be rejected. Test results, whether positive or negative, shall be submitted to the Engineer. Test records meeting Level III may be considered for weld repair, provided the 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.

(a)	Type I	Cracks/Hot Tears	0.014 in
(b)	Type II	Shrink	Degree 3
(c)	Type III	Inclusions	Degree 3
(d)	Type IV	Chaplets	Degree 2
(e)	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 repaired, 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 proposed weld repairs shall be performed prior to all heat treatment so that no weld repairs will be necessary after machining. In addition, all surface defects removed by machining shall be performed prior to heat

treatment. Carbon Steel and Alloy Steel Forgings shall meet the requirements of ASTM A668 unless otherwise approved by the Engineer.

5. BEARINGS AND BUSHINGS.

(a) Pillow Block Bronze Bushed Bearings. All pillow block housings shall be made from ASTM A709 Grade 50 Steel unless otherwise specified within the drawings or specifications. The housing shall be secured to the machinery support with a minimum of four hex high strength turned bolts sized appropriately for the bearing loads. The turned bolt holes shall be field drilled with the machinery support after final alignment of the bearing. As alternative means, the contractor can use structural heavy hex bolts (ASTM A325) with alignment dowel pins drilled and installed in the field if and only if there are interferences that make field drilling impractical. Under no circumstances shall slotted holes be used.

The bearing cap shall be secured to the housing using four threaded studs welded to the bearing housing. The contractor may either use alignment dowel pins or step the housing and cap to keep the two halves aligned radially.

The bearing bushings shall be of a bronze material and shall be of a split design such that one half is secured to the base and the other half is secured to the cap. The liners shall be secured using countersunk bolts along the thrust faces on either side of the bearing. The contractor shall refer to AASHTO for the appropriate bronze material for the maximum rotational speed and pressure that the bearing bushing will be subject to. Should the material specified be impractical to procure, the contractor shall recommend an acceptable substitute to the Engineer for review. No material shall be ordered without prior approval by the Engineer.

Grease grooves shall be machined into the bearing liner surfaces that interface with the shaft. The grease fittings shall install to allow grease to properly flow to all of the grease grooves. Grease shall be ordered based on the recommendation of the grease supplier.

The split bearing shall be supplied with 0.25 in thick nominal liners to adjust the height between the two halves. The liners shall be peelable and laminated brass. These shims shall be capable of an adjustment as small as 0.003 in.

The split bearing shall also be supplied with a 0.5 in thick nominal shim pack to adjust the height of the entire bearing assembly. These shims shall be capable of an adjustment as small as 0.008 in.

(b) Spherical Plain Bearings. Plain spherical bearings shall be the self-aligning type and shall be sized to accommodate the forces of the cylinder. All bores and attachments shall be machined to the dimensions and tolerances as specified by the bearing manufacturer. Plain spherical bearings shall have a means for grease lubrication and shall be provided with double lip seals to retain the grease and guard the spherical surfaces from contamination. Grease fittings shall be giant button head fittings (0.25 in min.) as manufactured by Stewart-Warner Alemite Corporation or approved equal.

Please note that other components specified herein will contain bearings. These bearings are not subject to the requirements specified here within the section, but by the requirements specified for that particular component.

6. HUBS. All wheel hub width shall not be less than the diameter of the bore. The minimum thickness at any place on the hub shall not be less than 0.4 times the diameter of the bore.

All hubs shall be provided with keys and a shrink fit, where practical, to transmit the designed torque between the shaft and the hub. The keys shall be designed to transmit all of the required torque neglecting the shrink fit.

7. SHAFTS AND PINS. All shafts and pins shall be accurately finished, round, smooth and straight and, when turned to different diameters, shall have rounded fillets at the shoulders. Each shaft or pin having a uniform diameter of 8 inches or more and each shaft or pin having several diameters, of which the smallest is 8 inches or more, shall be bored lengthwise through the center to a diameter approximately one-fifth the smallest body diameter.

All shafts shall conform to the tolerances in ASTM A29 unless otherwise indicated. Turned, ground and polished shafting straightness tolerances shall be 0.002in per foot for shafts up to and including 1.5in in diameter and 0.005in per foot for shafts over 1.5in in diameter.

Each end of all shafts, when finished to the required lengths shall have a 60-degree lathe center, with clearance hole, at the exact center of the shaft. Shafts that are bored with an inspection hole shall have the ends prepared for the attachment of a centering device equivalent to the lathe center. All such devices shall be furnished as part of the work.

Where shown on the drawings, stepped shafts shall have fillets blended in smoothly to adjacent surfaces without tool marks or scratches. Unless otherwise required herein or on the drawings to have a finer finish, the surfaces shall have an ANSI maximum roughness of 1.6 micron.

All cold-finished shafting shall be steel of the type and grade shown on the drawings and shall be tested for its mechanical properties and a test certificate shall be furnished to the Engineer. Each cold- finished shaft shall be free from camber and shall run without vibration, noise, or chatter at all speeds up to and including the maximum rated speed.

All hubs mounted on the ends of cold-finished shafts shall have the fit specified herein or on the drawings. To obtain the required fit between hub and shaft, the Contractor shall furnish the cold-finished shaft larger than the nominal diameter specified, as required, and shall turn the ends to the required dimension for the hub. The Contractor may, at his option, furnish any cold-finished shaft of one diameter end to end; but such a shaft shall have tolerances selected from the normal manufacturing range to provide the specified fit. The selected tolerances shall be shown on the shop drawings.

Turned, ground and polished commercial shafting of the grade specified shall be used where shown on the drawings.

8. SHAFT COUPLINGS. Couplings shall be the standard products of an established manufacturer unless otherwise noted on the contract drawings or here within.

   Coupling hubs shall be bored by the coupling manufacturer to the required size and tolerances, including keyways and each hub shipped to the proper location for installation on its shaft by the manufacturer of the connected component.

   All coupling hubs with interference fits shall be provided with tapped holes for a means of removal from the shafts.

9. MACHINERY SUPPORTS. Machinery supports shall be constructed of ASTM A709 Grade 50 steel unless otherwise specified on the contract drawings. The contractor shall be allowed to use a higher grade steel at no additional cost to the owner. Machinery support steel shall be 0.375 in thick or greater.

10. MACHINERY ENCLOSURES. Machinery Enclosures shall be supplied for all instrument drives. The machinery enclosure shall be as shown on the contract drawings.

Machinery Enclosures shall be easily removable by maintenance staff for regular maintenance of the components. Machinery enclosures shall be painted in accordance with section XX herein.

11. FASTENERS. All bolts for connecting machinery components to each other or to supporting members shall be as shown on the plans or specified otherwise and conform to one of the following types:

Machinery Fit, high-strength finished body bolts and shall meet the requirements of ASTM A449. High-strength turned bolts and shall meet the requirements of ASTM A449. Countersunk socket head cap screws and shall meet the requirements of ASTM A574

All bolts for securing machinery supports to structural steel, machinery enclosure to machinery support or structural steel, and hydraulic pipe clamps to structural steel shall meet the requirements of ASTM A325.

All anchor bolts for securing machinery supports or components to masonry shall meet the requirements of ASTM A449. All anchor bolt hoes in machinery supports shall be drilled oversized by 50% of the bolt diameter.

Holes for Machinery Fit high strength (finished body) bolts shall be individually reamed for a clearance of not more than 0.010 in with the actual bolt for that hole. The clearance shall be checked with a 0.011 in wire. The hole shall be considered too large if the wire can be inserted in the hole together with the bolt. To achieve this machinery fit throughout the entire grip length, it is the Contractors responsibility to correct any slight bend in the bolt shank.

All high-strength bolts shall be connected using nuts meeting the requirements of ASTM A563.

All high-strength bolts shall be installed with a hardened plain washer meeting ASTM F436 under both the bolt head and nut.

Turned bolts, turned cap screws, and turned studs shall have turned shanks and cut threads. Turned bolts shall have semi-finished, washer-faced, hexagonal heads and nuts. Turned cap screws shall have finished

washer-faced, hexagonal heads. All finished shanks of turned fasteners shall be 0.040 in larger in diameter than the diameter of the thread, which shall determine the head and nut dimensions. The shanks of all turned fasteners shall have Class LC6 fit in the finished holes in accordance with ANSI Standard B18.2. The material used for machining turned shank fasteners shall meet the requirements of ASTM A193, Grade B7. Turned bolts shall be connected using nuts meeting the requirements of ASTM A194. Turned fasteners shall be fully detailed on shop drawings. Socket flat countersunk head cap screws shall conform to ASTM F879 (Stainless Steel) for diameters less than 0.625 in and ASTM F835 (Alloy Steel) for diameters greater than or equal to 0.625 in.

The dimensions of socket-head cap screws, socket flathead cap screws and socket-set screws shall conform to ANSI Standard B18.3. The screws shall be made of heat-treated alloy steel, cadmium-plated and furnished with a self-locking nylon pellet embedded in the threaded section. Unless otherwise called for on the drawings or specified herein, set screws shall be of the headless safety type, shall have threads of coarse thread series and shall have cup points. Set screws shall neither be used to transmit torsion nor as the fastening or stop for any equipment that contributes to the stability or operation of the bridge.

Bolt holes through unfinished surfaces shall be spot faced for the head and nut, square with the axis of the hole.

Unless otherwise called for, all bolt holes in machinery parts or connecting these parts to the supporting steel work shall be sub- drilled at least 0.25 in smaller in diameter than the bolt diameter and shall be reamed assembled for the proper fit at assembly or at erection with the steel work after the parts are correctly assembled and aligned. Holes in shims for machinery parts shall be drilled 1/16” over final bolt size.

Wherever possible, high strength bolts connecting machinery parts to structural parts or other machinery parts shall be inserted through the thinner element into the thicker element.

Positive locks of an approved type shall be furnished for all nuts. If double nuts are used, they shall be used for all connections requiring occasional opening or adjustment. If lock washers are used for securing, they shall be made of tempered steel and shall conform to the SAE regular dimensions. The material shall meet the SAE tests for temper and toughness.

All cotters shall conform to the SAE standard dimensions and shall be made of half-round stainless steel wire, ASTM A276, Type 316.

All fasteners shall be of United States manufacture and shall be clearly marked with the manufacturer's designation.

12. KEYS AND KEYWAYS. Keys and keyways shall conform to the dimensions and tolerances for square and flat keys of ANSI Standard B17.1, Keys and Keyseats, unless otherwise specified. All keys shall be effectively held in place, preferably by setting them into closed-end keyways milled into the shaft. The ends of all such keys shall be rounded to ahalf circle equal to the width of the key. Keyways shall have a radius in the inside corners. Keyways shall not extend into any bearing. If two keys are used in a hub, they shall be located 120 degrees apart and in line with wheel arms where practicable. The fit between key and keyways shall be as shown on the drawings.

Unless otherwise specified herein or in the drawings, keys shall be machined from carbon steel forgings, ASTM A668, Class K.

13. SHIMS. Where shown on the drawings, all machinery shims required for leveling and alignment of equipment shall be steel, neatly trimmed to the dimensions of the assembled parts and drilled for all bolts that pass through the shims. In general, sufficient thicknesses shall be furnished to secure 0.015 in variations of the shim allowance plus one shim equal to the full allowance. Shims shall be Stainless Steel ASTM A666 Type 302. Shims shall be provided with subdrilled holes 1/16” over final bolt size. Shims greater than 0.5 in shall include one solid plate of thickness equal to 0.5 in less than total shim thickness.

Shims shall be shown and fully dimensioned as details on the working drawings. Shims with open side or U-shaped holes for bolts will not be permitted. No shims shall have less than two holes for bolts.

The use of peelable laminated shims with solder or resin bonding will be permitted. Plastic or other non-metallic shims will not be permitted.

14. WELDING. Welding required for machinery shall be done in accordance with the requirements for welding structural steel listed in the item, “Structural Steel” and include all provisions of the New York State Steel Construction Manual. Stress relieving will be required only when specified. All welds used to fabricate machinery shall be completely tested by ultrasonic inspection (ASTM E164-74) per AWS D1.1, Section 6, Part C, and are subject to the acceptance criteria of Section 9.25.3. All machining shall be performed after welding and stress relieving.

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

Distortion during fabrication shall be kept to a minimum by the use of welding fixtures and proper welding procedures.

15. LUBRICATION. Standard grease fittings for a pressure system of lubrication shall be provided for all bearings, and surfaces requiring external lubrication. No more than two sizes of fittings shall be used. The large size shall be used wherever possible, and the smaller size shall be used for motor bearings and other small devices. Pressure fittings shall be rated at a minimum of 10 ksi. Fittings shall contain a steel check valve that will receive grease and close against back pressure.

The large fittings shall be connected directly into the bushings by 0.25 in minimum size, stainless steel pipe compliant with BS EN10255 and forced threaded fittings. The smaller fittings shall be connected with 0.25 in pipe where pipe extensions are required or by the size pipe thread furnished with the device to be lubricated.

Pipe extensions shall be provided to facilitate access for lubrication but shall be kept as short as practical and shall be rigidly supported at the fittings and at intermediate points.

Immediately after the completion of fabrication, all grease fittings shall be plugged until components are installed and regular lubrication is started. The plugs will then be replaced with the proper grease fittings.

The Contractor shall furnish three sets of full size lubrication charts and the component manufacturer's lubrication literature for every machinery component, which requires lubrication.

(a) The charts shall consist of:

(1) A schematic diagram of all machinery showing the location of all lubrication fittings and other points of mechanical and electrical equipment that require lubrication of any kind. These diagrams shall indicate the type of lubrication to be used at each point, the method of application at each point and the frequency of lubrication at each point.

(2) A table chart listing each machinery component that requires lubrication, the minimum frequency of inspection, the minimum lubrication frequency, the minimum lubrication change frequency instructions, standards, guidelines and a history of most recent service.

(b) One set of charts shall be permanently mounted in each machinery room and one in the storage room in the generator house or as otherwise directed by the Engineer. The schematic charts shall be sealed in permanent plastic covers.

(c) A fourth set of charts shall be furnished to the Engineer as a reference set.

(d) A Phenolic nameplate matching the number designation shown on the lubrication chart shall be mounted at each lubrication point. Characters on the plates shall be a minimum of 1in high. Plates shall be fastened with stainless steel screws.

(e) Maintenance and lubrication manuals for each machinery component shall be kept in the machinery room in a heavy bound binder.

The contractor is responsible for supplying the lubrication for all components of the mechanical systems and applying the lubrication to the component per the manufacturer's recommendations prior to use. The following is a list of components that require lubrication:

(a) Spherical Bearings of Hydraulic Cylinders
(b) Hydraulic Oil in Hydraulic Power Unit
(c) Trunnion Bearings
(d) Lock Bar Receivers and Guides
(e) Limit Switch Reducers

The contractor shall also supply the Owner with enough lubrication to meet the requirements specified by the component manufacturer or within these specifications.

All lubrication recommendations shall be submitted to the Engineer prior to procurement.

16. LUBRICANTS.

(a) Roller Bearings. The roller bearing lubricant, the maintenance of the lubricant, method of application and re-lubrication intervals shall be recommended or approved by the manufacturer unless otherwise stated herein.

(b) Sleeve Bearings. The lubricant chosen shall be approved for use in sleeve bearings by the lubricant manufacturer.

The lubricant shall be lithium based, contain graphite, EP-2 grade, and be comparable to "Exxon/Mobil Mobilith SHC 1000 Special" or Exxon Lidok EP-2.

(c) Couplings. Coupling lubricant and its maintenance shall be specified by the manufacturer.

The lubricant chosen shall be approved for use in gear couplings by the manufacturer.

17. SPARE PARTS. In addition to the spare parts described under other items the following spare parts shall be provided:

(a) One grid for each grid-type coupling.
(b) One complete set of gaskets for every flexible coupling.
(c) One neoprene insert for each jaw coupling.
(d) Five lubrication fittings of each different type and size used.
(e) Replacement parts for the hydraulic system, see drawing "Hydraulic Schematic –Details for full list.
(f) One replacement pump and one replacement motor of same models.
(g) One directional control valve.
(h) Two pilot operated check valves.

18. PAINTS. All machinery shall be coated with two coats of epoxy mastic primer compatible with the paint selected for subsequent coats. No paints used shall contain lead.

Paint for the final painting of machinery shall consist of two coats of approved machinery enamel (minimum 0.002 in dry each coat).

No paints used shall contain lead. All layer thicknesses shall meet paint manufacturer's specification.

Paint for painting the interior of gear housings, pillow blocks and flexible couplings shall be special oil-resistant crankcase paint as manufactured by one of the following companies, or approved equal:

(1) E.I. Dupont de Nemours & Co.
#63-1517 Dulux
Wilmington, DE
Red Oxide Primer

(2) Sherwin-Williams Co.
#E61 -R-N30

Cleveland, OH
Shop Coat Primer

(3) Rust-Oleum Corp.
#678 Red Primer
Evanston, I L

(a) Machinery Enamel. The final field applied paint shall consist of one coat of approved polyurethane paint resistant to weathering and abrasion and compatible with the previous coats. No paints used shall contain lead. Colors shall be as specified elsewhere herein. Machinery enamel shall be the tested product of one of the following companies, or approved equal:

(1) The Glidden Co.
Y-4550 Glid-Guard

(2) Rust-Oleum Corp.,
Industrial Enamel 7600
Evanstown, IL

(3) Valspar, Baltimore, MD
V20 Series

(b) Coatings. Where indicated on the Contract Drawings fabricated steel parts and weldments shall be hot-dip galvanized in accordance with ASTM A123.

In general, fabricated steel parts having thicknesses less than 0.375 in shall be hot-dip galvanized unless made of corrosion resisting material.

The threads of all mounting bolts shall be coated with anti-seize compound before assembly of the nuts to prevent corrosion or galling and to facilitate future removal if necessary.

Anti-seize compounds shall be as manufactured by the following companies, or approval equal:

(1) Huron Industries, Port Huron, MI
Neolube #1

(2) Fel-Pro, Inc., Skokie, IL

#C-670

(3) SPC Technologies Unbrako, Jenkintown, PA

Rust-inhibiting coatings for temporary protection of machined surfaces shall be as manufactured by one of the following companies, or approved equal:

(1) E.F. Houghton & Co.
Rust Veto 344 Valley
Forge, PA Cosomoline
1058

(2) Sanchem, Inc., Chicago, IL
No-Ox-Id "A"
Special "X"

(3) A.W. Chesterton, Co.
Heavy-Duty Rust Guard
Stoneham, MA

(4) Texaco, Houston, TX Metal

Metal Protective Oil L

EXECUTION

1. GENERAL. Should the contractor deviate from the contract drawings, they are responsible for supplying calculations to back-up all design constraints to the satisfaction of the Engineer. At a minimum, all components shall be designed as specified in AASHTO.

2. FABRICATION.

Dimensions, Fits, and Finishes. Dimensions of machined parts are the finished dimensions after fabrication and machining. Unless otherwise specified, all dimensions for machine finished surfaces and parts shall be held within a tolerance of 0.010 in. Fits for cylindrical parts shall also apply to the major dimensions of non-cylindrical parts. Fit, finish, and tolerance of manufactured parts and their mating parts shall conform to AASHTO Specification Article 2.5.17.

3. SHOP ASSEMBLY AND TESTING. Machinery components shall be shop assembled to verify their correct fit and shop tested prior to shipment. Refer to Section Hydraulic Power Unit and Section Hydraulic Cylinders for testing requirements. Each hydraulic system comprises (1) Hydraulic Power Unit Assembly, (4) Hydraulic Cylinder Assemblies, and all of the accessories specified on the Hydraulic schematic (see Contract Drawings). There are a total of two hydraulic systems.

Shop testing of the span locks shall include operation of shop assembled components under no load at full speed of the motors. The machinery will be cycled 10 times. Motor current shall be measured continuously for each phase, recorded and shall be submitted to the Engineer. During shop testing the assembled units shall operate smoothly, freely, quietly, without vibration and shall be observed for lubricant leakage, overheating, proper alignment, travel, and freedom from interferences.

Shop testing will be required of the HPU, cylinders, and HPU Control Panel. The procedure shall be comprehensive and shall test the HPU for functionality at full power under simulated loads and load changes and shall incorporate the assembled HPU Control Panel. Each cylinder shall be tested through 50 cycles while under a simulated maximum load for the full stroke of the cylinder. This test procedure, to be prepared by the Contractor and shall be submitted to the Engineer for review.

All malfunctions shall be recorded and corrected and re-tested before release from the Hydraulic Vendor's shop. After each cylinder and HPU, including the HPU Control Panel, have passed the test a Certificate of Compliance shall be submitted with the test reports to the Engineer for review.

4. FIELD INSTALLATION. The Contractor shall submit plans and procedures detailing their intended scheme for installing all machinery. See the SUBMITALS section under this specification.

Construction and installation shall be done in a coordinated manner to ensure that the machinery components fit the adjacent material furnished under other items.

All parts of the machinery shall be match marked for proper assembly and correct orientation. Before final drilling or reaming, all parts shall be adjusted to exact alignment by means of shims. After final alignment and bolting, all parts shall operate smoothly.

The span shall not be operated by the operating machinery until hydraulic cylinders, bearings, and all other machinery are in final alignment and bolted as approved by the Engineer.

All edges and corners of machinery parts, sheet metal work, bedplates, and fabricated supports that are exposed in the finished work shall be rounded or chamfered. All burrs or other surface defects that could be injurious to workers erecting or maintaining the bridge machinery shall be removed.

Bolt holes in structural steel for connecting machinery shall, in general, be drilled after final alignment of the machinery. Sufficient erection holes, sub-drilled 0.25 in undersize for temporary bolts, may be used for erection and alignment of the machinery. When the machinery is aligned in its final position, full- size holes for the remaining bolts shall be sub-drilled and reamed, the full-size bolts installed, and the temporary bolts removed and the bolt holes for temporary bolts reamed full size and bolts installed.

Torques for bolts shall be proportioned to their strength and shall be indicated on the erection drawings.

The machinery shall be erected and adjusted by millwrights competent in the type of work involved. They shall be provided with all necessary measuring and leveling instruments and tools as may be required.

HYDRAULIC SYSTEM. Installation, start-up, piping and flushing shall be done by a certified fluid power technician with prior experience on similar sized systems. Submit back-up information on the technician showing prior experience to the Engineer for review and approval.

Flushing shall be done only when atmospheric particles are at a minimum (no current sandblasting or painting). Check reservoir condition through clean-out covers. All surfaces shall be clean of dirt, rust or moisture. Once the reservoir has been determined to be clean; charge the reservoir with the proper fluid for final use in the system. Replace return filter once reservoir is filled for final use. Spares shall not be used as replacements.

The Contractor shall be totally responsible for the coordination of the various subcontractors for this project and specifically the coordination of the mechanical and electrical work in order to assure proper fit up of the various components of the mechanical and electrical system.

Flushing requirements shall be as follows:

(1) After installation, the hydraulic system shall be flushed and tested to show that hydraulic fluid demonstrates a level of cleanliness: ISO-4406, 18/16/13 (NAS-1638, Class 7) or better.
(2) The contractor shall submit a flushing procedure for approval prior to implementing the flushing process.
(3) Fluid for flushing shall be the same as specified for final use.
(4) The hydraulic cylinders and all hydraulic valves shall not be included in the flushing loop. These components shall be cleaned individually by the Hydraulic Vendor.
(5) The hydraulic reservoir shall be flushed separately.
(6) A temporary cleanup filter shall be used in the flushing system. The cleanup filter micrometer rating shall be no courser than the filters used in the hydraulic power unit.
(7) Each portion of the system shall be flushed for a minimum duration of 20 minutes or as required to obtain proper fluid cleanliness.
(8) It is the Contractor's responsibility to obtain the required cleanliness level and verifying the level through re-sampling in the event of a deficient report from the first sample. The procedure of further cleaning the fluid, collecting, and processing additional samples shall be at the expense of the contractor.

5. HYDRAULIC INSPECTION AND TESTING. Fabrication of the hydraulic power units, cylinders and control panel shall be done in qualified shops. The Buyer will send an inspector to the shop for verification of compliance and witnessing of shop testing prior to shipment of any equipment to the field. Prior to testing, the Contractor shall notify the Engineer three (3) weeks in advance for the ability to witness the components during testing. No testing shall be performed without the presence of the Engineer or Engineer's representative unless the Contractor has been otherwise directed, in writing, by the Engineer.

In the event the Hydraulic Vendor should propose an alternate design which deviates from the designs shown in the plans, it shall become the responsibility of the Contractor to provide sufficient back-up data and working examples to demonstrate the functionality of the design. These working examples will be of large structures similar in concept to a bascule bridge. This data shall be compiled and neatly organized and submitted to the Engineer along with the proposed hydraulic drive system for review. No material submitted shall relieve the Hydraulic Vendor from performing the hydraulic power unit testing as required of this Specification.

When testing the HPU, all required command modules and associated relays and the assembled HPU Control Panel shall be present and interfaced to the HPU to provide required signals for valve controls.

Additional requirements for shop testing are as follows:

(a) Power Unit Testing
    (1) Full flow pump testing
    (2) No visible external leakage permitted.
    (3) Electric motor performance at various pressure levels.
    (4) Verify electrical signals from the Bridge Electrical Control System at the HPU Control Panel.

(b) Cylinder Testing
    (1) Pressure tested 4500 psi, duration 15 minutes each direction. The use of compressed air to retract at end of test is not allowed.
    (2) No visible external leakage permitted.
    (3) Verify manifold operation and manual release.

Prior to placing any of the hydraulic system in operation, the Hydraulic Vendor shall have a representative be on site to inspect the installation of the Hydraulic System. This representative shall furnish a letter to the Engineer after the inspection certifying that the installation is acceptable and in conformance to the requirements of the Hydraulic Vendor.

Field test requirements shall demonstrate full operation of the system under all potential conditions including the following:

(a) After all components (tubing, valves, etc.) of the fluid system have been physically torqued and inspected, energize the motors.
(b) Using the HPU Control Panel, fully open, close, and seat span. During this time, adjust electronic control cards to obtain smooth and safe motion from start to stop in both directions.
(c) After several operations of step (B), check all areas for leaks, fluid temperature, and motor current drawn. Connect all control wiring to the Bridge Electrical Control System.
(d) Repeat using bypass modes and emergency power.
(e) Demonstrate all interlocks, emergency stopping indications, etc.

After system start-up is complete and unit is properly adjusted, the Hydraulic Vendor shall draw an oil sample from the reservoir using accepted NFPA techniques and equipment. This sample will be analyzed by a qualified laboratory.

The report shall be forwarded, in shop drawing format, to the Engineer for review and approval. If the required cleanliness level or water content is not achieved, the Contractor shall be responsible to clean oil until proper cleanliness level/water content is verified through re-sampling of the fluid.

6. PAINTING.

(a) General. The Contractor shall submit for review with the working drawings an outline of painting materials and methods.

(b) Shop Painting. All unfinished machinery external surfaces shall be cleaned with final surface preparation, prior to painting, done by blast cleaning to meet the requirements of SSPC-SP6 "Commercial Blast Cleaning" with the following exceptions:

(1) Roller bearing pillow blocks
(2) Sleeve bearings with bushings in place
(3) Electric motors
(4) Limit switches
(5) Instrument Drive Couplings
(6) Other equipment with shaft seals

The excepted machinery or equipment shall be cleaned with solvent and hand tools to meet the requirements of SSPC-SP2; Hand Tool Cleaning as depicted in SSPC Vis. 1.

After proper surface preparation, all machinery whose surfaces are in moving contact shall be lubricated which will aid in the corrosion prevention of the surfaces. These parts include:

(1) Bronze Bushing Journals
(2) Shaft in contact with Bronze Bushings
(3) Lock Bar, Lock Bar Receiver Liners, and Lock Bar Guide Liners
(4) Live Load Shoe

After proper surface preparation, all machinery whose surfaces are in fixed contact shall be temporarily protected from corrosion until assembly. The temporary protection shall be stripped away prior to assembly. all machinery surfaces remaining exposed, except rubbing surfaces, shall be thoroughly cleaned with an approved high-flash solvent (noted below) and given two field coats of Machinery enamel (minimum 0.002in) dry each coat applied by hand brushing. Acceptable machinery enamels with low VOC (Volatile Organic Compounds) are given under PRODUCTS. Colors for the field coats will be selected from manufacturer's standard samples with the approval of the Engineer.

The Contractor shall take special care to avoid painting of machinery surfaces, which are in normal rubbing contact. All nameplates, legend

plates, and escutcheons mounted on machinery shall be masked for protection from paint. Lubrication fittings shall be kept clog-free.

After completion of the operating tests and acceptance of the machinery, all accumulated oil, grease, dirt, and other contaminants shall be washed from exposed machinery surfaces, excepting rubbing surfaces, with an approved high-flash solvent. The cleaned exposed surfaces shall then he hand brush painted a third field coat of machinery enamel as specified above, which shall color-code the machinery to distinguish between fixed and moving parts. The following colors shall be used:

(1) Federal Safety Orange - Except for rubbing surfaces, for all moving parts of the machinery such as shafting.
(2) Federal Safety Green - For all stationary parts of the machinery.

Paint for the final field coat, which shall be compatible with the previous field coats, shall be a high-gloss machinery enamel resistant to weathering and abrasion, conforming to OSHA color requirements of the Safety Color Code for Marking Physical Hazards, ANSI Z53.1. The brand and colors shall be submitted to the Engineer for approval. The Contractor shall place cautionary signs in the Operator's House and at the entrances to the machinery rooms, which shall explain the color code. A detail of the sign giving text, dimensions and materials shall be placed on a shop drawing.

(c) Field Painting. After erection is complete, apply field touch-up paint to shop applied coatings that may have been damaged during construction. If the paint was damaged to expose bar steel paint the exposed steel per the field painting requirements.

7. FINAL FIELD TEST. When testing is to be performed, which requires operation of the movable span, the testing shall be coordinated in accordance with all local regulatory agencies.

When the mechanical machinery and electrical equipment is ready for testing, the Contractor shall meet with the Engineer to arrange a test schedule, and shall keep available a complete crew of mechanics for a minimum of five working days in order to provide operation of the span for all tests and to make all adjustments and corrections which shall be required to complete the tests.

The Contractor shall prepare a field testing procedure, which shall be approved by the Engineer. The testing procedure shall be coordinated with tests required for the electrical equipment and shall include

measurements of power and current drawn by the motors when operating under load as required.

The testing procedure shall include but not be limited to the verification of the proper operation and/or final adjustment of the following:

(a) Cylinder Operation
(b) Shaft Bearings
(c) Machinery Mounting Integrity
(d) Span Operating Times
(e) Centering Device Engagement
(f) Span Lock Operation
(g) Instrument Drive
(h) Limit Switch Settings
(i) Live Load Bearings

When the machinery is ready for field testing, the operating machinery shall be driven by the Bridge Electrical Control System through at least ten complete cycles.

Current drawn by each hydraulic pump motor, pressures inside hydraulic cylinders and span position angle shall be automatically recorded on a strip chart. The recording shall be made for complete cycles of opening and closing and the number of cycles during which measurements are made shall be established by the Engineer.

During the test runs, the entire operating machinery shall be inspected to determine whether everything is in proper working order and fully meets the requirements of the Contract Drawings and these Special Provisions. The temperature rise of all electrical components shall not exceed design ratings. If any tests show that any components are defective or inadequate, or function improperly, the Contractor shall make all corrections, adjustments, or replacement required before the Final Acceptance at no additional cost.

A complete inspection shall be performed of all mechanical components. All bearing clearances shall be measured including, but not limited to the Trunnion Bearings, Hydraulic Cylinder Spherical Bearings, Span Lock Receivers and Span Lock Guides. This information shall be recorded and provided to the Engineer for review.

After system start-up is complete and units are properly adjusted, the Hydraulic Vendor shall draw an oil sample from the reservoir using accepted NFPA techniques and equipment. This sample will be analyzed by a qualified laboratory and the report shall be forwarded, in shop drawing format, to the Engineer for review and approval. A copy of this report shall be placed in Operation and Maintenance Manual.

This sample of oil will be analyzed for the following properties:

1. kinematic viscosity ASTM D445 @ 40°C (cSt)
2. total acid number ASTM D664, mg KOH/g (TAN)
3. oil cleanliness level ISO 4406 @ 4, 6, 14 microns
4. water content ASTM D6304 (ppm)
5. wear/metal particles ASTM D5185 (ppm)
6. color.

8. METHOD OF MEASUREMENT. Special provision provided for reference.

HYDRAULIC POWER UNITS

GENERAL

1. SUMMARY. This Section specifies the requirements for the furnishing of the Hydraulic Power Units (HPU) for the North Hero Grand Isle Bascule Bridge.

2. SCOPE OF WORK. The following specifies the requirements to furnish two (2) Hydraulic Power Units along with all hydraulic tubing, valves, fittings, and any other hydraulic materials incidental to the furnishing of the Hydraulic Power Units required on the Contract Drawings and here within.

   Labor for the installation, integration, and testing of the Hydraulic Power Units and their incidental materials shall be furnished under Section MECHANICAL GENERAL REQUIREMENTS.

3. REFERENCES. All work performed under this specification shall also conform to Section MECHANCIAL GENERAL REQUIREMENTS.

4. GENERAL REQUIREMENTS. All components of the hydraulic system shall be properly sized and selected such that no oscillation or chattering occurs during the operation cycle. The entire cycle shall be smooth regardless of weather conditions.

5. SUBMITTAL REQUIREMENTS. Shop drawings shall be submitted for all hydraulic components and equipment as required in this specification. In addition, the following additional data for the hydraulic system shall be submitted to the Engineer for review:
   (a) Hydraulic schematic with bill of materials. Hydraulic symbols utilized in the schematic and shop drawing submittals shall be in accordance with ANSI Y32.10.
   (b) Certified dimensional prints for all major hydraulic components. This shall include at a minimum the reservoir, the pumps and the electric motors.
   (c) Hydraulic Power Unit assembly drawing including overall dimensions, bill of materials, wet and dry weights, lifting/handling provisions, and required clearances/maintenance envelopes.
   (d) Engineering and performance data of all items supplied, including material specifications, component catalog cuts, etc.
   (e) Initial hydraulic fill and field flushing procedure.
   (f) Hydraulic fluid specifications.
   (g) Complete tubing layouts and details, including fittings, lengths, support types, support locations.

(h) Electrical submittals related to the hydraulic system shall include but are not limited to:
    (1) Dimensioned panel layout drawings with all components to scale. All components shall be labeled and referenced to a bill of materials.
    (2) Manufacturer's data sheets for all components (disconnects, timers, fuses, circuit breakers, panel heater, etc.)
    (3) Schematic drawings showing wire numbers and field wiring.
    (4) Engraving schedule for nameplates.
    (5) Submittal data for each motor to include horsepower, voltage, amps (full load and locked rotor), motor speed, NEMA frame size, insulation class, temperature rise, service factor, and optional equipment. Provide torque speed performance graph.
    (6) HPU Control Panel (HPUCP) wiring diagrams.

(i) The Contractor shall furnish maintenance and operation manuals giving complete instructions relative to assembly, installation, operation, adjustment, alignment, lubrication, maintenance, disassembly and carrying complete parts lists and assembly drawings for the new hydraulic system installed. The manuals, under a separate section, shall be part of a general maintenance and operation manual as specified elsewhere in these Special Provisions. Manuals shall be furnished concurrently with working drawings for review and approval by the Engineer.

(j) At the completion of work, the Contractor shall furnish a complete set of "as-built" drawings to the Engineer for review and approval.

PRODUCTS

1. HYDRAULIC POWER UNIT FOR SPAN OPERATION. Hydraulic power units (HPU) for span operation shall be of simple design and substantial construction. The arrangement of parts shall permit easy erection, adjustment, replacement of defective parts and shall be accessible for inspection, cleaning, lubrication, maintenance and repairing. The fastening shall be adequate to hold the parts in place under all conditions of service. All parts, motors, pumps, etc., shall be mounted over a drip pan to contain oil spills when servicing or replacing the unit. Drip pans shall be equipped with drain spigots and suitable clearance for drainage and collection. Drip pan material shall be ASTM A666 Type 304 stainless steel.

The power unit, plumbing, fittings, and all components shall be detailed to provide the intended functions of power and control. Unless otherwise noted, each component or assembly shall be rated for the maximum flow and pressure it will be subjected to 3,000 psi. Refer to the relief valve settings shown on the Contract Drawings for the maximum design pressures.

The Contractor is responsible for selecting components that provide the intended function and meet the specified performance criteria. Any

additional components or piping required to adapt specific components to meet the design intent, including external drains, reducing valves, flow control valves, etc., shall be furnished at no additional cost.

Hydraulic pumps shall be of the variable displacement axial piston type. Pumps shall be as specified on the plans with torque limiting controls. Each pump shall be coupled to a standard TEFC/NEMA TD-flanged electric motor by use of an adapter. This allows replacement of an electric motor without opening the oil reservoir. Electric motors shall be in accordance with the requirements as specified under the Electrical Section of these Special Provisions.

The pumps and electric motors shall be connected by means of suitable grid type flexible coupling with misalignment to be equal to or less than the manufacturer's recommendation. Coupling halves shall be keyed to their respective shafts. Coupling set screws shall be secured with a high quality thread locking material. The entire pump/motor assembly shall be mounted on standard vibration isolation shock mounts.

Command value modules and associated relays are installed in HPU Control Panel. These modules provide ramped signals (0 to 10 VDC) for the proportional valves. These valves incorporate on-board electronic amplifiers. The HPU unit shall have two pump/motor groups for normal span operation. If one unit is inoperable, they will be removed from service and operation will continue at 1/2 of full speed (raising). Manual valves are also included on the cylinder manifolds as another means of manual emergency span lowering. A placard with emergency instructions shall be located near the manual valves.

Hydraulic power units shall be completely pre-piped, tested in the Hydraulic Vendor's shop, and painted prior to arrival at the job site. Open ports for field piping shall be securely capped with steel plugs. Changes or modifications in the field are not permitted. Should the power units require piping changes they shall be removed from the bridge, modified, and re-tested in the Hydraulic Vendor's shop.

Standard electrical practices shall be adhered to HPU wiring. Watertight flexible electrical conduit shall be used between HPU Control Panel and HPU electrical components where runs will be less than two feet. For runs over six feet, PVC coated, galvanized rigid conduit shall be used in conjunction with watertight flexible electrical conduit, thereby keeping watertight flexible electrical conduit runs under two feet.

If a system is provided with a lower efficiency, the Contractor shall be responsible for increasing the size of the motors and/or other components as required to meet the functional requirements.

Hydraulic Power Units shall be as manufactured by one of the following companies, or approved equal:

(a) Bosch Rexroth AG
(b) Eaton Corporation
(c) Parker Hannifin Corporation
(d) Hunger Corporation

2. HYDRAULIC VALVES. All main system valves shall be rated for their intended flow and pressure. ANSI standard sub-plate mounted valves shall be used for ease of servicing.

a) Slow Shift Directional Control Valve: It is the custom assembled unit from off-the-shelf components. This valve shall be pilot operated directional control valve capable of controlling the start, stop and direction of motion for the bridge span. Long shifting time (1 sec to 2 sec) of this valve is required to avoid slam-shut when E-Stop will be activated. The main spool shall have metering notches and shall be spring centered.

b) Proportional Pressure Relief Valve: This valve is used to limit the pump working pressures for span raise, span lower and span seating. It means that the maximum driving torque developed by hydraulics is limited and the span structure is protected from overload.

c) Proportional Throttle Valve: This valve is used to limit the maximum acceleration/deceleration rate and set span creep speed for raise/lower. Raising span speed is established by the maximum flow capacity of two (2) hydraulic pumps. Lowering span speed is established by the maximum flow capacity of one (1) hydraulic pump.

Hydraulic Valves shall be as manufactured by one of the following companies, or approved equal:

(a) Bosch Rexroth AG
(b) Parker Hannifin Corporation
(c) Eaton Corporation
(d) Sun Hydraulics

3. HYDRAULIC FLUID. A hydraulic fluid shall be provided to test, store, clean and install the systems in working order.

The fluid shall be a premium grade, non-toxic, anti-wear hydraulic oil.

The selected hydraulic oil shall be in accordance with the hydraulic supplier requirements and oil specification data shall be submitted to the Engineer for approval.

The hydraulic fluid shall have a minimum viscosity index of 100 with viscosity of 32 cSt (150 SSU) to 46 cSt (214 cSt) at a temperature of 100°F. Recommended hydraulic oil for this project is MOBIL DTE-13M or equivalent.

All components, including gaskets, seals and fittings shall be compatible with the approved fluid.

Hydraulic Fluid shall be as manufactured by one of the following companies, or approved equal:

(a) Exxon Mobil Corporation
(b) Chevron, Inc.
(c) Royal Dutch Shell, PLC

4. FILTRATION. The hydraulic system shall be fitted with filtration suited for the application. The system shall be fitted with full flow pressure and return filtration. The return filter shall be tank mounted. Each filter shall have a bypass, local visual indicator as well as electrical contacts which activate under a clogged and/or bypass condition. Suction strainers shall be mesh #60, double pump flow with 3 psi by-pass.

Filtration shall be as manufactured by one of the following companies, or approved equal:

(a) Parker Hannifin Corporation
(b) HYDAC Technology Corporation
(c) Bosch Rexroth AG
(d) Eaton Corporation

5. RESERVOIRS. The hydraulic reservoir shall be fabricated from stainless steel ASTM A276 type 316L.

The reservoir shall have the minimum volume 170 gallon shown on the plans. The thickness of the wall material for the reservoir shall be sufficiently designed for all components mounted to the reservoir and any expected external forces, not less than 0.25 in. The thickness of top plate shall be not less than 0.50 in.

Removable clean out covers shall be provided on the reservoir. The size, location, and quantity of clean out covers shall allow the entire interior surface of the reservoir to be inspected.

A "KleanVent" breathers from Parker Co. shall be installed with the sealed reservoirs to keep moisture out. Location of the breathers in the Mechanical Rooms will be determinate by the Contractor.

A separate fill connection with a valve shall be provided to connect a portable filter cart.

In addition to the general items required in the reservoirs, the following items shall be incorporated into the reservoir:

(a) Low level float switches (16" & 20", measured from the top plate).
(b) High temperature warning switch (130°F) and high temperature shut down switch (150°F).
(c) Low temperature switches (25°F) and (45°F).
(d) Reservoir drain port with shutoff valve.
(e) Fluid sampling port.
(f) Oil level sight gauge with temperature indicator.

6. PLUMBING AND FITTINGS. All plumbing shall conform to current hydraulic system standards. Unless otherwise specified, rigid plumbing shall be seamless ASTM A269, Grade TP304 annealed stainless steel tube and ASTM A312 - Grades TP304 stainless steel pipe as applicable. Fittings shall be SAE four bolt O-ring flange, O-ring face seal. Threaded connections shall be SAE straight threads with O-ring seal wherever possible. All fittings shall be 316 series stainless steel. The use of hydraulic clamps is mandatory. All clamp fasteners, plates, and brackets shall be 316 series stainless steel. The Contractor shall follow clamp manufacturer's specifications for spacing and installation.

Flexible hose shall be of the proper SAE rating, consistent with the working pressure encountered and having the minimum burst pressure 12,000 psi. The minimum use of flexible hose shall include: drain, bypass, return and pressure lines connecting all pumps to the system and cylinders to field plumbing. All hose assemblies shall be assembled with stainless steal crimped fittings.

Tubing shall be sized to provide a minimum factor of safety of four(4) based on burst pressure. Factors of safety shall be based on the relief valve settings shown in the Contract Drawings. Fluid velocity in piping and hoses shall not exceed 25 feet/second for pressure lines, 4 feet/second for suction lines.

7. HYDRAULIC PIPE AND TUBE SUPPORTS. All clamps, fasteners, and channels shall be 316 series stainless steel. The maximum spacing between

pipe/tube supports shall be 4 feet or as required to minimize vibration.

The Contractor shall arrange the pipe and pipe supports to allow sufficient flexibility for thermal expansion, etc. ASME B31.1 shall be used for guidance for locating pipe supports to ensure proper flexibility.

8. HARDWARE AND FASTENERS. All fasteners bolts, nuts, washers, and all other mounting hardware used on all the hydraulic equipment and power units shall be type 316 stainless steel unless otherwise noted.

See also the requirements for Fasteners in Section MECHANICAL GENERAL REQUIREMENTS.

9. MANIFOLDS. Manifolds shall be used to house valves and other components as specified in the plans. Unless otherwise specified in the plans, manifolds shall be constructed from stainless steel or corrosion resistant steel for the specified working pressures.

EXECUTION

1. GENERAL. All electrical connections from the hydraulic equipment mounted on the HPU, except electric motors and oil heaters, to the HPU Control Panel (HPUCP) shall be made by the Hydraulic Vendor at the Hydraulic Vendor shop (terminated inside HPUCP). Field electrical connections for electric motors, oil heaters and HPUCP shall be made by the Contractor of the Bridge Electrical Control System.

   The hydraulic span drive system shall meet the requirements for hydraulic systems, components, and associated elements and Hydraulically operated equipment for use in movable bridge operation and control, as described herein. The requirements of AASHTO Standard Specifications for Movable Highway Bridges shall apply unless otherwise specified.

2. METHOD OF MEASUREMENT. All Hydraulic Power Unit work shall be measured on a lump sum basis.

3. BASIS OF PAYMENT. Payment will be made under:

a) The accepted quantity of Special Provision (Bridge Power Equipment) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all

labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 50 percent of the lump sum price will be made upon purchase of raw materials including forging, fabrication, shop testing, and delivery to the project site.

(3) The third payment of 35 percent of the lump sum price will be made upon approval of the installation work by the Engineer.

(4) Payment of the remaining amount will be made after acceptance testing and punch list items have be resolved.

c) Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Hydraulic Power Units)	Lump Sum

HYDRAULIC CYLINDERS

GENERAL

1. SUMMARY. This Section specifies the requirements for the furnishing of the Hydraulic Cylinders for the North Hero Grand Isle Bascule Bridge.

2. SCOPE OF WORK. The following specifies the requirements to furnish eight (8) Hydraulic Cylinders along with all hydraulic pipes, valves, fittings, manifolds, and any other hydraulic materials incidental to the furnishing of the Cylinders required on the Contract Drawings and here within.

   Labor for the installation, integration, and testing of the Hydraulic Cylinders and their incidental materials shall be furnished under Section MECHANICAL GENERAL REQUIREMENTS.

3. REFERENCES. All work performed under this specification shall also conform to Section MECHANCIAL GENERAL REQUIREMENTS.

4. GENERAL REQUIREMENTS. All components of the hydraulic cylinders shall be properly sized and selected such that no oscillation or vibration occurs during the operation cycle. The entire cycle shall be smooth regardless of weather conditions.

5. SUBMITTAL REQUIREMENTS. Shop drawings shall be submitted for all hydraulic cylinder components and equipment as required in this specification. In addition, the following additional data for the hydraulic cylinders shall be submitted to the Engineer for review:

   (a) Calculations for design of cylinder body and mounts and of all factors of safety required by this specification.
   (b) Assembly drawings for cylinder assemblies including overall dimensions (including extended and retracted positions), bill of materials, wet and dry weights, lifting/handling provisions, and required clearances/maintenance envelopes.
   (c) Complete piping layouts and details, including fittings, lengths, support types, support locations.
   (d) Hydraulic cylinder installation procedure (including alignment details). All procedures shall be submitted to the Engineer for review prior to the start of the work. Top and bottom support brackets shall be aligned in any direction to within 0.5 in.
   (e) At the completion of work, the Contractor shall furnish a complete set of "as-built" drawings to the Engineer for review and approval.

PRODUCTS

1. HYDRAULIC CYLINDERS. See drawing "Hydraulic Cylinder Assembly".

All cylinder support component alignments shall be verified by use of laser level or other approved method prior to final mounting of cylinder support components.

Cylinder supports shall be painted in accordance with the requirements for painting of structural steel.

Hydraulic cylinders shall be constructed to provide a minimum factor of safety of 3 against buckling. Factors of safety against buckling shall be based upon a setting of the pressure relief valve in the cylinder manifold on the cylinder cap side (port "A"). Data and calculations regarding buckling shall be submitted to the Engineer for review.

(a) Cylinder Mounts. Cylinders shall be designed and manufactured for mounting as shown in the plans. Rod ends shall be per plan details and shall be designed and fabricated for easy field removal of connection pins to allow for disconnecting a cylinder from the span to remove it from service. Cylinder mounts permanently attached to the cylinder and all associated bearings and hardware shall be supplied by the cylinder manufacturer and shall be included in the cylinder shop drawing for review by the Engineer.

(b) Cylinder Pressure Rating. The manufacturer shall submit certification that each cylinder was hydrostatically tested to 4500 psi with no evidence of leaking and that all dynamic seals are suitable for both frequent and infrequent operation and are capable of not less than 75,000 cycles of operation without failure.

(c) Rod Seals. A hard polyester scraper shall be provided. Spare rod seals and scraper shall be designed so that replacement can be performed in the field without disassembly of the cylinder.

Hydraulic Cylinders shall be as manufactured by one of the following companies, or approved equal:

(1) Eaton Corporation
(2) Bosch Rexroth AG
(3) Parker Hannifin Corporation
(4) Hunger Corporation

EXECUTION

1. METHOD OF MEASUREMENT. All Hydraulic Cylinder work shall be measured on a lump sum basis.

2. BASIS OF PAYMENT. Payment will be made under:

a) The accepted quantity of Special Provision (Bridge Power Equipment) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 65 percent of the lump sum price will be made upon purchase of raw materials including forging, fabrication, shop testing, and deliver to the project site.

(3) The third payment of 25 percent of the lump sum price will be made upon approval of the installation work by the Engineer.

(4) Payment of the remaining amount will be made after acceptance testing and punch list items have be resolved.

c) Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Hydraulic Cylinders)	Lump Sum

TRUNNION ASSEMBLIES

GENERAL

1. SUMMARY. The basic requirements of the MECHANICAL GENERAL REQUIREMENTS special provision shall apply to the work described in this section. The work shall consist of furnishing all labor, materials and equipment to install new trunnion machinery as detailed on the Plans. Installation of the structural supports is covered under the appropriate Structural Steel sections of work. This Section specifies the requirements for the furnishing of the material and labor to assemble the Trunnion Assemblies for the North Hero Grand Isle Bascule Bridge.

2. SCOPE OF WORK. The following specifies the requirements to furnish four (5) Trunnion Assemblies, and incidental material, required on the Contract Drawings and here within. The Trunnion Assemblies work shall include all labor, materials, and plant to provide a complete Trunnion assembly which shall consist of the following:

(a) Trunnion Shafts
(b) Trunnion Hubs
(c) Hub Rings
(d) Trunnion Bearing Bases
(e) Trunnion Bearing Caps
(f) Trunnion Bushings
(g) Bearing Cap Bolts
(h) Bearing Base Bolts
(i) Trunnion Bearing Liners
(j) Trunnion Bearing Shims
(k) Dowels
(l) Lifting Eyes
(m) Lubrication
(n) Painting

It is the intent and purpose of this Section of the Special Specifications to cover and include all apparatus, tools, devices, material, equipment, and labor necessary to properly detail, manufacture, shop assemble and test, ship, install, erect, align, adjust, lubricate, field test, paint, and put in approved working order the above listed work as specified herein. Any apparatus, tool, device, material and labor not specified herein, mentioned, or included at a substantial manner satisfactory to the Engineer shall be furnished by the Contractor and without additional cost to the owner.

PRODUCTS

All materials shall conform to the requirements shown on the Plans and as specified in the MECHANICAL GENERAL REQUIREMENTS special provision.

EXECUTION

All construction shall conform to the requirements shown on the Plans and as specified in "Machinery in General", and as listed below:

(a) Shop Assembly and Operation. After shop assembly of the two girders of one bascule span, the holes for the trunnion hubs shall be line bored in one setup. Refer to structural drawing for geometric tolerances and surface finishes. After completion of the two bores, the trunnion components shall be assembled as outlined on the Contract drawings under "Shop Notes". The Contractor shall submit the assembly procedure for review and approval. The use of liquid nitrogen to cool such components is prohibited.

(b) Machinery Component Inspection/Assembly. Machinery components shall be temporarily shop assembled to verify their correct fit prior to shipment.

(c) Field Alignment. Each trunnion bearing shall be adjusted to the requirements shown on the Contract drawings under "Field Notes".

(d) Final Testing. Audible and physical observations shall be undertaken after the final alignment of the trunnion shafts has been established. Observations shall include inspection of journal surfaces with the bearing caps removed. Lubrication distribution shall be inspected for full bearing. The contractor shall adjust bearing position until this requirement is accepted by the Engineer.

1. METHOD OF MEASUREMENT. All trunnion assembly work shall be measured on a lump sum basis. No separate measurement will be made for work in this section.

2. BASIS OF PAYMENT. Payment will be made under:

a) The accepted quantity of Special Provision will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 65 percent of the lump sum price will be made upon purchase of raw materials including forging, fabrication, shop testing, and delivery to the project site.

(3) The third payment of 25 percent of the lump sum price will be made upon approval of the installation work by the Engineer.

(4) Payment of the remaining amount will be made after acceptance testing and punch list items have be resolved.

c) Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provisions (Trunnion Assemblies)	Lump Sum

LIVE LOAD SHOES

GENERAL

This Section specifies the requirements for the furnishing of the material and labor to assemble the Live Load Shoes for the North Hero Grand Isle Bascule Bridge.

1. SCOPE OF WORK. The following specifies the requirements to furnish eight (8) Live Load Shoe Assemblies, and incidental material, required on the Contract Drawings and here within. The Live Load Shoes work shall include all labor, materials, and plant to provide a complete Live Load Shoe assembly which shall consist of the following:

   (a) Structural Steel
   (b) Live Load Shoe Shims
   (c) Elastomeric Pad

Work associated with the installation of each completed Live Load Shoe assembly and materials provided in the form of bolts or anchor bolts shall be furnished under Section MECHANICAL GENERAL REQUIREMENTS.

PRODUCTS

1. STRUCTURAL STEEL. Structural steel used in the fabrication of the live load shoes shall be of the material type, grade, dimensions, and quantity specified on the contract drawings. The contractor shall be allowed to use ASTM A709 Grade 50 steel at no additional cost to the owner

   Structural Steel shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

2. LIVE LOAD SHOE SHIMS. Live load shoe shims used in the fabrication of the live load shoes shall be of the material type, grade, dimensions, and quantity specified on the contract drawings. Shims may be required to be feathered/tapered in order to achieve full contact between live load shoe and sole plate.

   Live load shoe shims shall also meet the requirements of Section MECHANICAL GENERAL REQUIREMENTS.

EXECUTION

1. ALIGNMENT. The live load shoes shall be aligned with shims such that full bearing is achieved between the live load shoes and sole plates. Bluing shall be used to check for full contact at all four corners of each shoe as the acceptance criteria for contact. When the span is fully seated on all live load shoes the elevation between the span lock front guides and receivers shall not vary by more than 0.25 inch. This section shall be coordinated with the SPAN LOCKS special provision.

2. PAINTING. All Live load shoe assemblies shall be shop painted and field painted with the paint materials specified per the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

3. METHOD OF MEASUREMENT. All live load shoe work shall be measured on a lump sum basis. No separate measurement will be made for work in this section.

4. BASIS OF PAYMENT.

a) The accepted quantity of Special Provision will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 55 percent of the lump sum price will be made upon purchase of raw materials including forging, fabrication, shop testing, and delivery to the project site.

(3) The third payment of 35 percent of the lump sum price will be made upon approval of the installation work by the Engineer.

(4) Payment of the remaining amount will be made after acceptance testing and punch list items have be resolved.

c) Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Live Load Shoes)	Lump Sum

SPAN LOCKS

GENERAL

1. SUMMARY. This Section specifies the requirements for the furnishing of the Inboard and Outboard Span Lock Assemblies for the North Hero Grand Isle Bascule Bridge.

2. SCOPE OF WORK. The following specifies the requirements to furnish two (2) Inboard Span Lock Assemblies and two (2) Outboard Span Lock Assemblies along with all incidental materials required on the Contract Drawings and here within. The Span Lock Assemblies work shall include all labor, materials, and plant to provide a complete span lock assembly which shall consist of the following:

   (a) Lock Bars
   (b) Front and Rear Lock Bar Guides
   (c) Lock Bar Receivers
   (d) Machinery Supports
   (e) Position Switch Actuator
   (f) Fasteners
   (g) Lubrication

The work to furnishing the span lock linear actuators, motors, and position switches shall be furnished under the ELECTRICAL GENERAL REQUIREMENTS special provision.

3. REFERENCES. All work performed under this specification shall also conform to the MECHANCIAL GENERAL REQUIREMENTS special provision.

PRODUCTS

1. LOCK BARS. The lock bar shall be of the material type, grade, dimensions, and quantity specified on the contract drawings.

   Lock bars shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

2. FRONT AND REAR LOCK BAR GUIDES. The front and rear lock bar guides shall be of the material type, grade, dimensions, and quantity specified on the contract drawings.

Front and rear lock bar guides shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

3. LOCK BAR RECEIVERS. Lock bar receivers shall be of the material type, grade, dimensions, and quantity specified on the contract drawings. Lock bar receivers shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

4. MACHINERY SUPPORTS. Machinery supports for mounting the linear actuators, lock bar guides, and lock bar receivers shall be of the material type, grade, dimensions, and quantity specified on the contract drawings.

Machinery supports shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

5. POSITION SWITCH ACTUATOR. Position switch actuators shall be of the material type, grade, dimensions, and quantity specified on the contract drawings.

Position switch actuators shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

6. FASTENERS. Fasteners for the mounting of linear actuators, lock bar guides, lock bar receivers and position switch actuators shall be of the material type, grade, dimensions, and quantity specified on the contract drawings.

Fasteners shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

7. LUBRICATION. Span lock lubrication fitting and piping shall be of the material type, grade, and size specified on the contract drawings.

Span lock lubrication fittings and piping shall also meet the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

EXECUTION

1. SHOP ASSEMBLY AND TESTING. Machinery components shall be shop assembled to verify their correct fit prior to shipment. Each span lock system shall be shop tested under load. Each span lock system comprises (1) linear actuator, (1) lock bar, (1) set of front and rear lock bar

guides, (1) lock bar receiver, and all of the accessories specified on the span lock assembly drawing (see Contract Drawings). There are a total of four span lock systems.

2. FIELD ALIGNMENT. During final alignment of the new lock bar machinery, the span must be fully seated so that the live load bearings are in full contact. The guides and sockets must be mounted so that the lock bars are seated level and there is full contact between the lock bars and shoes. A procedure shall be submitted for approval for the installation and alignment of the lock machinery.

3. FINAL TESTING. After installation and final adjustments, the span lock bar machinery shall be cycled a minimum of ten (10) operations for inspection and the clearance requirements specified on the drawings shall be verified by the Contractor in the presence of the Engineer.

4. PAINTING. All span lock assemblies shall be shop painted and field painted with the paint materials specified per the requirements of the MECHANICAL GENERAL REQUIREMENTS special provision.

5. METHOD OF MEASUREMENT. All Span Locks work shall be measured on a lump sum basis. No separate measurement will be made for work in this section.

6. BASIS OF PAYMENT.

a) The accepted quantity of Special Provision will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 45 percent of the lump sum price will be made upon purchase of raw materials including forging, fabrication, shop testing, and delivery to the project site.

(3) The third payment at 45 percent of the lump sum price will be made upon approval of the installation and alignment work by the Engineer.

(4) Payment of the remaining amount will be made after acceptance testing and punch list items have be resolved.

c) Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Span Locks)	Lump Sum

SPAN BALANCING

xx. GENERAL. This work shall consist of the Contractor developing calculations and testing the operation of the bascule span to ensure its balance. This work also includes the steel blocks required to achieve the balance condition plus an additional 1% to be left on site for future balance adjustments.

Products. All materials shall conform to the requirements shown on the Plans and as specified in the MECHANICAL GENERAL REQUIREMENTS special provision. Balance blocks shall be as shown on the balance sheet.

xx. EXECUTION.

(a) Calculation Procedures. During the shop drawing development, the Contractor shall prepare complete and thorough center of gravity calculations for the bascule span. These center of gravity calculations shall be obtained by using weight take-off from approved shop drawings for the structural steel and bridge railing, bar lists for the concrete deck, sidewalk and parapets, test blocks for all types of concrete to be used on the bascule span and estimation of the weight of paint on the structural steel along with incidentals such as navigation lighting, conduits, wiring, span locks, platforms, etc.

Weights for structural steel shall be computed on the basis of the net finished parts as shown on the shop drawings deducting for cope, cuts, clips and all open holes; but including weights of bolts, nuts, washers and welds.

The Contractor shall compute the weights of individual components to two decimal places and summarize to the nearest whole number. Calculations shall be furnished showing the development of these weights.

The center of gravity of each component shall be located both horizontally and vertically. The center of gravity distances shall all be dimensioned to the centerline of trunnion. All dimensions shall measured in fee to two decimal places.

Positive (+) distances will be for elements forward and above the centerline of trunnion, while negative (-) distances will be for elements having centers of gravity behind or below the centerline of trunnion.

The Contractor shall submit center of gravity calculations in a tabulated form showing the component's weight, distances from center of roll to the components center of gravity (both horizontally, vertically and transversely, where necessary), the product of the weights and arms and the net summation for the quantity take-off. This tabulation shall be developed for each

bascule leaf, each counterweight and the complete structure, which is the combination of both.

These calculations shall be utilized by the Contractor in developing the required information for the counterweight calculations.

No construction shall proceed on the counterweight until the balance calculations have been reviewed and approved by the Engineer. The balance calculations shall be prepared, signed and sealed by a Professional Engineer familiar with movable bridges.

Balance calculations shall be prepared and balance adjustments performed such that, in the calculations, the bascule span is balanced. It is desired to have a slight unbalanced condition, which will be specified in the ensuing paragraphs and adjusted for, in the field.

The Contractor shall maintain a copy of the balance tabulation on site and correct the calculations to reflect any adjustments required for field installation of the components.

Balancing Procedures (to be performed on each leaf individually)

After the concrete counterweight and slabs, sidewalks and curbs, railings are constructed and the counterweight adjusted for the predetermined balance by installing some of the balance blocks, the Contractor shall take a preliminary balance reading of the bascule span. This preliminary reading shall be performed by jacking the span using pressure readings from hydraulic jacks placed under the live load shoe. No extraneous loads shall be on the span during the jacking.

The Contractor shall place a calibrated load cells under each bascule girder live load bearing shoe and apply sufficient load to unseat the span from the bearings. Pressure readings at each jack shall be taken to determine the rough unbalanced moments.

An unbalanced moment no greater than 212 kip-ft in the direction of the channel (span heavy) will be considered acceptable. If a greater moment exists, the Contractor shall rebalance and re-jack the span until this moment is attained. At no time will a moment in the direction of the counterweight (tail heavy) be acceptable. The Contractor shall repeat this procedure until the amount of unbalanced moment is acceptable.

Once this initial balancing has been performed, the Contractor shall operate the bascule span utilizing the hydraulic drive system. The operation of the span shall occur with no extraneous loads on the span and when the weather and wind conditions impose no additional loading on the span.

Pressure gages shall be installed on both ends of the hydraulic cylinders. The span shall be raised and lowered for two cycles.

Pressure readings at both ends of both cylinders will be taken simultaneously at five-degree increments for the full operating cycle of raising and lowering the span. With this information, the Contractor shall record the pressure readings as compared to the angle of span opening and develop a graph of span unbalance.

From this information, the Contractor shall calculate the magnitude of friction, unbalance and recommend a placement of balance blocks to obtain the prescribed state of balance to the Engineer for review and approval.

After the balance blocks have been placed, a second test operation will be run and recorded as previously mentioned. If the operation indicates a need to further refine the balance, the Contractor shall make the adjustments in balance block placements. This procedure shall be repeated until the desired span balance is obtained.

The desired state of balance for the bascule spans provides a distance of XX Feet from the center of trunnion to the combined center of gravity of the counterweight and the span. The center of gravity of the counterweight and span shall be located at a angle of 20 degrees above a horizontal line through the center of the trunnion.

The Contractor may submit for review and approval an alternate method of span balance. Rejection of alternate method shall at no time be considered extra cost to the owner.

xx. METHOD OF MEASUREMENT. Span Balancing shall be paid at the Lump Sum Price for all calculations, equipment and required to achieve the desire span balance condition.

xx. BASIS OF PAYMENT. Balance blocks required to achieve the desired span balance condition balance an each basis.

Payment will be made for all of the work as described in this special provisions required to balance the bridge to the desired balance condition as approved by the engineer at the Lump Sum price bid for Item 900.645 Special Provisions (Bridge Balance).

Payment will be made for Each Balance Blocks installed in the counterweight or as directed by the engineer for future use at the price bid for Item 900.635 Special Provisions (Balance Blocks - Weight)

Payment will be made under:

Pay Item	Pay Unit

900.635	Special Provision (Balance Blocks - Weight)	LB
900.645	Special Provision (Bridge Balance)	Lump Sum

GENERAL ELECTRICAL REQUIREMENTS

xx. DESCRIPTION. This section consist of general requirements for the Electrical contractor and system integrator

xx. GENERAL REQUIREMENTS.

A. Bridge Operation. The contractor shall be responsible for all bridge operation during construction, including any interim balancing under the supervision of the Engineer. The contractor shall coordinate all operations including but not limited to all bridge openings with the Engineer. The contractor shall provide rechargeable 2-way radios with a minimum range of five miles to the bridge tender, the superintendent, flaggers, etc. as required.

B. Plan of Operation. The Contractor shall submit a detailed written plan of operation to the Engineer prior to beginning any work. The plan of operation shall include all details of construction staging, lane closure, and span operation for a successful execution of the work as shown in the contract drawings and described in this specifications. The cost for this written plan of operations shall be considered as included within the price bid for various pay items of this Contract. Review of the shop drawings will not commence until the Engineer has completed his review and approval the written plan of operations.

xx. APPLICABLE STANDARDS AND SPECIFICATIONS. Work under each individual section shall comply with, but not be limited to, all applicable requirements of the codes and standards referenced throughout this special provision. Work shall comply with all applicable Federal, State and Local rules, regulations and ordinances. In the event of a conflict between these specifications and the above mentioned codes, standards, rules, regulations and ordinances, it shall be brought to the attention of the Engineer and the most stringent requirement shall apply.

xx. SUBMITTALS.

a) Shop Drawings and Required Submittals: The Contractor shall prepare shop drawings in accordance with AASHTO Standards and in addition, meet the requirements listed in this special provision and VTRANS Standard Specifications for Construction.

(1) The Contractor shall submit the required assembly drawings in accordance with Section 105. The assembly drawings shall show all components mounted to supports, erection drawings, shop drawings, certified prints & catalog cuts for the equipment as listed in the individual section to the Engineer for review.

(2) In case of correction or rejection, the Contractor shall resubmit prints of assembly drawings, erection drawings, shop drawings, certified prints & catalog cuts until they are approved. The Contractor shall bear all costs for damages, which may result from the ordering of any materials prior to the

approval of the shop drawings; and no work shall be done until the shop drawings therefore have been approved. After approval of the shop drawings, the Contractor shall supply the Engineer prints of the approved shop drawings as may be ordered.

(3) Shop Drawings, Final Record Drawings, Certified Drawings, Operation and Maintenance Manual, Machinery Installation Procedures and other required submittals specified within these Special Provisions shall be submitted to Engineer for review and approval. Submittals that do not meet the minimum requirements identified below will be considered non-responsive and will be returned without review. Submittals that have not been approved or require correction shall be resubmitted until such time as they are acceptable to the Engineer, and such procedure shall not be considered cause for delay. The Contractor shall bear all costs for damages which may result from ordering or fabrication of any materials prior to acceptance of Shop Drawings. The Contractor may request in writing from the Engineer approval to order raw materials of the correct type for later fabrication from approved Shop Drawings after they have been accepted. Such approval by the Engineer shall be in writing. No installation or assembly shall commence without approved installation and alignment procedures and supporting Assembly or Erection Drawings.

(4) See individual section for the required shop drawing submittal, test reports, installation, operational and maintenance requirements.

(5) Manufacturer's data and/or shop drawings shall be submitted for all manufactured and purchased bridge equipment items.

(6) The Contractor shall coordinate the work of the equipment manufacturers where components interface. The Contractor shall review and approve all shop and working drawings prepared by those Manufacturers for coordination prior to submittal of shop drawings to the Engineer for approval.

(7) Shop drawings shall show all parts completely detailed and dimensioned as mentioned under each equipment section. Reproduction of the contract drawings shall not be used as base sheets for assembly or erection drawings.

(8) Materials and material specifications shall be stated for each part. Where ASTM or any other standard specifications are used, the applicable numbers of such specifications shall be given.

(9) Submittals for each manufactured item shall be manufacturer's descriptive literature, drawings, diagrams, performance and characteristic curves and catalog cuts and shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, certified layout dimensions, capacity, specification reference, including ASTM, ANSIand any other

applicable references and all other information necessary to establish Contract compliance.

(10) Shop drawings shall show all external dimensions and clearances necessary for installation and operation of all equipment.

(11) For all assemblies and parts, the Contractor shall furnish complete assembly drawings or diagrams showing each part contained therein and the manufacturer's part number assigned to each part. The drawings or diagrams shall be sufficient to enable complete disassembly and reassembly of the assemblies covered. In the event that any part is modified in any manner from the way it is described or delivered by its original manufacturer, the Contractor shall furnish a drawing which details each modification and the part shall be assigned a unique part number to assure the furnishing of replacement parts modified in similar fashion.

(12) Certified prints of each manufactured assembly shall be furnished. Certified prints are manufacturer's drawings of proprietary products on which the manufacturer or supplier states mounting dimensions, ratios, speeds, ratings and any other correctness for use on this specific project. In addition to identifying and describing each part, they shall show.

a. Dimensions of all principal parts comprising the assembly.

b. Certified external dimensions affecting clearances and required for installation.

c. Capacity and normal operating ratings.

d. Details or description of all fasteners required to mount the assembly.

e. Gross weight.

f. Certified prints shall be signed by an officer of the manufacturing company.

(13) All proprietary items shall be shown in outline on shop drawings, which shall also indicate the method and sequence to be employed in assembly of bridge equipment and installation of necessary utilities to support and service facilities. The assembly drawings of each item shall, in addition to identifying and describing each internal part, contain dimensions of all principal elements within the item; certified external dimensions affecting interfaces or installations; gross weight capacity and normal operating ratings; method.

(14) Complete shop bills of materials shall be made for all electrical and mechanical equipment. If the bills are not shown on the shop drawings, prints of the bills shall be furnished for approval in the same manner as specified for the shop drawings.

(15) The weight of each piece of equipment shall be stated on the shop drawing upon which it is detailed or billed.

(16) Complete assembly and erection drawings shall be furnished. These drawings shall give part numbers, match marks and essential dimensions for locating each part or assembled unit with respect to the bridge structure or foundation.

(17) Where equipment or materials are specified to conform to requirements of the standards of an organization, such as Underwriters Laboratories (UL), that use a label or listing as method of indicating compliance, proof of such conformance shall be submitted and approved. The label or listing of the specified organization will be acceptable evidence. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization adequately equipped and competent to perform such services and approved by the Engineer, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code.

(18) As used herein, certified test reports refer to reports of tests conducted on previously manufactured materials or equipment identical to that proposed for use.

(19) As used herein, factory tests refer to tests required to be performed on the actual materials or equipment proposed for use. Results of the tests shall be submitted in accordance with the provisions of this Contract for laboratory test results.

(20) If any departures from the Contract Documents are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Engineer in writing as soon as practicable for his approval. No departures from Contract Drawings shall be made without the Engineer's approval.

(21) If the Contractor has any objection to any feature of the bridge system as designed or required by the contract drawings, it shall be stated in writing to the Engineer at the time of submitting shop drawings or prior thereto; otherwise his objection will not be considered if offered later as an excuse for malfunctioning, defective, broken machinery or tolerances that cannot be achieved.

(22) It is the Contractor's responsibility to manufacture and install suitable functioning electrical system. Review and approval of shop drawings by the Engineer does not relieve the Contractor of this responsibility

(23) It is the contractor's responsibility to determine the size, weight and type of all construction equipment to be used on the structure based on the existing condition of the structure. No overload vehicles shall be permitted on the structure. The

determination of permissible loads shall be made by a Professional Engineer licensed in the state of Vermont and employed by the Contractor. Intended loadings shall be submitted to the Engineer for approval prior to moving any construction vehicles onto the bridge structure.

(24) All equipment and materials specified shall be new. All equipment, materials, and workmanship shall be first-class in every aspect and shall be manufactured and erected to the satisfaction of the Engineer. The Contractor shall warrantee the in-service working of the systems listed herein and associated equipment for two years following the date of project acceptance (unless otherwise noted). If the Contractor has any objection to any feature of the equipment as designed and laid out, he must state his objection at once, in writing, to the Engineer. Otherwise, his objection will not be valid as an excuse for operational malfunctioning of the equipment for defective and/or broken apparatus.

xx. TESTING

a) Field Start-Up and Testing. Included with the furnishing of the major items of equipment by the manufacturer shall be the furnishing of all necessary field supervisory start-up time by the manufacturer's Service Engineering Agency to facilitate proper adjustment of the equipment.

(1) The manufacturer's Field Service Engineering Personnel shall be experienced in the adjustment and functioning of the particular control equipment furnished by the manufacturer. The personnel shall be capable of locating and correcting faults or defects and of obtaining from the manufacturer, without delay, new parts or replacements for apparatus that, in the opinion of the Engineer, does not perform satisfactorily.

(2) When the permanent machinery is ready for field testing, the operating machinery shall be driven by the main electrical system (utility power) through at least fifteen complete cycles with no fault and with the alternate power (generator) system a minimum of five(5) times to be considered complete. A final testing procedure shall be submitted which includes testing the new drive systems with the main and alternate power.

(3) See Commissioning & Start Up section for testing requirements.

b) Inspecting and Testing

(1) Whenever factory testing is required to be witnessed by the Engineer. The Contractor shall give no less than ten (10) working days notice to the Engineer (unless otherwise noted) prior to the beginning of work at manufacture facilities so that inspection may be provided. No materials shall be produced

before the Engineer has been notified where the orders have been placed.

(2) The Engineer shall reject materials or workmanship, which do not fulfill the requirements of these Specifications.

(3) Inspection at the manufacturer facilities is intended as a means of facilitating the work and shall not relieve the Contractor of their responsibility in regard to imperfect material or workmanship and the necessity for replacing defective materials or workmanship which are delivered to the job site.

(4) The Contractor shall furnish the Engineer with a copy of all orders covering work performed by subcontractors or suppliers.

(5) The acceptance of any material or finished parts by the Engineer shall not be a bar to their subsequent rejection if found defective. Rejected material and workmanship shall be replaced or made acceptable by the Contractor at no additional cost.

(6) Contractor Inspection:

a. After installation is completed, the Contractor shall make a thorough inspection to insure that all equipment has been properly installed, that all electrical wiring and grounding conductors are properly landed and that no conductors will cause shorts upon energization.

b. The Contractors shall be accompanied by the Engineer, during his final inspection before bridge testing. On the basis of the results of this inspection, the Engineer shall determine whether the bridge is ready for testing.

xx. OTHER REQUIREMENTS.

a) Delivery and Storage

(1) All equipment shall be cleaned of dirt, chips, grit and all other injurious materials prior to shipping and shall be given a coat of corrosion-inhibiting preservative unless otherwise noted.

(2) Finished metal surfaces and unpainted metal surfaces that would be damaged by corrosion shall be coated as soon as practicable after finishing with a rust-inhibiting preservative.

(3) Any interface between stainless steel or aluminum and Structural Steel shall receive an Engineer approval coat of zinc-chromate primer prior to assembly.

(4) All equipment shall be completely protected from weather, dirt and all other injurious conditions during manufacture, shipment and storage.

(5) Assembled equipment shall be mounted on skids or otherwise crated for protection during handling and shipment.

b) Spare Parts: See spare part list under each equipment section.

c) Packaging and Delivery of Spare Parts:

(1) Spare parts shall be protected for shipment and prolonged storage by coating, wrapping and crating.

(2) All spare parts shall be durably tagged or marked with a clear identification showing the designation used on the approved shop drawing.

(3) Crates for spare parts shall be clearly marked on the outside to show their contents. Coordinate storage location of spare parts with the Engineer. Spare parts shall be delivered to a location designated by the Engineer.

d) Guarantees and Warranties

(1) Manufacturer's warranties or guarantees on equipment, materials or products purchased for use on the contract which are consistent with those provided as customary trade practice, shall be obtained by the Contractor and, upon acceptance of the Contract, the Contractor shall assign to VTRANS, all manufacturer's warranties or guarantees on all such equipment, material or products furnished for, or installed as part of the work.

(2) The Contractor shall warrant the satisfactory in-service operation of the bridge equipment, material, products and related components. This warranty shall extend for a minimum period of two years following the date of final acceptance of the Project, unless individual sections in this spec requires longer warranty period.

e) Quality Assurance

(1) Qualifications, Personnel and Facilities

a. Products used in this work shall be produced by manufacturers regularly engaged in the manufacture of the specified products.

b. For the fabrication, installation, cleaning, aligning, testing and all other work required by each individual section, the contractor shall use adequate numbers of skilled and trained staff who are thoroughly familiar with the requirements and methods specified for the proper execution of the specified work. The Contractor shall provide personnel and supervisory personnel with a minimum of two movable bridge jobs as previous experience in the installation of bridge equipment.

c. The Contractor shall provide all necessary tools and instruments required for the proper performance of the personnel engaged in the execution of the specified work.

f) Measurement and Verifications: Dimensions indicated on the Contract Drawings are nominal and are intended for guidance only. All variations from the nominal dimensions on the Contract Drawings shall be noted on the shop drawings.

g) Shop Assembly: Wherever stated in the equipment section, visual inspection of the shop-assembled equipment shall be made by, and shop tests shall be witnessed by, the Engineer or a designated representative of the Engineer. If any malfunctions are observed, they shall be corrected and such units shall pass all shop tests before release from the equipment manufacturer's shop. After each unit has passed all shop tests, the manufacturer shall prepare Certificates of Compliance with the specified tests and shall submit them to the Engineer.

h) Specialized Electrical Component Field Installation and Inspection: For the installation of all specialized electrical components, the Contractor shall provide for the presence at the job site of manufacturers service personnel skilled in these specialties. Such service personnel shall be properly equipped with all necessary instruments to assure that related components have been provided within acceptable tolerances and to make all necessary adjustments for attaining the specified ratings.

i) Defective Material And Workmanship:

(1) All equipment rejected during inspection and testing shall be removed from the work site and replaced without additional cost to VTRANS.

(2) Delays resulting from the rejection of material, equipment or work shall not be the basis of any claim.

(3) All defects found during the guarantee period resulting from faulty material, components, workmanship, or installation shall be corrected by the Contractor at no cost to VTRANS. VTRANS reserves the right to make necessary correction with its own forces and charge the resulting costs to the Contractor.

j) Training

(1) The Contractor shall provide five (5) days of instruction to VTRANS maintenance personnel. The instruction shall include but not be limited to the following with respect to all bridge components:

d. Maintenance

e. operation

f. Troubleshooting Procedures

g. Manufacturer's Recommendations

h. Lubrication

(2) The instruction shall be given during regular working hours on dates and times selected by VTRANS. The instruction may be divided into two or more periods at the discretion of VTRANS. The training sessions shall be videotaped by the contractor. Videotapes shall be delivered to VTRANS.

(3) Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material. The Contractor shall provide all special machining, conductors, or electrical devices and installation required by the manufacturer.

AMEND SECTION 529 - REMOVAL OF STRUCTURES AND BRIDGE PAVEMENT

xx. DESCRIPTION. The work shall consist of the following:

a) Demolition of existing electrical equipment as shown on the contract drawings.

b) Demolition work shall be staged as specified in the contract drawings to accommodate new work.

xx. REQUIREMENTS: The contractor shall employ lockout/tagout procedure during electrical demolition

xx. SUBMITTALS

a) Provide documentation of demolition and removal. Indicate limits and sequencing to be used. Show and identify any items to be kept for VTRANS reuse or retention.

b) Provide schedule of demolition activities including overall schedule, planned utility interruptions, interruptions of Owner/Using Agency services and traffic control if required.

c) Submit lockout/tagout procedure for Engineer review and approval.

xx. METHOD OF MEASURREMENT

a) Payment for demolition of the existing Electrical equipment will be paid under section 529 Removal of Structure and Bridge Pavement.

BRIDGE POWER EQUIPMENT

xx. DESCRIPTION. This work shall consist of furnishing all labor, materials, tools and equipment, and performing all operations necessary to install, field test and place in satisfactory condition, the bridge power equipment system as indicated on the contract drawings and specified herein. Included in this work is the furnishing and installation of the following:

a) Service Disconnect and Metering Equipment

b) Standby Generator

c) Automatic Transfer Switch with Surge Suppressor

d) Low voltage distribution transformers

e) Panelboards

f) Disconnect Switches

g) Boxes/Enclosure/Cabinets/

h) Heating Contactors

i) Lighting and Receptacles

j) Heat Trace System

k) CCTV system

l) Grounding

m) Underground pull box (Hand hole)

n) Conduits, conductors and all other materials necessary for providing power to the movable bridge.

Any incidental apparatus, appliance, material, or labor not herein specifically mentioned or included that may be found necessary to comply with the requirements of the related documents and referenced standards or codes shall be furnished by the Contractor just as if specifically mentioned in these Specifications and without additional cost to VTRANS.

xx. REFERENCES AND STANDARDS: Electrical equipment manufactured and installed shall conform to the requirements of the latest revisions of the applicable portions of the following standards:

a) AASHTO Standard Specifications for Movable Highway Bridges (AASHTO).

b) American National Standards Institute (ANSI)

c) NFPA 70, National Electrical Code (NEC), latest edition.

d) NFPA 79, Electrical Standard for Industrial Machinery, latest edition.

e) NFPA 110, Standard for Emergency and Standby Power Systems, latest edition

f) National Electrical Contractors Association, NECA 1-latest edition, Standard Practices for Good Workmanship in Electrical Contracting.

g) National Electrical Manufacturer's Association (NEMA).

h) Underwriters Laboratory (UL).

i) American Society for Testing and Materials (ASTM)

j) Institute of Electrical and Electronics Engineers (IEEE).

k) Any applicable local rules and ordinances.

xx. REQUIREMENTS: The materials shall meet the minimum requirements specified herein. Materials and equipment shall be essentially the standard catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements. Where two electrical units of the same class of equipment are required, these units shall be products of a single manufacturer. Each major component shall have the manufacturer's name and address and the model and serial number on a nameplate, securely affixed in a conspicuous place when installed. The name plate of the distributing agent will not be acceptable. All equipment and materials furnished under the items specified herein shall be brand-new. All new equipment, materials and workmanship shall be first class in every particular, and shall be manufactured and installed to the satisfaction of the Engineer and be in accordance with the recommendations of the manufacturer of the material being installed. Printed copies of these recommendations shall be furnished to the Engineer prior to installation. Portions or all of certain recognized industry or association standards or specifications referred to herein as being a requirement of these Special Provisions shall be considered as binding as though reproduced in full herein unless supplemented and/or modified by more stringent requirements of the Contract Documents. Unless otherwise stated the reference standard or specification which is current as of the date of issuance shall be used.

xx. SUBMITTALS:

a) Product Technical Data (Manufacturer Data): Submit the following

(1) Service Disconnect

(2) Standby Generator

(3) Automatic Transfer Switch

(4) Low Voltage Distribution Transformers

(5) Panelboards

(6) Disconnect Switches

(7) Boxes/Enclosure/Cabinets

(8) Contactors

(9) Light Fixtures

(10) Wiring/Conduits

(11) Light Fixtures and Receptacles

(12) Heat Trace Equipment

(13) CCTV equipment

(14) Grounding Equipment

(15) Underground pull box (Hand hole)

(1) And as listed in the individual sections

b) Drawings and Catalog Cuts: Provide the following:

(1) Certified dimension prints of all electrical equipment specified in this section.

(2) A complete schematic wiring diagram, including all power, control, and lighting connections. Each electrical device and each wire between devices shall be identified by an individual designation of letters, numbers, or a combination of both; and such designations shall be used wherever the devices or wires appear on other drawings. A complete set of catalog cuts for materials furnished shall be included for review at the time of schematic submittal.

(3) A schedule of electrical apparatus listing each electrical device by its designation as shown in the schematic wiring diagram and shall state for each device its rating, number of poles, contacts, function, catalog number and location.

(4) A complete schematic conduit and cable diagram showing the interconnection of all devices and equipment, including ducts and junction boxes, and showing all multiconductor cables. The size of each wire and conduit, the wire number of each conductor in multi conductor cables, shall be shown on the diagrams. Each conduit and multiconductor cable shall be suitably numbered and lettered, and percent wire fill shall be shown.

(5) A complete set of layout and installation drawings for the electrical work showing the location and installation, including support and mounting details, of all electrical apparatus and equipment. These drawings shall be made to scale and shall show the exact location of all conduits, cables, wiring ducts, boxes, limit switches, disconnect switches, and other electrical equipment and the method of supporting them on the structure.

(6) Outline drawings and mounting details of all lighting fixtures, navigation lights and air horns.

(7) Catalog cuts of lighting fixtures, switches and outlets.

(8) Arrangement of service light wiring and fixtures, including service outlets, showing all conduits, boxes (including their support) and wiring.

(9) Detail drawing showing the construction and mounting detail of all wireways and raceways.

(10) A complete list of all spare parts furnished as part of this Contract.

(11) Outline drawings and connection diagrams of the contactors used in the electrical lighting and heating system

(12) Any other drawings which may, in the opinion of the Engineer, be necessary to show the electrical work.

(13) And as listed in the individual sections.

c) All components of the same system shall be submitted together for review, unless otherwise approved by the Engineer. Review will not be performed unless all technical data, shop drawings and associated documents are submitted for all components that make up a system. An incomplete submittal will be rejected. Any delay in the project schedule due to an incomplete submittal will be at no additional cost to VTRANS.

d) Test Reports: Indicate procedures and values obtained as listed in the individual sections.

e) Nameplates shall be provided for all equipment enclosures and shall be made of laminated phenolic plastic with white front and back and black core and shall be not less than 0.25 inch thick. The lettering shall be etched through the front layer to show black engraved letters on a white background. Lettering shall be not less than 6mm high, unless otherwise detailed on the contract drawings. A sample Nameplate shall be submitted to the Engineer for Approval. Nameplates shall be securely fastened to the equipment/cabinet back panel with stainless steel screws. Nameplates on equipment installed outdoors exposed to the weather shall be engraved brass or stainless steel.

xxi. PRODUCTS

a) Service Disconnect and Metering Equipment: The contractor shall furnish and install a service disconnect switch and utility metering equipment as indicated on the contract drawings.

b) Generator: The contractor shall furnish and install a standby diesel generator and its auxiliary equipment in an outdoor enclosure as indicated on the contract drawings and specified herein. The generator

set installation and on-site testing shall conform to the requirements of the following codes and standards:

a. IEEE 446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

b. NFPA 70 National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

c. NFPA 99 Essential Electrical Systems for Health Care Facilities.

d. NFPA 110 Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

e. NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).

(2) The generator set and supplied accessories shall meet the requirements of the following standards:

a. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.

b. UL142 Sub-base Tanks.

c. UL1236 Battery Chargers.

d. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

(3) The control system for the generator set shall comply with the following requirements:

a. EN50082-2, Electromagnetic Compatibility Generic Immunity Requirements, Part 2: Industrial.

b. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.

c. FCC Part 15, Subpart B.

d. IEC8528 part 4. Control Systems for Generator Sets.

e. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.

f. UL508. The entire control system of the generator set shall be UL508 listed and labeled.

g. UL1236 Battery Chargers.

(4) The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

a. Submittal for review and approval the following information:

1. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.

2. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, microprocessor control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, fuel tank, radiator, thermal damage curve for generator, time-current characteristics curves for generator protective device, sound test data based on free field requirement.

3. Prototype Test Reports: Submittals will not be reviewed without submission of prototype test report as specified herein.

4. Submit statement of compliance which states that the proposed product is certified to the emission standard required by the location for EPA, stationary emergency application.

5. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing Agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

6. Manufacturer’s Certificate: Certify that Products meet or exceed specified requirements.

7. Alternator data indicating sub transient reactance and temperature rise rating to meet requirements specified herein.

(5) Generator Testing:

a. To provide proven reliability of the Generator set, these series of tests shall be performed, no exceptions taken:

1. Prototype model tests

2. Fully assembled factory production model tests

3. Field acceptance tests

4. Project specific equipment test

b. The manufacturer shall provide documentation demonstrating satisfactory prototype and production test results. Generator sets that have not been prototype tested and Factory Production tested as described herein shall not be acceptable.

c. Generator set Prototype Tests: These tests and evaluations must have been performed on a prototype generator set representative of the model specified. Prototype testing shall consist of factory test of an engine-generator set of the same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

d. Test shall comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

e. A summary of the generator set testing results shall be submittal for review. The manufacturer=s standard series of components development tests on the generator system, engine and other major components shall be performed and available for review, but shall not be acceptable as a substitute for a prototype testing on the complete representative generator set prototype.

f. Torsiograph Analysis and Test: The manufacturer of the generator set shall verify that the engine generator set, as configured, is free from harmful torsional stresses. The analysis shall include correlation of empirical data from tests on a representative prototype. The empirical data must include spectrum analysis of the torsional transducer output within the operating speed range of the engine generator set. Calculations based on engine and generator separately are not acceptable.

g. Temperature Rise Test: Complete thermal evaluation of a prototype generator rotor and starter must include actual measurement of internal generator and exciter temperatures by embedded detector method, and measurement of average

temperature rise by resistance method. No position measured any place in the windings may exceed the temperature rise limits of NEMA for the particular type of insulation system used. Resistance method temperature rise data shall be confirmed by a full load test on the generator set prototype to include conducted and radiated heat from the engine.

h. Short Circuit Test: A test on a prototype generator set shall have demonstrated that the generator set is designed to withstand the mechanical forces associated with a short circuit condition. With the generator set operating at rated load and speed, the generator terminals must be short circuited on all three phases for duration of 20 seconds. At the conclusion of this test, the generator set must be capable of full load operation.

i. Endurance Run Test: A minimum of 500 continuous hours of endurance testing with a representative generator set prototype operating as defined by the manufacturer's standby rating shall have been performed. Endurance testing shall be used to verify structural soundness and durability.

j. Maximum Power Test: With the prototype generator set at normal operating temperature and with all power consuming auxiliaries in place, the maximum power available at rated speed shall be determined with the governor set at its fuel stop. The generator set shall maintain this power for a minimum of two (2) minutes.

k. Linear Vibration Test: A test for in-line motion of components occurring along a repeatable path shall meet the manufacturer's acceptable criteria.

l. Cooling System Test: A cooling system test shall demonstrate the ability of the generator set cooling system to maintain normal operating temperature while operating at full rated load and power factor at the highest ambient temperature (122 °F) of the system rating. Cooling air requirements, radiator air flow and maximum allowable restriction at radiator discharge shall be verified by this test.

m. Maximum Motor Starting KVA Test: Motor starting KVA shall be determined by test, based on a sustained RMS recovery voltage of at least 90 percent on no load voltage with the specified load KVA at near zero power factor applied to the generator set.

n. Transient Response, Steady State Speed Control and Voltage Regulation Test: Prototype generator set tests shall demonstrate consistent performance as follows; stable voltage and frequency at all loads from no load to full rated load, consistent frequency kp on load acceptance and rejection and restoration to steady state after sudden load changes.

Transient response is a complete generator set (engine, generator, exciter, and regulator) performance criteria and cannot be established on generator data alone.

o. Witness-Generator Set Factory Production Tests: The test shall be performed prior to shipment and shall be witnessed by the Engineer or Engineer approved personnel. A four (4) hour test shall be performed at rated load and 0.8 PF. These tests shall include certified data to document the following: run at full load, maximum power, voltage regulation, transient and steady state governing, single step load pickup and safety shutdowns. Provide a factory test record of the production testing. The Contractor and/or equipment supplier at their expense shall coordinate and provide all transportation and lodging for the owner and Owner's Engineering representative to witness the above stated factory test. Tests performed at facilities other than the manufacturer's factory shall not be acceptable.

p. Factory Test: The unit shall completely assembled and all preliminary adjustments made before the test is initiated. 200 KW genset shall be tested with the complete radiator and fan assembly to be shipped. Outside radiator, heat exchanger attachments shall not be acceptable. Before shipment, perform tests at rated load and power factor. Include the following tests:

    1. Test engine generator to demonstrate compatibility and functionality.

    2. Full load run.

    3. Maximum power.

    4. Voltage regulation.

    5. Steady-state governing.

    6. Single-step load pickup.

    7. Simulated safety shutdowns.

    8. Testing Procedure: Test diesel-alternator unit at 0.8 PF in the following sequence

        a. 0.5 hour at 30% load.

        b. 1.0 hour at 20% load.

        c. 1.0 hour at 50% load.

        d. 2 hours at full load.

    9. Provide 14 days advance notice of factory tests and opportunity for observation of tests by the Engineer.

10. Above testing shall be strip chart recorded and certified. During this test, the following measurements shall be taken and recorded on a certified report format:

    a. Barometric Pressure.

    b. Intake Air Pressure.

    c. RPM.

    d. Output voltage per phase.

    e. Output amperes per phase.

    f. Power Factor.

    g. KW.

    h. Winding temperature.

    i. Transient response testing sequence:

    j. 0-25%, 25%-0.

    k. 0-50%, 50%-0.

    l. 0-75%, 75%-0.

    m. 0-100%, 100%-0.

11. Comparison shall be made to the specified alternator performance characteristics prior to acceptance.

12. Field Acceptance Tests:

    a. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system.

    b. Generator supplier shall provide and conduct a two (2) hour 100% load bank test at unity power factor for the generator set. Load bank test shall test each generator at full nameplate KW ratings. Generator manufacturer's representative shall record test data, as described below. Test data shall be tabulated and typed for submission and approval by the Engineer for final

acceptance. No handwritten field notes will be allowed.

c. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

d. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

e. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

13. Initial start up and field acceptance tests are to be conducted by the authorized representative of the system manufacturer who supplies the equipment. Contractor responsible for protection of testing equipment and any additional cable, etc., required if equipment cannot be located internally during testing.

14. Test data shall be collected and recorded on the following: Time of day, coolant temperature, operating oil pressure, battery charging rate, cranking time, crank-to-rated frequency time, voltage and frequency overshoot, load assumption-to-steady state voltage and frequency stabilization time, operating voltage, frequency, current, kilowatts and power factor. All data shall be taken every fifteen (15) minutes.

(6) Manufacturer

a. The generator shall be manufactured by Cummins-Onan, Caterpillar, Kohler or approved equal:

b. The generator manufacturer shall have a minimum of ten (10) years documented experience. The manufacturer shall have an authorized distributor offering 24 hour parts and service availability within 50 miles of the project site. The proposed engine/generator combination shall have been in production for a minimum of five (5) years.

c. The manufacturers authorized distributor of specified manufacturer with minimum five (5) years documented

experience with specified products and factory-trained service technicians.

d. Packaged generator set and auxiliary components shall be obtained from a single manufacturer.

e. The manufacturer shall be able to maintain model and serial number record for the generator set installed for at least 20 years.

(7) Delivery, Storage and Handling

a. Provide written verification that Genset tested and Genset received are one and the same.

b. Protect equipment from dirt and moisture by securely wrapping in heavy plastic during construction and prior to shipping. Inspect for damages prior to shipping and installation. The Contractor shall bear all costs for damages, which may result from shipping and installation of the generator

(8) Spare Parts: Provide two (2) of each fuel, oil and air filter element, engine belts and hoses.

(9) Warranty: Manufacturer shall provide base warranty on the material and workmanship of the generator set for a minimum of five (5) years or 1500 hours from the registered commissioning and startup date.

(10) Service Agreement: Manufacturer shall provide Owner with a one (1) year service agreement that includes changing all fluids and filters once a year and a minor inspection six (6) months after each change.

(11) Generator Engine Set

a. The basis of design is Cummins Power Generation Equipment, model DSGAE rated for STANDBY POWER.

b. It is intended that all products specified herein be of standard ratings, therefore, the KW and KVA, starting KVA and maximum allowable voltage dip, ratings, etc., shall be the manufacturer’s next size or rating to exactly meet the specifications. No exceptions.

c. Rating:

1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 200.0kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 wire, 60 hertz.

2. Alternator shall be capable of accepting maximum 920.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the

application of the specified kVA load at near zero power factor applied to the generator set.

d. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

e. Generator Set Performance:

3. Steady State Voltage Operational: 0.5 percent of rated output voltage from no load to full load.

4. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.

5. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.

6. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

7. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

8. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic and no third order harmonics or their multiples. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 40.

9. Sustained Short-Circuit Current (For PMG-excited alternator engine-generator) : For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

10. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.

11. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

f. Engine

1. The Engine shall be diesel, EPA TIER 3 Certified, 4 cylce, radiated and fan cooled.Minimum displacement shall be 408 cubic inches. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories.

2. Fuel: ASTM D975 #2 Diesel Fuel

3. Rated Engine Speed: 1800RPM

4. Lubrication System: The following items shall be mounted on the engine or skid:

    a) Lube oil pump: Oil pump shall be positive displacement, mechanical, full pressure pump.
    b) Filter and Strainer: The filter and strainer shall be provided by the engine manufacturer of record. Provide adequate filtration for the prime mover to be used.
    c) Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

5. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer’s instructions

6. Main Fuel Pump: Fuel pump shall be mounted on the engine and it shall ensure adequate primary fuel flow under starting and load conditions.

7. Coolant Jacket Heater: Jacket heater shall be electric-immersion type, it shall be factory installed in coolant jacket system. Jacket heater shall comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.

a. Heater shall be designed for operation on a single 120 VAC, single phase, 60Hz power connection. Heater voltage shall be shown on the shop drawings
b. Heater shall be installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
c. Heater shall be provided with a 12VDC thermostat, installed at the engine thermostat housing

8. Engine generator system shall withstand the following environmental condition without mechanical or electrical damage or degradation of performance capability:

9. Ambient Temperature: -28.89 degree C (-20.0 degree F) to 10.0 degree C (50.0 degree F).

10. Relative Humidity: 0 to 95 percent.

11. Altitude: Sea level to 104.0 feet (31.7 m).

g. Governor

1. The governor shall be adjustable isochronous, with speed sensing, the governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

h. Cooling System: Closed loop, liquid cooled

1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 50 deg C.

2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.

7. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.

8. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

9. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.

    a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified above.
    b. Cranking Cycle: As required by NFPA 110 for level 1 systems.
    c. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
    d. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
    e. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads

connected within 4 hours after a normal engine starting sequence.

f. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:

i. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

ii. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

iii. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

iv. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

v. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

vi. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet

10. Fuel Oil Storage

a. Oil storage shall comply with NFPA 30.
b. Generator shall be provided with a sub base tank with double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 142 listed and labeled. The fuel tank shall include the following features:
c. Capacity: Fuel for 24 Hour(s) continuous operation at 100 percent rated power output.
d. Tank rails and lifting eyes and they shall be rated for the full dry weight of the tank, genset, and enclosure.
e. Electrical stub up(s)
f. Normal & emergency vents
g. Lockable fuel fill
h. Mechanical fuel level gauge
i. High and low level switches to indicate fuel level
j. Leak detector switch
k. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
l. Fill port with overfill prevention valve (OFPV)
m. Tank design shall meet the regional requirements for the Project location

11. Controlling and Monitoring

a. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
b. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut

down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

12. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

13. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

14. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

    a. AC voltmeter (3-phase, line to line and line to neutral values).
    b. AC ammeter (3-phases).
    c. AC frequency meter.
    d. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
    e. Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
    f. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
    g. DC voltmeter (alternator battery charging).
    h. Engine-coolant temperature gauge.
    i. Engine lubricating-oil pressure gauge.
    j. Running-time meter.

d) Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.

e) Fuel tank derangement alarm.

f) Fuel tank high-level shutdown of fuel supply alarm.

g) AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR over current, loss of voltage reference, and over excitation shut down protection. There shall be an overload warning, and overcurrent warning alarm.

h) Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.

i) A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.

j) Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.

k) Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.

l) DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

15. Generator, Exciter, Voltage Regulator and Protection shall comply with NEMA MG-1

16. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

17. Electrical Insulation: Class H

18. Temperature Rise: 105 / Class F environment.

19. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

20. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.

21. Enclosure: Drip-proof.

22. Voltage Regulator: SCR type, Separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.

23. The alternator shall be provided with anti-condensation heater(s) in all applications where the generator set is provided in an outdoor enclosure, or when the generator set is installed in a coastal or tropical environment.

24. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

25. Sub transient Reactance: 15 percent maximum, based on the rating of the engine generator set.

26. The alternator shall be provided with an overcurrent protection relay that is UL-listed under category NRGU. The overcurrent protection system shall be coordinated with the thermal damage curve of the specific alternator provided. Submit thermal damage curve for alternator and protection curve (and settings if applicable) for the overcurrent protective system

i. Vibration Isolation Devices

1. The Generator shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

j. Finishes

2. Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the contract drawings.

k. Generator Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

l. Generator Connection

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.

2. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

m. Generator Engine and Engine Equipment

1. The engine shall be diesel, EPA TIER 3 Certified, 4 cycle, radiator and fan cooled. Minimum displacement shall be 408 cubic inches. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories.

2. A digital electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant

temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cool down at idle function. While operating in idle state, the control system shall disable the alternator excitation system.

3. Skid-mounted radiator and cooling system rated for full load operation in 132 degrees F (55 degrees C) ambient as measured at the alternator air inlet. With sound attenuated enclosure, unit shall have an overall rating of 132 F (55 degrees C). Radiator fan shall be suitable for use in a system with 0.5 in H2O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental Electric starter(s) capable of three complete cranking cycles without overheating.

n. Generator Engine Accessory Equipment

1. The engine for the generator shall include the following accessories:

   a. Positive displacement, contact.

   b. Mechanical, full pressure, lubrication oil pump.

   c. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

   d. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.

e. Replaceable dry element air cleaner with restriction indicator.

f. Flexible supply and return fuel lines.

g. Engine mounted battery charging alternator, 35-ampere minimum, and solid-state voltage regulator.

o. Coolant Heater: Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled

1. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

2. The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

   a. The coolant heater(s) shall be 120V, sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

3. Provide vibration isolators, pad type, quantity as recommended by the generator set manufacturer.

4. Starting and Control Batteries shall be calcium/lead antimony type, 12 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.

5. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade.

6. A UL listed 15 amp voltage regulated battery charger shall be provided for the engine-generator set, factory installed inside transfer switch.

7. Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the Drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.

8. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

Condition	Lamp Color	Audible Alarm
Genset Supplying Load	Amber	No
Charger AC Failure	Amber	Yes
Low Coolant Level	Amber	Yes
Low Fuel Level	Red	Yes
Check Genset	Amber	No

Not In Auto	Red	Yes
Genset Running	Amber	No
High Battery Voltage	Amber	Yes
Low Battery Voltage	Red	Yes
Weak Battery	Red	Yes
Fail to Start	Red	Yes
Low Coolant Temperature	Red	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Red	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
(4) Spares	Configurable	Configurable

c) Automatic Transfer Switch(ATS): The contractor shall furnish and install an automatic transfer switches as indicated on the contract drawings.

(1) The automatic transfer switch (ATS) system shall consist of completely enclosed contact assemblies and a separate control logic panel. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

(2) The transfer switch shall be bypass isolation type

(3) The transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically locked in position in both normal and emergency positions. A neutral position shall not be possible under normal electrical operation.

(4) The automatic transfer switch shall be rated in amperes for total system. Automatic transfer switches not intended for continuous duty or repetitive load transfer switching are not acceptable.

(5) The automatic transfer switch shall be rated to withstand the rms symmetrical short circuit current available at the automatic transfer switch terminals, with the type of overcurrent protection shown on the Contract Drawings.

(6) The ATS shall be furnished and installed in a NEMA 4X stainless steed enclosure as shown on the contract drawings.

(7) The ATS enclosure shall contain two circuit breakers and a surge protection device as shown on the contract drawings.

(8) The transfer switch shall have the following characteristics:

a. 400 amp current rating, 3 Pole, 4-wire, 3-phase, 600Volt-60Hz switched, overlapping neutral

b. The withstand and closing ratings with a current-limiting fuse shall be 65,000 Amps

c. The withstand and closing ratings with any overcurrent protective device shall be minimum 22,000 Amps

d. The ATS shall be furnished and installed in a NEMA 4X stainless steed enclosure as shown on the contract drawings.

e. The ATS enclosure shall contain two circuit breakers as shown on the contract drawings.

f. The switch shall be a 600 volt class.

g. All main contacts shall be of silver composition. The main contacts shall be protected by arcing contacts.

h. The contact transfer time shall not exceed one-sixth of a second.

i. Transfer switches shall be capable of being operated manually under full load conditions.

(9) Transfer Switch Control System

a. The control module shall direct the operation of the transfer switch. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller. Set points shall be stored in Non-Volatile memory, and use of an external battery source to maintain operation during “dead” periods shall not be required.

b. The control module shall be mounted separately from the transfer mechanism unit for safety and ease of maintenance.

c. The microprocessor-based controller shall include a backlit LCD display, and shall display the following:

   i. Line-to-line voltages for each source and the load

   ii. Line frequency for each source

   iii. Real-time clock

   iv. Set points

   v. The microprocessor-based controller shall include individual LED’s for indicating the following:

   vi. Source 1 available

   vii. Source 1 connected

   viii. Source 2 available

   ix. Source 2 connected

   x. Unit status

d. The microprocessor-based controller shall contain the following voltage and frequency features:

   i. The voltage of each phase of the normal source and the alternate source shall be monitored, with under voltage dropout adjustable from 50% to 97% of nominal and pickup adjustable from dropout setting +/-2% to 99% of nominal.

   ii. The voltage of each phase of the normal source and the alternate source shall be monitored, with over voltage dropout adjustable from 105% to 120% of nominal and pickup adjustable from dropout setting +2% to 103% of nominal.

   iii. The microprocessor-based controller shall contain the following time delay features:

   iv. A time delay to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.

   v. A time delay on transfer to alternate source

   vi. A time delay on retransfer from alternate source to normal source, adjustable from 0 to 1800 seconds. This time delay shall be bypassed if emergency source fails and normal source is available.

vii. A time delay after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 1800 seconds.

e. The microprocessor-based controller shall contain Three (3) SPDT contacts for control functions, rated 10A, 250VAC.

d) Low Voltage Distribution Transformers: The Contractor shall furnish and install single-phase and three-phase general purpose individually mounted dry-type transformers. The transformers shall be of the two windings type, self-cooled with electrical ratings as shown on the contract drawings and specified herein.

(1) The transformers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI, NEMA and UL.

(2) Transformers shall meet the requirements of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment"

(3) All transformers shall be UL listed and bear the UL label.

(4) Transformer Submittal: Submittal for review and approval the following

a. Outline dimensions and weights

b. Product data sheets/ Test Reports

c. Transformer ratings including:

1. kVA

2. Primary and secondary voltage

3. Taps

4. Design impedance

5. Insulation class and temperature rise

6. Sound level.

d. Final Submittal

1. The following information shall be submitted for record purposes.

2. Final as-built drawings and information for items listed in above and shall incorporate all changes made during the manufacturing process

3. Connection diagrams

4. Installation information

5. Seismic certification and equipment anchorage details as specified

e. Delivery, Storage and Handling

1. The transformers shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment.

f. Operation and Maintenance Manuals

1. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

g. Manufacturer: The transformers shall be manufactured by Square D or approved equal

h. Ratings: The KVA and voltage ratings shall be as indicated on the contract drawings

i. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

j. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Rating	**Noise Level**
0 to 9 kVA	40 dB
10 to 50 kVA	45 dB
51 to 150 kVA	50 dB

k. Construction

2. The transformer shall have an insulation system of 180°C with 115°C rise.

3. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40°C maximum ambient, and a 24-hour average ambient of 30°C

4. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

5. Transformer core shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current

losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical constructors grade copper with continuous wound construction

6. All cores to be constructed with low hysteresis and eddy current losses. The core flux density shall be well below the saturation point to prevent core overheating caused by harmonic voltage distortion. Transformers shall be common core construction. Transformers utilizing more than one core, or Scott-T connections, will not be acceptable

7. Transformer windings shall be of copper, shall be of continuous wound construction, and shall be impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads.

8. Transformer efficiency shall meet the DOE 10 CFR ART 431 at minimum.

l. Taps

1. Three-phase transformers rated 15 through 225 kVA shall be provided with six 2-1/2% taps, two above and four below rated primary voltage.

2. All single-phase transformers and three-phase transformers rated below 15 kVA shall be provided with the manufacturer’s standard tap configuration.

m. Enclosure

1. The enclosure shall be made of heavy-gauge steel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees C. The core of the transformer shall be grounded to the enclosure.

2. The enclosure construction shall be encapsulated, totally enclosed, non-ventilated, NEMA 3R. Enclosures shall be finished with ANSI 61 color, weather-resistant enamel.

3. NEMA 3R unless otherwise noted

(5) Factory Testing

a. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. Ratio tests at the rated voltage connection and at all tap connections

2. Polarity and phase relation tests on the rated voltage connection

3. Applied potential tests

4. Induced potential test

5. No-load and excitation current at rated voltage on the rated voltage connection.

b. Submit copies of test results to the Engineer for approval.

c. Installation

1. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

d. Field Adjustments

1. Adjust taps to deliver appropriate secondary voltage.

e. Field Testing

1. Measure primary and secondary voltages for proper tap settings.

e) Panelboards: The Contractor shall furnish and install panelboards, where indicated on the contract drawings and as specified herein

(1) The panel board shall consist of a dead-front panelboard incorporating circuit breakers of the number, rating, and type noted herein or shown on the contract drawings.

(2) Panel board shall be NEMA 1 unless otherwise noted

(3) Panelboards shall be circuit breaker equipped.

(4) Panelboards shall have general purpose enclosures and shall be surface mounted except where noted

(5) References

a. The panelboard shall be designed , manufactured and tested according to the latest revision of the following specifications

1. NEMA PB 1 - Panelboards

2. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

3. NEMA AB 1 - Molded Case Circuit Breakers

4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

5. UL 50 - Enclosures for Electrical Equipment

6. UL 67 - Panelboards

7. UL 98 - Enclosed and Dead-front Switches

8. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures

9. Federal Specification W-P-115C - Type I Class 1

10. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.

11. NFPA 70 - National Electrical Code (NEC)

12. ASTM - American Society of Testing Materials

13. IBC – International Building Code – Seismic compliance requirements

14. NFPA 5000 – NFPA Building Code – Seismic compliance requirements

15. NECA (National Electrical Contractors Association) "Standard of Installation."

16. ASCE 7 – American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures – Seismic compliance requirements

8. ICC ES AC156 – International Code Council Evaluation Services Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems – seismic testing protocol

(6) Submittal for Approval/Final Submittal

a. Submit for approval the overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions.

b. The location of the main, branches, and solid neutral shall be clearly shown on the drawings.

c. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

(7) Qualifications

a. Company specializing in manufacturing of panelboard products with a minimum of fifty (50) years documented experience.

b. Panelboards shall be manufactured in accordance with standards listed above.

(8) Delivery, Storage, and Handling

a. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish during shipping and installation.

b. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

c. The panelboards shall be installed per the manufacturer installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

(9) Manufacturer: The panelboard and its interior components shall be manufactured by square D, Eaton, General ELectric or approved equal

(10) Interior:

a. All panelboards shall be rated for the intended voltage and shall be in accordance with the Underwriters' Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes. They shall be rated for the intended voltage and shall be in accordance with the Underwriters' Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes."

b. Panelboards shall also comply with NEMA Standard for Panelboards, National Electric Code, and Federal Specification 115a (Power Distribution Panels) where applicable.

c. All interiors shall be completely factory assembled with switching and protective devices, wire connectors, etc. All terminals shall be suitable for copper wire of the sizes indicated.

d. Interiors shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so

designed that circuits may be changed without machining, drilling, or tapping.

e. Branch circuits shall be arranged using double row construction. A factory nameplate shall be provided listing panel type and ratings.

f. Bus bars for the mains shall be copper and sized in accordance with Underwriters' Laboratories standards. Unless otherwise noted, full size neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. The short circuit rating of the assembled panelboard shall be in accordance with Underwriters' Laboratories standards and their test verification.

g. The minimum Short Circuit Rating shall be 35KA rms symmetrical amperes

h. Provide one (1) continuous copper bus per phase; phase bussing shall be full height without reduction. Cross and center connectors shall be copper. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. Spaces for future switching and protective devices shall be bussed for the maximum device that can be fitted into them.

i. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.

j. A solidly bonded copper equipment ground bar shall be provided.

k. Split solid neutral shall be silver plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.

l. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers

(11) Box

a. Boxes shall be made from galvanized code gauge steel. Boxes shall be of sufficient size to provide a minimum gutter space of 140 mm on all sides. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be so sized as to include this wiring space. This wiring space shall be in addition to the minimum gutter space specified above and the limiting width may be increased accordingly. At least 4 (four) interior mounting studs shall be provided.

(12) Trim

b. The panel trim shall include hinged doors covering all switching device handles.

c. The Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting space

d. Doors in panelboard trims shall conform to the following:

1. In making switching device handles accessible, doors shall not uncover any live parts.

2. Doors shall have cylinder lock and catch, except that doors over 47.2 inches in height shall have auxiliary fasteners at top and bottom of door in addition to cylinder lock and catch. All locks shall be keyed alike; directory frame and card having transparent cover shall be furnished on each door.

3. The trims shall be fabricated from code gauge sheet steel.

4. All exterior and interior steel surfaces of the panelboard trim shall be properly cleaned and finished with gray ANSI-61 paint over a rust-inhibiting phosphatized coating.

5. Surface trims shall have the same width and height as the box. Trims shall be mountable by a screw-driver without the need for special tools

(13) Main Circuit Breaker (Molded Case Circuit Breaker)

a. All panelboards shall be furnished with a main circuit breaker. The main circuit breakers shall have an over center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.

b. Two- and three-pole main circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

c. The main circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall

be UL Listed for reverse connection without restrictive line or load markings.

d. The main circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.

e. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for the temperature rating of the wires specified and the temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.

f. The main circuit breakers shall be UL listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

g. The main circuit breakers shall be furnished and installed with surge protection

(14) Branch Circuit Breakers

h. The branch circuit breakers shall be UL Listed with amperage ratings, and number of poles as indicated on the contract drawings.

i. The branch circuit breakers shall be molded case and shall have bolt-on type bus connectors.

j. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole branch circuit breakers shall have common tripping of all poles.

k. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be an indicator appearing in the clear window of the circuit breaker housing.

l. The exposed faceplates of all branch circuit breakers shall be flush with one another.

m. Lugs shall be UL listed to accept solid or stranded copper conductors only. Lugs shall be suitable for the temperature rating of the wires specified and the temperature rating per NEC Table 310-16.

n. The branch circuit breakers shall be and UL listed

f) Disconnect Switches

(1) The in sight disconnect switch shall be rated for 480/277VAC and have a minimum rating of 200A for the Main motors and 30A for the emergency motors, brake motors, pump motors, and span lock motors. The enclosure shall be NEMA 4X, 316 Stainless steel, with a gasketed door. All disconnect switches shall be UL listed and conform to NEMA KS 1, and UL 98.

(2) The operating mechanism for heavy duty fused disconnect switches shall be quick make, quick – break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started. The disconnect switch operating handle shall be an integral part of the box, not the cover. The disconnect switch shall have provisions for padlocking the switch in the OFF position with at least three padlocks shall be provided. The handle position shall travel at least 90 degrees between OFF and ON positions to clearly distinguish and indicate handle position.

(3) All heavy duty disconnect switches shall have a dual cover Interlock mechanism to prevent unintentional opening of the switch cover when the switch is ON and prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

(4) All motor insight disconnect switches shall be furnished with a minimum of 2NO/2NC factory installed auxiliary early-make/early-break contacts for strip heater wiring.

g) Boxes/Enclosure and Cabinets

(1) All wall-mounted boxes/enclosures shall be NEMA 4X (stainless steel) with continues hinge.

(2) For boxes installed in humid areas, drain holes shall be provided in the boxes with protective drain fittings. Drain fittings shall be NEMA 4X stainless steel with neoprene tube

(3) All boxes shall be provided with mounting lugs and shall be securely fastened to the structure with not less than four stainless steel bolts.

(4) The conduit ends projecting into all boxes and enclosures shall be equipped with insulated bushings and grounding bushings.

(5) No box or enclosure shall be drilled for more conduits than actually enter it.

(6) All enclosures will be provided with grounding terminals.

h) Heating Contactor

(1) Furnish and install heating contactors as shown on the contract drawings.

(2) The contactors shall be designed to withstand the large initial inrush currents without contact welding

(3) Coils shall be permanently marked with voltage, frequency and part number

(4) The Contactors shall be suitable for the addition of up to eight (8) external auxiliary contacts of any combination of normally open or normally closed contacts

(5) Contacts shall be equipped with double break alloy contacts. The contactors shall have straight-through wiring.

i) Lighting and Receptacles

(1) Furnish and install lighting and receptacles in control house, machinery rooms and transformer room as shown on the contract drawings.

(2) The new lighting and receptacles shall be installed in accordance with AASHTO LRFD service lights and receptacles design standards

(3) All new lighting shall be LED type

(4) All receptacles shall duplex, three wire, GFI type

(5) Lighting and receptacles shall be fed from independent branch circuits Lighting circuit shall not be supplied from branch circuits that supply receptacles.

j) Heat Trace

(1) Furnish and install heat tracing cable as required for heat tracing of the pipe as shown on the plan.

(2) Heat Tracing shall be in accordance with the following:

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

b. National Electric Code

(3) Heat Trace Submittal: Submittal for review and approval the following

a. Power requirements for each circuit based upon actual length of heat trace and maintained temperature.

b. Circuit breaker rating based upon inrush current at minimum expected start-up temperature.

c. Length of heat tape for each pipe size and run.

d. Coordinate and verify length and Watts/FT of heat tape required based upon pipe size and insulation thickness. Include the calculation to support the heat tape output.

e. Wiring diagrams showing physical locations of thermostats and heat trace power supply.

f. Provide Operation and Maintenance Data

g. Test reports: Megger test results.

(4) Delivery, Storage, and Handling

a. Prior to installation Heat Trace equipment shall be sored such that they are not exposed to sunlight or other UV rays.

(5) Manufacturers

a. The heat trace system shall be manufactured by Thermon, Chemelex Division: Raychem Corp., Chromalox and approved equal.

(6) Heat Tracing

a. Design Parameters:

1. Temperatures requirements:

i. Low ambient temperature for the specific location: 0 DegF.

ii. At lower temperatures, there will be a larger in-rush current, so the circuit breaker needs to be size at this temperature as a minimum.

iii. Maintain temperature (power thermostat set point): 40 DegF.

iv. High temperature exposure with power off: 185 DegF.

2. Wind factor for the specific location: 10 MPH.

3. Electrical requirements:

i. Voltage: 277 V.

ii. Circuit breaker: 20A GFEPCI type.

iii. Safety factor: 10 PCT.

b. Self-regulating circuit construction consisting of an inner core of conductive material between parallel copper bus

wires, with inverse temperature - conductivity characteristics with metal overbraid.

c. Thermostats adjustable between 35 and 200 DEGF minimum with maximum differential range of 9 DEGF, furnished complete with NEMA 4 enclosures in all areas, stainless steel temperature bulb and capillary.

d. All necessary or required components and accessories, such as power connection boxes, end seals, straps, tape and fitting brackets.

e. Insulation shall be Fluoropolymer (Teflon).

(7) Installation

a. Insulate and heat trace wet pipe systems as indicated on Drawings.

b. Install materials in accordance with manufacturer's instructions.

c. Each circuit shall not exceed the manufacturer's recommended maximum length.

d. Piping:

i. Heat tracing shall be installed completely wired.

ii. Cut heat trace to lengths as required and secure to pipe with glass or polyester fiber tape.

e. Protection and Control Requirements:

i. Protect circuit by a GFEPCI circuit breaker.

ii. Breaker amperage rating shall be coordinated with Contractor when different than the Contract Drawings.

f. Provide an ambient sensing thermostat for power and line sensing thermostat for alarm.

g. The alarm thermostat shall be placed on the opposite end of the circuit from the power thermostat or power connection to allow for annunciation of partial failure of a circuit or the loss of power from a tripped GFEPCI circuit breaker.

h. Provide a monitoring module that monitors the voltage (circuit breaker status) to each circuit.

i. The alarm from the alarm thermostat and monitor module shall be annunciated on the indicated control system.

(8) Testing

a. Megger the cables at the manufacturers recommended voltage level three (3) times.

i. Before installation.

ii. After attachment to pipe but before insulation is installed.

iii. After pipe insulation is installed but before energization.

k) CCTV Equipment

(1) Furnish and install the CCTV system as shown on the plan.

l) Grounding and Bonding

(1) Furnish and install a Grounding system as indicated on the Contract Drawings and specified herein.

(2) Grounding shall be in accordance with the following:

a. NFPA 70, National Electric Code (NEC), latest edition.

b. AASHTO Standard Specifications for Movable Highway Bridges.

c. Underwriters Laboratory (UL)

d. Any applicable local rules and ordinances.

(3) The grounding and bonding system, and all associated equipment and materials shall be new.

(4) Equipment ground conductors shall be stranded, softdrawn, bare, tinned, copper wire conforming to ASTM B33 and not smaller than No. 8 AWG.

(5) Ground rods shall be made of copper or copper-clad steel and shall not be less than 1 inch in diameter and 10-feet in length unless otherwise specified. A permanent, exothermic weld connection to the permanent steel sheet piling at the bridge towers is an acceptable grounding means at the indicated locations. If the steel sheet piling is not accessible, ground rods shall be used as grounding electrodes. Insulated green ground conductor shall be used when exposed to wet environment.

(6) Exothermic welds shall be used to connect ground conductors to ground rods and ground bus bars. The resistance to ground shall be 5 ohms or less. Exothermic welds shall be molded fusion, type as required, as manufactured by Cadweld, Thermoweld, Metalweld, or approved equal.

(7) All conduits, boxes, wiring, cables, and other equipment required to extend the necessary circuits to and from the

grounding and bonding system shall be furnished and installed as specified herein.

(8) The bridge steel work on each side of the channel shall be solidly bonded and grounded to ground rods installed in the piers and at the towers, using No. 4/0 AWG bare, stranded, tinned copper cable.

(9) Traffic signal poles, warning gates, Resistance Gates, standby generator neutral conductor and engine block, grounding conductors in conduits, navigation lighting units, all metal framing, cases, and enclosures of the electrical equipment, such as motors, control desk, control cabinets, boxes, and all other metal parts in the proximity of current carrying conductors or equipment shall be bonded together and solidly connected to a ground bus in the switchboard room, and ground bus in the generator room. All electrical equipment ground busswork shall be connected to the closest main ground bus.

(10) The utility service neutral conductor, the bridge grounding conductor and grounding electrode conductors shall all be exothermically welded together.

(11) Ground system terminals shall be solderless lugs and shall be secured by means of hexagonal-head, copper plated, steel machine bolts with lock washers or lock nuts. Ground system conductors shall be continuous unspliced connections between terminal lugs. Paint, rust, and scale shall be removed over the contact area. All connections shall be made up as tightly as possible, and any bare metal or paint undercoat remaining exposed shall be spot painted to restore the surface with the same coating and number of coats as applied to the adjacent metal. Bolted connections shall be restricted to removable items (e.g., motors).

(12) A minimum of two ground rods per pier shall be installed to establish the bridge grounding system.

(13) The utility service neutral conductor shall be grounded in accordance with the utility company’s standard requirements.

(14) Upon completion of installation of electrical grounding and bonding system for continuity on all cables and connections, test ground resistance with ground resistance tester per IEEE Standard 81-1983. Where tests show resistance-to-ground is over five (5) ohms, reduce resistance to five (5) ohms or less, by driving additional grounding electrodes. The test shall be repeated to demonstrate compliance.

m) Underground Pull Box (Hand Hole)

(1) All underground pull boxes shall comply with ANSI/SCTE 77-2007, Tier 15.

(2) It shall be fabricated of Polymer Concrete

(3) Minimum size shall be as designated on the plans.

(4) No slice or termination shall be performed in the underground pull box

(5) Underground pull boxes shall be manufactured by Hubbell, Maclean Highline, Armorcast or Engineer approved equal.

n) Conduits

(6) See Subsection 752.08 for general conduit requirements

(7) All conduits shall be supported at 5’ maximum intervals. Conductors in any vertical runs shall be supported inside the conduit as outlined in the NEC

(8) Polyvinyl Chloride Rigid Galvanized Steel (PVC-RGS) Conduit

a. All conduits shall be PVC-RGS unless otherwise noted.

b. All conduits prior to coating shall conform to: Federal Specification WW-C-581E, ANSI specification C80.1 and UL 6.

c. The conduit shall be “Hot Dipped” galvanized inside and out with hot dipped galvanized threads. The “Hot Dipped” galvanized threads shall be coated with blue urethane. The zinc coating shall be intact & undisturbed.

d. Conduits shall be investigated by Underwriters Laboratories for both the zinc as the primary coating and the PVC (polyvinyl chloride) as the primary coating ensuring double protection. Conduit shall be labeled with the UL Label having only one exception requiring the use of threaded fittings. No disclaimer.

e. The interior of the conduit shall have a blue urethane coating of a nominal thickness of .002" (2 mils).

f. The exterior of the conduit shall have PVC coating of a minimum thickness of .040" (40 mils) applied by dipping in liquid plastisol.

g. All coated conduit shall conform to NEMA Standard No. RN-1.

h. The conduit shall be bendable without damage to either interior or exterior coating.

i. A .002" (2 mils) nominal thickness coating of blue urethane shall be applied to the exterior, the interior, and the threads of all fittings.

j. A .040" (40 mils) minimum thickness coating of PVC shall be applied to the exterior of all fittings. The PVC shall be applied using the plastisol method.

k. The PVC coating on all form 8 covers shall form a gasket-like flange of at least 5/16" wide and .040" thick covering the bottom of the cover and mating with the flange of the fitting.

l. Stainless steel encapsulated screws shall be supplied with all form 7 and form 8 fittings.

m. All hubs on fittings and couplings shall have a PVC sleeve extending one pipe diameter or 2 inches, whichever is less. The I.D. of the sleeve to be equal to the O.D. of the uncoated pipe.

n. The bond between the coatings and the metal shall be greater than the tensile strength of the coatings.

o. All conduits embedded or penetrating walls, floors and ceilings shall penetrate the wall, floor or ceiling through a 316 stainless steel pipe sleeve.

p. PVC coated RGS conduit shall be manufacture by Thomas and Betts (Ocal Blue), Robroy, Caldbond or Engineers approved equal.

(9) Liquid-Tight Flexible Metal Conduit (LFMC):LMFC conduit shall be manufactured and installed in accordance with the following:

a. UL-360 Liquid-Tight Flexible Metal Conduit

b. Standard for Safety, Fittings for Conduits and Outlet Boxes

c. LFMC will be used to make the connections to limit switches and the length shall not exceed 12 inches.

d. LFMC shall also be used to make the connections to the motors, span lock area equipment, and anywhere else as specified on the contract drawings.

e. LFMC shall be:

1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.

2. Extruded PVC outer jacked positively locked to the steel core.

3. Liquid and vapor tight.

o) Conduit Expansion Fittings

a. At any point where a conduit crosses an expansion joint longitudinally or where movement between adjacent sections of conduit can be expected, conduit expansion fittings shall be installed.

b. The fittings shall be provided with flexible bonding jumpers to maintain the electrical continuity across the joints.

c. The fittings shall be hot-dip galvanized malleable iron expansion fittings.

d. The fittings shall permit a total conduit movement (203 mm) 8 inch and shall be O.Z. Gedney Type EX or equal as approved by the Engineer.

e. In addition, all fittings shall be PVC coated as specified for outdoor and weather exposed locations.

p) Conduit Expansion and Deflection Fitting:

a. At any point where a conduit crosses a joint laterally or where an offsetting type movement between adjacent sections of conduit can be expected, expansion and deflection fittings shall be installed.

b. The fittings shall permit a movement of 3/4" from the normal in any direction except for locations where the bridge structure can move longitudinally.

c. Where the structure can move longitudinally such as at rocker bearings, expansion joints shall also be installed.

d. The fittings shall permit a movement beyond 19mm from the normal in any direction.

e. In addition all fittings shall also be PVC coated as specified for outdoor and weather exposed locations.

q) Conduit Supports and Miscellaneous Hardware

a. Framework for supporting boxes, switches, conduits, disconnect switches, small limit switches, and other separately mounted items of electrical equipment shall be hot-dipped galvanized steel

b. Mounting bolts, nuts, washers, and other detail parts used for fastening boxes, disconnect switches, small limit switches, conduit clamps, cable supports, brackets, and other electrical equipment shall be of stainless steel conforming to the requirements of ASTM Designation A276, Type 316 SS. Bolt heads and nuts shall be hexagonal and shall be provided with medium-series lock washers.

c. Stainless steel anchor bolts will have a minimum embedment of 3 ½”.

d. The conduit supports, in general, shall consist of PVC coated or 316 stainless steel U-bolts, properly sized for PVC coated conduit, attached to structural steel supports (clip angles ,

bent plates or preformed metal framing channels) clamped to the structural members.

e. Preformed metal framing channels shall be UL listed, vinyl coated and rated for outdoor use with PVC-RGS conduit.

f. All U-bolts for non-coated conduits shall be stainless steel, provided with medium series lock washers and hexagonal nuts.

g. The bolts, nuts and washers shall be of stainless steel conforming to the requirements of the Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes, ASTM Designation A276, Type 316.

r) Fittings for use with PVC-RGS

a. All fittings shall conform to the following standards: NEMA TC 2, UL 467, UL 514B, UL 651, UL 886.

b. All fittings shall be/have:

4. A PVC coating compound which includes inert modifiers to improve weatherability and heat distribution.

5. Rated for direct sunlight exposure.

6. Fire retardant and low smoke emission.

7. Suitable for use with 90 Deg. Celsius wire and shall be marked "maximum 90 Deg. Celsius".

c. Couplings, adapters and conduit bodies shall be the same material, thickness, and construction as the conduits with which they are used, homogeneous plastic free from visible cracks, holes or foreign inclusions, and bore smooth and free of blisters, nicks or other imperfections which could damage the conductor. The solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.

s) Wiring

d. All wiring and cables and their insulation and covering shall be of a nationally recognized brand, acceptable to the Engineer, and shall have marks always used on the particular brand for identifying it.

e. All wiring and cables shall conform to the requirements of NEMA Publication No. WC-70, and UL Standard 44.

f. Before wire and cable orders are placed with any manufacturer, the contractor shall submit for approval typical published test data for the type of insulation proposed, showing that it meets the requirements of NEMA

Publication No. WC-70 for 0-600V rated circuit voltage phase-to phase.

g. The wire shall be listed by Underwriters Laboratories for use in accordance with Article 310 of the National Electrical Code.

h. All conductors shall be megger tested to insure proper insulation after installation.

i. All materials used to fabricate insulated wiring and cables shall be certified to be from stock not more than 1 year old.

j. All conductors unless otherwise noted shall be UL-listed Type RHW-2, suitable for operation at 600Volts or less in wet or dry locations, including direct burial in the earth.

k. All splices and taps shall be made in accordance with AASHTO Section 8.9.2. Splices and taps shall be made only within junction boxes, terminal cabinet and conduit bodies, and splices shall be made on terminal blocks. The use of wire nuts shall not be permitted.

l. Conductors shall be annealed copper, cross-linked polyethylene (XLP) insulated.

m. Conductors shall not be smaller than No. 12 AWG, except as approved for control panel and console wiring or for lighting fixtures

n. Installation Requirements

    1. All conductors shall be separated and installed in compliance with NEC article 725.

    2. Fire alarm systems shall be separated and installed in compliance with Article 760.

    3. Communications shall be separated and installed in compliance with Article 800.

    4. Noncurrent-carrying conductive members of optical fiber cables shall be grounded in accordance with Article 250.

o. Cables and conductors of Class 2 and Class 3 circuits shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of Class 1 unless the following exceptions are met:

    1. Where the conductors of Class 1, are separated by a barrier from the Class 2 and Class 3 circuits. In enclosures, Class 2 or Class 3 circuits shall be permitted to be installed in a raceway within the

enclosure to separate them from Class 1, electric control and power circuits.

2. Occupancy of the same cabinet, outlet box, panel or similar enclosure shall be permitted where nonconductive optical fiber cable is functionally associated with the electric light, power, Class 1, and nonpower-limited fire alarm circuit.

3. Occupancy of the same cabinet, outlet box, panel, or similar enclosure shall be permitted where nonconductive optical fiber cables are installed in listed factory- or field-assembled control centers.

xxi. METHOD OF MEASURREMENT

b) The quantity of Special Provision (Bridge Power Equipment) specified to be measured for payment shall be on a lump sum basis. The lump sum shall include the cost for all Bridge Power Equipment, Grounding and Bonding System and CCTV System

xx. BASIS OF PAYMENT

a) The accepted quantity of Special Provision (Bridge Power Equipment) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 30% percent of the lump sump price will be made upon delivery of bridge power equipment including but not limited to the transformers, generator, ATS, service disconnect, CT cabinet, metering equipment, and panelboard to the project site.

(3) The third payment of 50% of the lump sum price will be made upon installation of the bridge power equipment, conduit and cables, including all cable termination and testing.

(4) Payment of the remaining amount will be made after final acceptance testing and all punch list items have be resolved

c) Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Bridge Power Equipment)	Lump Sum

BRIDGE CONTROL SYSTEM

xx. DESCRIPTION. This work shall consist of furnishing, installing and placing in satisfactory operating condition the complete bridge electrical control system for the permanent operation of the movable span and its auxiliaries, as shown on the contract drawings and detailed in these specifications, including and not limited to the following items

(1) Hydraulic Pump Motor

(2) Relay Based Control System

(3) Bridge Control Console

(4) Motor Control Center including all starters and breakers as shown on the contract drawings.

(5) Instrumentation devices such as Position resolvers, limit switches, Power monitor metering

(6) Air Horn

(7) Navigation Lighting

Also included in this work is the furnishing and installing of span position instrumentation, and all other materials necessary for controlling the movable bridge span. Apparatus for controlling the operation of the traffic signals and gates as shown on the contract drawings shall be furnished and installed under this item.

All conduits, boxes, wiring, cables, and other equipment required to extend the necessary circuits from the control house to the control circuits are included under separate pay items (bridge power equipment).

Omissions from the contract drawings and specifications, or the incomplete description of details of work, which is evidently necessary to carry out the intent of the contract drawings and specifications in providing a fully functional bridge electrical control system, or which is customarily performed, shall not relieve the Contractor from performing such work. All such work shall be performed as if fully and correctly set forth and described in the contract drawings and specifications. In any case of discrepancy in figures, catalog numbers, or descriptions in the contract drawings or in the specifications, the matter shall be properly submitted to the Engineer who shall promptly make determination in writing. Any adjustment in the contract drawings by the Contractor without written approval shall be at the Contractor's own risk and expense.

The alignment and fastening of electrical equipment to be incorporated into the bridge machinery, such as rotary limit switches, shall be done under the appropriate machinery item.

xx. REFERENCES AND STANDARDS. Electrical equipment manufactured and installed shall conform to the requirements of the latest revisions of the applicable portions of the following standards:

(1) AASHTO Standard Specifications for Movable Highway Bridges (AASHTO).

(2) American National Standards Institute (ANSI)

(3) NFPA 70, National Electrical Code (NEC), latest edition.

(4) NFPA 79, Electrical Standard for Industrial Machinery, latest edition.

(5) NFPA 110, Standard for Emergency and Standby Power Systems, latest edition

(6) National Electrical Contractors Association, NECA 1-latest edition, Standard Practices for Good Workmanship in Electrical Contracting.

(7) National Electrical Manufacturer's Association (NEMA).

(8) Underwriters Laboratory (UL).

(9) American Society for Testing and Materials (ASTM)

(10) Institute of Electrical and Electronics Engineers (IEEE).

(11) Any applicable local rules and ordinances.

Any local and National codes and regulations that are relative to electrical, control and power work local to this project shall be in full force. Conflicts between local codes and the requirements herein shall be brought to the attention of the Engineer.

Any incidental apparatus, appliance, material, or labor not specifically mentioned or included herein, that may be found necessary to comply with the requirements of the related documents and referenced standards or codes shall be furnished by the Contractor just as if specifically mentioned in these Specifications and at no additional cost to VTRANS.

xx. SUBMITTALS. Submit the following:

(1) Product Data: Data sheets and publication on all major components that make up the bridge control system

(2) Product technical data show the complete electrical ratings and performance specifications confirming compliance with specified ratings and performance including but not limited to the following: Maximum rate of heat rejection from all related components and associated cooling requirements, manufacturer's installation instructions, shop drawings, fabrication and layout drawings. See general electrical section for shop drawing requirements. Fabrication and layout drawing shall include top,

front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions. It shall identify minimum clearances from other electrical equipment required for proper installation and operation

(3) Test Procedures/Reports

a. Shall be per manufacturer requirements.

b. Reports shall indicate procedures and values obtained.

(4) Operation and Maintenance Manual

a. Submit operation and maintenance manuals for all major portions of the electrical control system for this bridge. Where multiple vendors are used to provide various aspects of the work described in these contract documents, the general contractor shall provide the coordination required to form a single consolidated and comprehensive manual. See section on "As built documentation, operation and maintenance manual"

xx. CONTROL SYSTEM INTEGRATOR

a. All apparatus and equipment comprising the bridge control system, including, but not limited to, motors, limit switches, motor controls, control cabinets, special control panels, control desk, hardware for local troubleshooting, and other apparatus required to provide a complete functioning system, shall be manufactured or furnished and assembled by a single qualified control system integrator. The integrator shall assemble the control panels and console at an Underwriters Laboratory approved Facility in accordance with UL 508

b. The Control System Integrator shall have experience in providing electrical control systems for movable bridges of various types, including bascules, vertical-lifts, swing bridges, and control systems, including relay system control. Such experience shall be demonstrated by identifying a minimum of five (5) hydraulically operated movable bascule bridges for which the system integrator has provided complete working systems, within the past ten (10) years.

c. Prior to fabrication of any items described above, the control system integrator shall submit to the Engineer for approval, shop drawings containing detailed schematics of the proposed control and power distribution systems, Hydraulic Power Unit, MCC, control desks, etc. as mentioned in this specification.

d. The following applies to the control system integrator:

1. The control system integrator shall assume complete system responsibility for the integrated functioning of all components to provide a satisfactory assembled system operating in accordance with specified requirements.

2. Assume responsibility for the detailed schematics and fabrication of the total control systems to ensure compatibility of equipment and suitability for the intended system functioning. Submit to the Engineer for approval prior to ordering and fabrication.

3. Provide supervisory assistance in the installation of equipment to ensure maximum reliability and ease of maintenance.

4. During testing of the electrical systems, it may be found that deviations from the performance specifications are required for optimum bridge operation. Include all hardware required for these modifications in the control system integrator scope of work at no additional cost to VTRANS.

5. Provide a field service staff having the capability of providing services for field coordination of construction and final adjustments to the control and drive systems. Upon final acceptance of the bridges, provide on-call warranty service for a period of one (1) year. Field staff shall be capable of responding to an emergency within 8 hours.

6. Provide written certification of compliance with specified requirements for the control system integrator. Include this certification in the bid documents. The certification shall be subject to approval by the Engineer.

7. Control system integrator shall coordinate with the electrical contractor, control system manufactures, and the plans to furnish and install a complete working system.

8. Before ordering any equipment the control system integrator shall field verify all necessary information, coordinate with Hydraulic system vendor.

xx. MATERIALS:

a) Hydraulic Pump Motor: The contractor shall furnish and install two (2) hydraulic power units, each equipped with two (2) pump motor as shown on the contract drawings. The pump motor along with the Hydraulic power unit shall be supplied by the hydraulic vendor.

(1) The pump motor shall be 20HP/1760RPM, FRAME 254TD, NEMA DESIGN B or approved equal

(2) General Requirements:

a. Standards: NEMA MG 1, UL 674

b. Identify each motor by a specific tag name, as specified in the contract drawings

c. Motor shall be totally enclosed, fan cooled (TEFC) with cast iron construction.

d. An embossed or engraved stainless steel nameplate, with the required NEC and NEMA data, to be permanently attached to the motor.

e. Maximum motor loading shall not exceed motor nameplate horsepower rating, exclusive of service factor.

f. All motors shall be sized to carry continuously all loads, which may be imposed through their full range of operation.

g. NEMA MG 1, Design B, with low starting current.

h. Suitable for the starting with solid state reduced voltage starter.

i. Motors shall have windings vacuum pressure impregnated two times with severe sea coast or open ocean rated epoxy. The motors shall be marine duty rated.

j. Lifting devices: Motors shall have lifting eyes for installation and removal.

k. Grounding:

i. Lug suitable to terminate ground wire in terminal box, sized as indicated on the Drawings.

l. Stator windings: Copper.

m. Rotor cage: Copper.

n. Motor leads shall be non-wicking with permanent identifiers.

o. Totally enclosed motor to have one-way breather drains.

p. Efficiency:

i. Meet NEMA MG 1 (NEMA Premium) efficiencies.

ii. If motor type, horsepower or speed is not included in the NEMA requirements for NEMA Premium, provide manufacturers "premium energy efficient" design.

i. Power factor: Minimum of 80 percent lagging at full load, except on motors with speed slower than 900 RPM.

j. Service factor:1.15

k. See mechanical special provision for more details/requirements.

b) Motor Control Center (MCC): The contractor shall furnish and install a low voltage motor control center as shown on the contract drawings and specified herein.

(1) The MCC shall meet or exceed the requirements within the following standards for MCC

a. NEMA ICS 18 - Industrial Control and Systems: Motor Control Centers

b. UL 845 - UL Standard for Safety for Motor Control Centers NOTE: UL 845 is a harmonized standard consisting of:

1. Underwriters Laboratories Inc. (UL) UL 845

2. Association of Standardization and Certification (ANCE) NMX-J-353-ANCE-2006

3. NFPA 70 - National Electrical Code

c. The MCC shall be designed, manufactured, and tested in facilities registered to ISO 9001.

(2) Design Requirements

a. Provide MCC based upon applicable NEMA and UL standards and in accordance with the detailed contract specifications and drawings.

b. The manufacturer of the MCC shall also be the manufacturer of the branch circuit breakers, motor circuit protector, across-the-line motor starters, across-the-line contactors and solid-state reduced voltage starters unless otherwise noted. The use of third-party supply and assembly for these components in the motor control center is not acceptable and will be rejected

c. The contractor shall confirm motor full-load amperage ratings and provide those to the MCC manufacturer to ensure proper sizing of the motor branch circuit and overload protection.

(3) MCC Submittal

a. Elevation drawing with overall dimensions.

b. Starter and component schedule.

c. Identification of units and their location in the MCC.

d. Location of incoming line terminals.

e. Mounting dimensions.

f. Available conduit entrance areas.

g. Nameplate schedule.

h. Single line diagram.

i. Assembly ratings (amps, volts, short circuit, etc.).

j. Product Data

8. Data sheets and publications on all major components including, but not limited to the following:

    a. Motor starters
    b. Overload relays
    c. Circuit breaker and fuse information including time current characteristics
    d. Control power transformers
    e. Pilot devices
    f. Relays

9. Installation Instructions.

10. Provide a copy of the manufacturer's installation instructions that includes the following:

    a. Receiving, handling, and storage instructions
    b. General description for reading nameplate data, serial numbers, UL markings, and short circuit ratings
    c. Installation procedures including splicing procedures
    d. Conduit and cable installation
    e. Installing and removing plug-in units
    f. Operation of operator handles and unit interlocks
    g. Checklist before energizing
    h. Procedure for energizing equipment
    i. Maintenance procedures

(4) Final Submittal

11. The contractor shall provide certification that the MCC has been installed in accordance with the

manufacturer’s instructions and with local codes and standards that govern MCC installations.

12. The contractor shall provide certification that all circuit breaker settings have been adjusted per field requirements.

13. The contractor shall provide certification that all power fuses have been selected and installed per field requirements.

14. The contractor shall provide certification that all solid-state motor overload settings have been adjusted per installed motor characteristics.

15. The contractor shall provide certification that all settings for solid state devices such as reduced voltage solid-state controllers have been adjusted per the specific application requirements.

16. The contractor shall provide certification that any timing devices have been properly adjusted.

17. Final Drawings.

18. The manufacturer shall provide final drawings reflecting the ‘As-Shipped’ state of the MCC documents previously submitted

19. Manufacturer drawings shall be provided in PDF format

20. Manufacturer drawings do not need to be stamped if a drawing schedule is provided that lists the drawing numbers, version levels, and status of drawings (such as, Preliminary, Approval, Final)

21. The contractor shall be responsible for making any changes to the ‘As-Shipped’ drawings from the manufacturer to reflect any field modifications and it shall be reflected in the final drawings

(5) Test reports indicating manufacturer's standard testing was performed.

(6) Maintenance Data.

(7) MCC installation instructions

a. Two (2) copies of these instructions shall be included with the equipment at time of shipment.

b. MCC spare parts listing

(8) Quality Assurance

a. The manufacturer of the MCC shall have a minimum of 35-years experience in the manufacturing and assembly of NEMA Low Voltage motor control centers.

b. The manufacturer shall have ISO 9001 registered facilities for the design, manufacture, and testing of MCCs.

c. MCC sections and individual MCC units shall be designed and manufactured in accordance with UL 845 requirements.

d. MCC sections and individual MCC units shall be UL listed, where possible.

(9) Regulatory Requirements

a. Contractor shall ensure that the installation conforms to the requirements of the latest edition of the NFPA 70 'National Electrical Code' and/or other applicable installation standards.

(10) Delivery, Storage, and Handling

a. The contractor shall coordinate the shipping splits with the MCC manufacturer for entry into the building.

b. Shipping splits shall be noted on the MCC manufacturer drawings.

c. The contractor shall store the MCCs in a clean, dry, and heated space.

d. The contractor shall protect the units from dirt, water, construction debris, and traffic.

e. During storage the contractor shall connect internal space heaters (if specified) with temporary power.

f. MCCs are to be shipped with external lifting angles at the top and running continuously for each shipping split. Lifting eyelets are not acceptable.

(11) Field measurements

a. The contractor shall verify all field measurements prior to the fabrication of the MCC.

(12) Spare materials

a. The contractor shall furnish and install the MCC with the recommended spare part list:, and any other part deemed necessary by the manufacturer not listed below

(13) Spare part lists

a. One starter assembly of each size used

b. One spare branch circuit breaker of each sized used

c. The contractor shall coordinate the storage location of the spare parts with the Engineer.

d. Manufacturers

1. The MCC shall be manufactured by Eaton, Square D, Allen-Bradley or Engineer approved equal.

(14) Ratings

a. The MCC shall be rated for the system voltage as indicated on the contract drawings.

b. The horizontal and vertical power bus bracing shall be rated to meet or exceed the available fault current as shown on the contract drawings, but shall not be less than 65,000 A rms symmetrical

c. Horizontal Power Bus

1. The MCC horizontal power bus shall be rated for 600 Amps.

2. The horizontal bus material shall be copper with tin plating

3. The horizontal bus shall be supported, braced and isolated from the vertical bus with a high strength, non-conductive, non-tracking, glass polyester material

4. For standard sections the horizontal bus shall be continuous within each shipping block and shall be braced within each section

5. Horizontal bus splices shall have at least two bolts on each side

d. Vertical Power Bus

1. The vertical power bus shall have an effective rating of 600 A.

2. The vertical bus material shall be copper with tin plating

e. Ground Bus.

1. Provide a ground bus system consisting of a horizontal ground bus connected to vertical ground buses mounted in each section

2. Provide an tin-plated copper 0.25 x 2 in. horizontal ground bus mounted in the bottom of the

MCC unless otherwise specified in the contract drawings

3. Provide a pressure-type mechanical lug mounted on the ground bus in the incoming line section

4. Provide a unit ground stab on all unit inserts. The ground stab shall establish unit insert grounding to the vertical ground bus before the plug-in power stabs engage the power bus. The grounding shall be maintained until after the plug-in power stabs are disengaged.

f. Enclosure

1. The MCC enclosure shall be NEMA Type 1

2. All interior and exterior surfaces shall be painted ANSI 49 medium-light gray. The vertical wireways and unit back plates shall be painted high-visibility gloss white.

3. All unpainted parts shall be plated for corrosion resistance.

g. Structure

1. The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units.

2. Vertical sections shall be rigid, free-standing structures:

3. Vertical sections shall have internal mounting angles running continuously within the shipping block

4. An external mounting channel that is required to maintain structure integrity is not acceptable

5. Vertical sections shall be 71 in. high, 15 in. deep and 20 in. wide, except where larger dimensions are required

6. The vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block

7. Lifting eyes are not acceptable

8. Each standard section shall be capable of being subdivided into 12 usable, unit spaces

9. Two unit spaces shall constitute one space factor and shall be 13 in. in height

10. One unit space shall constitute one-half space factor and shall be 6.5 in. in height

h. Wireways

1. Horizontal wireways:

a. The horizontal wire way shall be located at the top and bottom of the MCC.

b. The horizontal wireways shall be 6 in. in height and extend the full depth of the vertical section to allow maximum flexibility in locating conduit for MCC feeds and loads

c. The horizontal wireways shall be continuous across the length of the MCC, except where access needs to be denied due to electrical isolation requirements

d. The horizontal wireways shall be isolated from the power bus

e. The horizontal wireways shall have removable covers held in place by captive screws

2. Vertical wireways:

a. The vertical wireway shall be isolated from the vertical and horizontal buses

b. The vertical wireway shall be covered with a hinged and secured door

c. Wireway tie bars shall be provided

d. Isolation between the wireway and units shall be provided

e. Vertical wireway doors shall be provided with arc resistant latches to help keep the door latched in the event that an internal arcing fault occurs

i. Unit Information

1. The minimum compartment height shall be 6.5 in. and this shall be considered one-half space factor.

2. NEMA Size 5 FVNR starters and below shall be provided as plug-in units.

3. Plug-in units.

   a. Plug-in units shall consist of a unit assembly, unit support pan, and unit door assembly

   b. Units shall be supplied with removable doors. The unit doors shall be fastened to the structure so that the doors can be closed when the unit is removed

   c. A unit support pan shall be provided for support and guiding units. Unit support pans shall remain in the structure when units are removed to provide isolation between units

   d. A service position shall be provided for plug-in units that allows for the unit to be supported, but disengaged from the bus. The unit shall be capable of being padlocked in the service position. This position is to be used to isolate a unit from the bus to allow service to be performed on the connected load equipment

4. Power Stabs

5. Unit stabs for engaging the power bus shall be tin-plated copper and provided with stainless back-up springs to provide and maintain a high pressure 4-point connection to the vertical bus

6. Wiring from the unit disconnecting means to the plug-in stabs shall not be exposed on the rear of the unit. A separate isolated pathway shall be provided for each phase to minimize the possibility of unit fault conditions reaching the power bus system

7. Power cable termination at the plug-in stab shall be a maintenance-free crimp type connection

j. Withdrawable Power Stabs.

1. Plug-in units shall have the capacity of withdrawing the power stabs, allowing the primary voltage to be disconnected with the unit door closed

2. The withdrawable assembly shall accept a standard 1/4’ hex-style drive socket

a. A complete power engagement shall occur when turning the mechanism ¼ turn in clockwise direction

b. Complete power disengagement shall occur when turning the mechanism ¼ turn in counter-clockwise direction

3. The withdrawable stabs design shall include a set of stab assembly-mounted shutters

a. shutters shall automatically open before the power stabs can extend and connect to the vertical bus

b. shutters shall close as soon as the power stabs are disconnected from the vertical bus and are completely inside the stab housing

4. The withdrawable stabs design shall include interlock mechanisms

a. A through-the-door mechanism shall allow the unit to be locked in the 'Power Stabs Disconnected' position

1. This mechanism shall be such that it can be padlocked to prevent the connection of the stabs to the vertical bus even when the unit is inserted into the vertical section

2. Unit door shall be capable of opening with the padlock and lockout engaged

b. Unit disconnect handle must be in the OFF position (load side of the disconnect device removed from line power) before the stabs can be disconnected from the vertical bus

1. Mechanism shall also allow the removal of the unit from the vertical section but only after the disconnect handle has been turned OFF and the power stabs have been disconnected from the vertical bus

2. Unit stabs have to be disconnected (withdrawn) before the unit can be re-inserted into the vertical section

5. The withdrawable stabs design shall include feedback mechanisms that are verifiable with the unit door closed

a. A two-position indication system shall be provided (Power Stabs Connected/Disconnected) and shall be visible from the door

    1. Connected with Red Indication–Primary voltage stabs fully engaged and connected to the vertical bus

    2. Disconnected with Green Indication–Primary voltage stabs fully disconnected from the vertical bus

b. A set of test points shall be located on the front of the unit for identification of:

    1. Power stabs position: a positive continuity check between these probes shall verify that all three power stabs have been disconnected from the vertical bus and completely withdrawn inside the stabs housing

    2. Stab-mounted shutters position: a positive continuity check between these probes shall verify that the shutters are closed, meaning that all three power stabs have been disconnected and withdrawn inside the stab housing

c. Withdrawable power stabs with door closed mechanism shall not increase the original unit height design so total space in the motor control center is optimized

d. A remote operating device shall be supplied to allow the connection and disconnection of the power stabs with the door closed

    1. The minimum distance shall be not less than three times the minimum default value recommended by the NFPA 70E (Arc Flash Protection Boundary–Annex D)

k. Disconnect Handle

1. Plug-in units shall be provided with a heavy-duty, non-conductive, industrial duty, flange mounted handle mechanism for control of each circuit breaker

2. Use of rotary operators is not acceptable

3. Disconnect handles may pivot in the vertical or horizontal plane

4. On-off condition shall be indicated by the handle position, red and green color indicators with the words ON and OFF, and the international symbols 1 and O along with a pictorial indication of the handle position

5. Handles shall be capable of being locked in the OFF position with up to three padlocks

6. Plug-in units shall be provided with interlocks per NEMA and UL requirements Interlocks shall be provided for the following:

    a) Prevention of unit insertion or withdrawal with the disconnect in the ON position
    b) Prevention of the unit door from being opened when the disconnect is in the ON position.
        i. A feature for intentionally defeating this interlock by qualified personnel shall be provided
    c) Prevention of the disconnect switch from being moved to the ON position if the unit door is open
        i. A feature for intentionally defeating this interlock by qualified personnel shall be provided.

l. Pilot Devices.

1. Units shall be furnished with pushbuttons, selector switches, and pilot lights.

2. Pilot devices shall be rated NEMA Type 4/13 water tight/oil tight

3. Pilot devices shall be manufactured by the same manufacturer as the MCC

4. Pilot devices shall be mounted to the door of the MCC compartments.

m. Terminal Blocks.

1. Control terminal blocks shall be provided on all contactor and starter units.

    a. Control terminal blocks shall be a pull-apart design on all plug-in units for easy removal of the unit from the structure

2. Control terminal blocks on non-plug-in contactor and starter units shall be fixed type.

3. Power terminal blocks shall be provided on all contactor and starter units, rated NEMA size 3 (100

A) and below that utilize vertically operated disconnects

a. Power terminal blocks shall be pull-apart for NEMA size 1 and 2 (30 A and 60 A contactors)

b. Power terminal blocks for NEMA size 3 starters (100 A contactors) shall be non- pull-apart

4. Terminal blocks shall not be located adjacent to or inside the vertical wireway

n. Doors.

1. Each unit shall be provided with a removable door mounted on removable pin-type hinges

2. The unit doors shall be capable of being opened at least 110 degrees

3. The unit doors shall be removable from any location in the MCC without disturbing any other unit doors

4. The unit door shall be fastened to the structure so it can be closed to cover the unit space when the unit is removed

5. The unit doors shall be held closed with quarter-turn latches

6. Unit door latches shall be provided with arc resistant latches to help keep the door latched in the event that an internal arcing fault occurs

o. Disconnect

1. Main Circuit Breaker Disconnect

a. Furnish and install the MCC with lugs to accommodate the incoming power conductors as indicated on the contract drawings shall be provided by the MCC manufacturer

b. Size the circuit breaker frame and trip rating as shown on the drawings

c. The interrupting capacity rating shall meet or exceed the available fault current mentioned above (Interrupting capacity based on a slash rating is not acceptable)

d. Provide a circuit breaker with thermal magnetic trip unit for 250 A and smaller frames; provide electronic trip unit for 400 A and larger frames

e. Provide a removable protective barrier to reduce the possibility of incidental contact with the line terminals

f. Provide one normally open and one normally closed circuit breaker auxiliary contact that follows the position of the circuit breaker main contacts for indication of 'On' or 'Off/Tripped'

g. Provide integrated ground fault protection with adjustable pick-up and adjustable time delay

2. Branch Feeder Disconnects

a. Disconnecting means for feeders shall be circuit breakers with thermal-magnetic trip units for 250 A and smaller frames; provide an electronic trip unit for 400 A and larger frames

b. Interrupting capacity rating shall meet or exceed the available fault current as shown on the contract drawings (Interrupting capacity based on a slash rating is not acceptable)

c. Breaker frame and trip setting shall be as shown on the plans

d. Provide one normally open and one normally closed circuit breaker auxiliary contact which follows the position of the circuit breaker main contacts for indication of 'On' or 'Off/Tripped'

3. Combination NEMA Across the line starters

a. Branch Starters shall meet applicable NEMA and UL requirements.

b. Starters shall be minimum NEMA Size 1.

c. Starter shall be manufactured by the same manufacturer as the MCC.

d. Starters shall be provided with a 3-pole solid state overload relay that includes the following features:

1. Selectable trip classes of 10, 15, 20, or 30

2. Set for class 20 unless otherwise indicated on the contract drawings

3. Overload protection

4. Phase loss protection

5. Trip current adjustment range of 5:1

6. Visual trip status indication

7. Test/Reset button

8. Bipolar latching relay with one normally open and one normally closed contact, rated NEMA B600 for use in motor contactor control circuits

9. Thermal memory circuit to model the heating and cooling effects of motor on and off periods

10. Ground fault protection shall be provided with a selectable trip value between 20 mA and 5 A

4. In addition to the hold-in contact, starters shall be provided with the auxiliary contacts as shown on the contract drawing wiring diagrams. The starter shall be capable of accommodating up to six contacts in addition to the hold-in contact.

5. Provide a control power transformer with a rated secondary voltage of 120V AC. The control power transformer shall be provided with primary and secondary fusing.

6. Overload relays shall have a reset button located on the outside of the unit door.

7. Provide a door mounted selector switch for Hand-Off-Auto operation. The Hand mode shall provide local control at the MCC unit door. In the Auto mode, control shall be provided through a remote contact.

8. Provide door mounted 120V AC push-to-test pilot lights with incandescent lamps for On (Red) and Off (Green) status indication.

p. Ratings:

1. 600 V class, 3 PH, 60 Hz with operating voltage and number of wires as indicated on the Drawings.

2. Minimum short circuit rating of 65KAIC.

q. Motor Starters

1. Standards: NEMA ICS 2, UL 508.

2. Full Voltage Non-Reversing (FVNR) Magnetic Starters:

a. NEMA full size rated contactor.

b. NEMA half sizes and IEC contactors are not permitted.

c. FVNR Magnetic Starters shall be a minimum of NEMA 1.

d. Double-break silver alloy contacts.

e. Overload relays:

f. Ambient compensated bimetallic type with interchangeable heaters, 24 percent adjustability, single phase sensitivity, an isolated arm contact and manual reset.

1. Interlock and auxiliary contacts, wired to terminal blocks:

g. Holding circuit contact, normally open.

h. Overload alarm contact, normally closed.

i. Normally open auxiliary contact, for remote run status.

j. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.

k. Two (2) additional normally open spare field replaceable auxiliary contacts.

3. Full Voltage Reversing (FVR) Magnetic Starters:

a. Two (2) FVNR starters with one (1) overload relay assembled together.

b. Mechanically and electrically interlocked to prevent line shorts and the energizing of both contactors simultaneously.

c. See FVNR paragraph for additional requirements.

c) Relay Control Cabinet and Auxiliary Cabinet: The contractor shall furnish and install a relay control and an auxiliary cabinet as shown on the contract drawings.

(1) The relay control cabinet shall be 12 gauge minimum NEMA 4X, stainless steel and manufactured to the required dimensions per applicable codes. Cabinets shall be wide enough to house the equipment to be installed within. Cabinets wider than 36 inches (91 cm) shall have oil resistant double-doors with a 3-point handle latching mechanism and neoprene gasketed seal with oil-resistant adhesive and held in place with steel retaining strip all around.

(2) Door handles shall be lockable and of stainless steel hardware

a. The doors for the auxiliary control cabinet shall be such that they can easily be removed at the hinge to allow for full working clearance during construction.

b. The auxiliary cabinet shall be supplied with Heavy-duty 316 stainless steel lifting eyes. As well as a fluorescent light package.

c. The relay control cabinet shall be floor mounted.

d. Provide enclosure cooling required to not exceed temperature ratings of components.

(3) Control Relays:

a. Control relays shall be multi contact magnetic NEMA type machine-tool relays with contacts rated at 10 amperes, 600 volts, on a continuous basis. Relays shall be Square D or equal as approved by the Engineer.

b. All exposed relays and wiring shall be protected to avoid accidental contact with live wires.

(4) Control Circuit Breakers:

a. Control circuit Shall conform to the following standards: IEEE, C37.13,C37.16, C37.17, NEMA AB1, NFPA 70, UL 943, 1066. Frame sizes shall be sized per NEC and as shown on the Plans. The breakers shall be equipped with instantaneous, magnetic trip units, with trip ratings as shown on the contract drawings or as required.

(5) Timer Relays:

a. Timer relays shall have a timing range of 0 to 10 seconds. Timer relays shall be UL listed with an ampere rating of 10A and rated for 120VAC operation. Each timer relay shall have a minimum of two (2) NO contacts and two (2) NC contacts or as required by the contract drawings and shall be of the “on-delay” type. Timer relays shall have a wide voltage operating range.

(6) Magnetic Contactors:

a. The continuous current rating of contactors shall be adequate for the connected loads. All contactors shall be rated for 600 VAC, 60 Hertz, rated with 120 VAC operating coils, unless otherwise noted. All contact poles shall be provided with arc chutes, and contactors rated 150 amperes and above shall be equipped with magnetic blowouts. Three-element, automatic reset. Reversing contactors shall be electrically and magnetically interlocked. Specialized contacts shall be as shown on the contract drawings

(7) Power Distribution Blocks:

a. Power distribution blocks, for all conductors larger than No. 8 AWG, shall be constructed from a single piece of hard-drawn copper, machined, and electro-tinned. All blocks shall be mounted on heavy-duty phenolic material and furnished with safety cover kits. Number and size of primary and secondary wire openings will be selected by the Contractor/Integrator and shall be Ferraz Shawmut or equal as approved by the Engineer.

(8) Wiring:

a. The wiring in the components shall be neatly installed in wire ways or with wire ties where wire ways are not practical.

b. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.

c. Bases with a self-sticking back will not be allowed.

d. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.

e. Provide terminals for shield continuity where required.

f. Terminal blocks shall be complete with marking strip, covers and pressure connectors.

g. Non-brittle, interlocking, track-mounted type.

h. A terminal for each conductor of external circuits plus one (1) ground for each shielded cable.

i. Not less than 15 percent spare terminals shall be provided.

j. Terminals shall be labeled to agree with identification indicated on the supplier’s submittal drawings.

k. Individually protect each control loop with circuit breakers and clearly label as shown on the plans.

l. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.

m. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.

n. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.

o. Markings or color code shall match the manufacturer's drawings.

p. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 Deg C.

q. The relay cabinet shall be fabricated by a certified a UL industrial panel builder and will bear a UL label confirming the requirement.

d) Control Console (Control Desk): The contractor shall furnish and install a control desk as shown on the contract drawings.

(1) The control desk shall be constructed of 12 gauge Stainless Steel and shall be reinforced to provide adequate support using Stainless Steel angles or channels.

(2) Spare terminals totaling at least 15 percent of those actually used shall be provided in the control console. Shorting terminal blocks shall be provided for all CT leads.

(3) All meters used on the control console shall have uniformly spaced graduations in black on a white background and shall be dust-proof and splash proof switchboard type meters. The meters shall be approximately be 4.5 inch square, with circular scales about 7 inches long, and shall be mounted semi-flush. The meters shall be ANSI specified C39.1, IP54 (NEMA 3) protected and shall be magnetically shielded to prevent interaction, and have accuracy of plus or minus 1.5% (maximum). The meters shall also be provided with a 3-1/2 digit LED display to complement the analog scale and pointer. The meters shall be include an Anti-glare window option. Meters shall be Crompton Instruments Model 077-DIAA-HFHF-PQ-BR, equal manufactured by Simpson or Modutec, or equal as approved by the Engineer. The meters shall be connected to the pump motor and motor soft starters as shown on plans and scaled as shown on plans. The face plates of the meters shall be customized to show the range of current as shown on plans.

(4) Two span position indicators shall be supplied with the control desk. The span position indicators shall be large, approximately 8.5” square analog indicators that show key positions of the span as well as the degree of span elevation with a custom printed faceplate. The key positions that will be highlighted are the Fully Closed, Nearly Closed, Nearly Open, and Fully Open positions

of the span. The meters shall have a 4-20mA signal input from the resolver which is attached to trunnion and shall be scaled appropriately to show the elevation of the span. The meters shall be of the 1% accuracy class with a minimum of 800V insulation rating. Scale windows shall be non-glare and shatterproof. It shall be the control system integrator to properly adjust and match the span position to the meter dial face plate reading.

(5) Pushbuttons and control switches shall be heavy-duty, oil-tight, contact blocks operated by selector knobs and push operators as indicated on the Plans. Contacts shall be fine silver, capable of interrupting 6 amperes at 120 volts AC, and of continuously carrying 10 amperes. Selector switches shall have gloved or pistol-grip handles.

(6) All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

(7) All selector switches and buttons shall be minimum size 30 mm and shall have a minimum of one normally open, one normally closed contact or as shown on the contract drawings. It shall be the control system integrators responsibility to match the final number of contacts to the control drawings.

(8) All bypass switches shall be keyed in their open position, which have to be unlocked and turned in order to release the switch for bypassing.

(9) Indicating Lights:

a. Indicating lights for 120 volts source, mounted on the control desk shall be LED type, heavy-duty, and oil-tight. The illuminated lamps must be easy to distinguish, in the sunlight, from non-illuminated units. All lenses shall be scratch-resistant, with color and marking as shown on the Plans.

(10) Terminal blocks for conductors of Size No. 8 AWG and smaller shall be one-piece blocks of phenolic material recognized under the UL Component Recognition Program. Barriers shall be not less than 13mm high and 3mm thick and shall be spaced 16mm center-to-center. Straps and screws shall be of brass; nickel plated for use in highly corrosive atmospheres, and shall be rated for 60 amperes minimum. The blocks shall provide a withstand voltage rating of 750 volts per IEEE switchgear standards. The terminal blocks shall provide strap screws suitable for use with ring tongue wire connectors. Terminal blocks used for monitoring such as current transformers (CT's) shall be of shorting type terminal blocks. Corrosion resistant marking strips shall be provided for conductor identification. At least ten percent spare terminals shall be provided. Terminal blocks shall be General Electric, Marathon, or equal as approved by the Engineer.

(11) Control desk shall be furnished with a convenience 120VAC rated GFCI receptacle and a fluorescent light in the inside cabinet. The receptacle and fluorescent lighting shall have a dedicated feed from the lighting panel

(12) The control desk shall be fabricated by a certified a UL industrial panel builder and will bear a UL label confirming the requirement.

e) Limit Switches: The contractor shall furnish and install a control desk as shown on the contract drawings.

(1) Rotary Limit Switches

a. The leaf position limit switch shall be rotary, cam operated type.

b. The limit switch shall be NEMA 4, 316 stainless steel enclosure and shall be driven by gearing-furnished with the operating machinery, which shall rotate the input shaft. The limit switches shall have a minimum of 10 circuits individually micro-adjustable. The limit switch shall allow for a + or - 1/4 degree contact operation repeatability. Each contact of the limit switch shall be SPDT precision-type, snap-action switch. The switch contacts shall have a minimum AC inductive continuous current carrying rating of 15A and a minimum DC resistive continuous current carrying rating of 15A. Each limit switch shall be GEMCO Series 1980 or equal as approved by the Engineer, and shall be driven by gearing furnished with the operating machinery.

c. Furnish and install the rotary cam limit switch enclosure with an internal heater

(2) Lever Type Limit Switches

a. The fully seated, over travel, and span lock limit switches shall be heavy-duty lever-operated, spring-return, two-circuit, snap-action limit switches in watertight, NEMA 4 enclosures. The switches shall be Eaton type E84 heavy duty crane control limit switch with stainless steel lever arm or approved equal.

f) Air Horn

(1) The air horn shall be used as an aural signal to draw attention to operation of the bridge.

(2) The projectors shall be made of spun brass, approximately 18 inches in overall length each, and shall feature a diaphragm designed for high pressure operation and low air consumption. The projectors shall be capable of producing a tone between 250 and 320 Hz with a decibel rating of 120db at 10 feet.

(3) The compressor motor shall be 1 HP, 120V, 60 Hz. Full load current for the air horn shall not exceed 12Amps. Compressor shall be a weatherproof, rapid response, direct drive piston type compressor. Piston and cylinder shall be an oil-less, non-lubricated type, with a Teflon compound piston ring. Compressor valves shall be stainless steel. Bearings shall be permanently sealed, pre-lubricated ball type, requiring no maintenance. All components and fasteners shall be corrosion resistant.

(4) The standard air horn assembly shall be a single unit comprised of compressor and horns and shall be suitable for outdoor mounting.

(5) The air horn shall be connection to a push button on the control desk as shown on the plans.

(6) Test that the air horn produces a tone acceptable to the Engineer. If necessary, the air horn sound tone shall be re-tuned to an acceptable pitch and level.

g) Navigation Lights:

(1) Navigation lights shall be provided in accordance with the rules and regulations of the United States Coast Guard as shown on the contract drawings.

(2) The bascule span lights shall be controlled by the fully open limit switches so that the green lights shall show when the span is fully open, and the red lights shall show at all other times. A selector switch shall be installed on the control desk to verify that the green navigation light is operational.

(3) All navigation lights shall have corrosion resistant metal plates with product information engraved. At minimum the plate shall display, operating voltage, wattage, and lumens

(4) A cast junction box with gasketed access cover is to be provided with the navigation lights. Junction box is to be of the same material as the fixture assembly and must match the navigation light base footprint.

(5) Provide cast silicon bronze housing or approved equal. Casting alloy used to be suitable for marine environment. Construction is to be rain-tight and fully gasketed. The light assembly is to be designed for heavy duty, long life service. Design to provide ready access for lamp service and be vandal resistant.

(6) Lamp shall be LED type, 120VAC powered. Medium base receptacle is to be rated for 250V, 660W and must be porcelain with a nickel-plated brass shell to resist lamp freezing. LED lamps shall be factory filled with optically clear silicon.

a. Movable Span Navigation Lights:

1. Lenses shall be tempered Fresnel glass. Lens sections for shall be 180 degrees green over 180 degrees red. Inside lens diameter shall measure approximately 7inch. Outside lens diameter shall measure approximately 8inch. Lamp fixture head and base shall be suspended from the swivel on a 1 1/2inch schedule 40 pipe, 1.90inch O.D. Pipe material is to be stainless steel with bronze castings. Standard dimension from center of swivel to focal plane of upper lens shall be 48inch.

b. Pier Navigation Lights:

1. Lens is to be tempered Fresnel glass. Nominal lens section is to be 180 degrees or 360 degrees as necessary to be visible from all approach angles of the navigable channel. Inside lens diameter to measure approximately 7inch. Outside lens diameter to measure approximately 8inch Color is to be red

2. The base is to be cast of the same material as the fixture head (silicon bronze). Mount light assembly with four 1/2inch diameter bolts through the base, provided by installer to suit installation

3. Mount lamp fixture head and base on a 1 1/2inch schedule 40 pipe, 1.90inch O.D. Pipe material is to be stainless steel pipe bronze casting. Standard dimension from the light base to the focal plane of the lens is to be approximately 15inch.

h) Wire Number Identification:

(1) Wire markers shall be used for wire marking at all splices, terminals and lugs in all cabinets, wire ways and junction boxes. Wire identification shall be professionally and permanently typewritten or heat sensitive markings, in black, on a white field. Markers shall be at least 4.0 mills thick vinyl with a high tack acrylic adhesive. Markers shall be self-laminating and shall incorporate a laminating feature to protect the legend (wire marker identification) with a clear overlay of vinyl. Other wire marker types meeting the general specifications above, applied by professional marking equipment may be considered by the Engineer, when submitted. Sleeve type markers which are sized to fit the wire snugly shall be required to be provided with adhesive or be of the heat shrinkable type. However, clear vinyl must be used to protect the legend in all cases. Embossing or painting wire insulation for wire identification shall not be permitted. The Engineer reserves the right to deny the use of any type wire marker he deems to be inferior to the type specified for use.

(2) Wire numbers shall be permanently attached to the wire within 1.0 inches of termination. All wiring connections at any terminal

strips or lugs shall have the numbers facing out for easy troubleshooting.

i) Nameplates

(1) Nameplates shall be provided inside the control console, drive cabinet, auxiliary control center and PLC monitoring cabinet. See general section for nameplate specification.

j) Spare Parts

(1) Spare parts shall be supplied in accordance with AASHTO Article 8.14 requirements and the Contract Plans. The spare parts supplied shall include, but not be limited to the following:

a. Control Desk:

1. Provide two (2) spare height indication meters.

2. Provide two (2) current indication meters.

3. Twelve (12) LED indicating lamps per each color

4. Four (4) indication lamp sockets / fixtures.

5. Two (2) lens caps of each indicator light color installed.

6. Two (2) of each type of switch / pushbutton switch units.

b. Relay Control Cabinet:

1. One (1) coil for every five or less of each size relay, contactor, and motor starter installed.

2. One (1) complete time delay relay, contactor, and starter for each unit or fractional unit of five or less of each kind and size installed.

c. Control Limit Switches:

1. One (1) limit switch of each type specified. In addition, a full set of contacts and contact fingers for each type of limit switch. For rotary limit switches, furnish twelve (10) contact assemblies.

k) Contractor Inspection

(1) After installation is completed, the Contractor shall make a thorough inspection to insure that all electrical control system has been properly installed, that all grounding conductors are

properly landed and that no conductors will cause shorts upon energization.

(2) The Contractors shall be accompanied by the Engineer, during his final inspection before electrical testing. On the basis of the results of this inspection, the Engineer shall determine whether the bridge is ready for testing.

l) Field Testing

(1) When the permanent machinery is ready for field testing, the operating machinery shall be driven by the main control system through at least ten complete cycles before final test. See Commissioning & Start Up section of this specification

xx. METHOD OF MEASUREMENT

a) The quantity of Special Provision (Bridge Control System) specified to be measured for payment shall be on a lump sum basis. The lump sum shall include the cost all Bridge Control System Equipment

xxi. BASIS OF PAYMENT

a) The accepted quantity of Special Provision (Bridge Control System) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 45% percent of the lump sum price will be made upon delivery of the bridge control system equipment including but not limited to the tested and approved control console, relay cabinet and Auxiliary/control panels to the project site.

(3) The third payment of 40% of the lump sum price shall be made after installation of the bridge control equipment and all cables termination have been completed.

(4) Payment of the remaining amount will be made after final acceptance testing and all punch list items have be resolved

c) Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Bridge Control System)	Lump Sum

SUBMARINE CABLE SYSTEM

xx. DESCRIPTION: This work shall consist of installing, testing and placing in satisfactory operating condition a new submarine cable system. The submarine cable system shall consist of high-density polyethylene (HDPE) ducts and submersible armored conductors for carrying power, control, lighting, and other circuits across the navigable channel. The work shall include but not limited to the following items:

(1) Furnishing and installing flexible solid wall submarine HDPE ducts under the channel, as well as the on-site services of the HDPE duct manufacturer's representative and Construction Diver.

(2) Contractor shall install the concrete mattress above the HDPE ducts as shown on the plans and backfill the open trench such that the original channel profile is established.

(3) The excavation and backfilling of trenches for the HDPE ducts in the lake bottom shall be done under this item.

(4) The ducts shall be furnished and installed across the navigable channel in sizes and quantities as shown in the plans.

(5) The Submersible Cable/HDPE duct termination cabinet shall be furnished under this item.

(6) The work shall include furnishing and installing termination cabinets, conduits on the rest piers, armor clamps, cable terminators/termination, brackets, supports, and other equipment required for completing the installation.

(7) As part of this work, sounding shall be taken to determine the existing elevation of the riverbed.

(8) The location of the existing submarine cables shall be determined prior to commencing work.

(9) The new HDPE ducts shall be installed in the same location as the existing submarine cable. The existing cables shall be removed prior to installing the new HDPE ducts.

Any damage incurred during handling or installation of the HDPE ducts or cables installation shall be the responsibility of the Contractor. The Contractor shall replace the ducts, cables, or both at no additional cost to the County. The Contractor shall warrantee the in-service performance of the HDPE ducts for two years following final project acceptance.

The Contractor shall furnish all materials, plant, and equipment for carrying the power, control, lighting, and other circuits across the navigable channels, where indicated on the Plans, in the HDPE ducts. .

All work shall be inspected by the Engineer who shall have the authority to halt construction if, in his opinion, these specifications or standard construction practices are not being followed. Whenever any portion of

these specifications is violated, the Engineer, by written notice order further construction to cease until all deficiencies are corrected.

Where all or part of a Federal, State or Local, ASTM, ANSI, NEMA, UL, etc., standard specification is incorporated by reference in these Specifications, the reference standard shall be the latest edition and revision.

xx. REFERENCE AND STANDARDS: The HDPE ducts and armored cables shall be manufactured according to and shall be UL listed.

xx. SUBMITTALS

(1) Product Data: Submit the following:

a. Data sheets and publication on all major components that make up the submarine cable system

b. HDPE ducts

c. Submersible wiring to be installed inside HDPE duct

d. Concrete Mattress

e. Support Devices

f. Submarine Cable Termination Cabinet

g. Cables/HDPE Clamps

h. Product technical data show the complete submarine cable system components and performance specifications confirming compliance with specified ratings and performance.

i. The contractor shall submit a qualification report for the ducts prior to obtaining approval of the shop drawings. The qualification report shall specify the materials of construction and essential parameters of the manufacturing process required to produce the qualified ducts. The qualification test report shall demonstrate a qualified life of 40 years considering immersion, ultraviolet exposure, and thermal cycling.

j. Manufacturer’s installation instructions.

k. The duct manufacturer shall have in place a quality assurance system that provides assurance of the quality of the ducts. The system shall encompass the following criteria:

22. Organization

23. Quality Assurance Program

24. Design Control

25. Procurement Document Control

26. Instructions, Procedures and Drawings

27. Document Control

28. Identification and Control of Materials, Parts and Components

29. Inspection Control

30. Material Control

31. Test Control

32. Control of Special Processes

33. Inspection

34. Control of Measuring and Test Equipment

35. Handling, Storage and Shipping

36. Nonconforming Materials, Parts or Components

37. Corrective Action

38. Quality Assurance Records

39. Independent Audits

l. The duct manufacturer shall maintain a system of records to substantiate that the ducts meets the requirements of the Qualification Test Report, referenced standards and requirements of this specification. All records shall be available for audit.

m. No ducts shall be shipped until they are fully tested as required by the referenced standards and specification requirements. All testing required shall be done using specimens of the production ducts.

n. Stock components shall require the same level of traceability and testing as project produced components. No components shall be spliced/fused to make up a production run of duct.

o. The Contractor shall submit to the Engineer certified copies of all the factory test data for approval before accepting shipment of ducts from the manufacturer. The test data shall include, in tabulated form, a description of the material undergoing test, a description of each test performed, the measured or observed results, and the value and limits required by the all applicable Standard for acceptance.

p. The Contractor shall submit to the Engineer copies of a statement certifying that the ducts delivered for use under this Contract has passed the required factory inspections and tests and complies with all the requirements, including

materials and construction, of the Standards and Specifications in the Contract.

q. Typical published test data providing the physical and electrical characteristics of the proposed ducts.

r. Certified test reports shall be provided in accordance with the testing required for HDPE ducts specified herein.

s. Provide bill of materials with model and catalog number for each item

t. Shop Drawings: See general electrical section for shop drawing requirements.

u. HDPE Ducts System:

1. Provide Standard Dimension Ratio (SDR) selection, pulling calculation, ballast weight and spacing, concrete mattress weight to land transition plan, manufacturers data to prove that the ducts is capable of withstanding all the loads during the installation and all the loads after final installation along with submersion plan.

2. Layout and installation details of the HDPE ducts, including a complete description of the equipment, method and procedure to be used in excavating trenches, laying the ducts, concrete mattress and backfilling.

(2) Test procedures/Reports:

a. Testing shall be per manufacturer requirements.

b. Standard testing requirements are those noted in ASTM F2160 and include: Dimensional evaluation, elongation at break and low-temperature impact.

c. All specimens shall be measured before testing in accordance with Test Method ASTM D 2122 “Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings”.

d. The minimum elongation at break shall be 400% when tested according to Test Method D 638 “Standard Test Method for Tensile Properties of Plastics”.

e. The duct shall not fail when tested at the low-temperature conditions of -4° F as specified in ASTM F 2160 and using the test apparatus as described in Test Method ASTM D 2444 “Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)”.

f. Coupling or joint of the HDPE ducts are not permitted. If the contractor or manufacturer for whatever reasons chooses

to join/couple the HDPE duct, a written notification must be provided to the Engineer for review and approval.

g. Any coupling/conduit joint shall not fail by leakage when subjected to sustained internal pressure testing as noted in ASTM F 2176.

h. The coupling/conduit joint assemblies tested shall be able to comply with tensile loading requirements as specified in ASTM F 2176.

i. The joint or coupling shall not fail by pullout when loaded to axial tensile load requirements as specified in ASTM F 2176.

j. As specified in ASTM F 2176, the coupling shall not fail when conditioned at low temperature condition of 10° F and tested by an impact with a force of 20 ft-lbf using Tup "B" as described in Test Method ASTM D 2444.

k. A manufacturer's certification shall be furnished to the Engineer that the conduit was manufactured, sampled, tested and inspected in accordance with this Specification and found to meet the requirements.

(3) Field Testing

a. The Contractor shall ensure that the Engineer receives at least 72 hours written notice in advance when field tests are to be made.

b. The Contractor shall arrange for and provide all the necessary field tests and inspections, as directed by the Engineer, to demonstrate that the entire Submersible HDPE ducts system is in proper working order, not been damaged during installation and is completely dry after installation and in accordance with the Plans and Specifications.

c. After the HDPE ducts have been installed in the trench, clamped, secured, and terminal connectors attached, the submersible cables have been pulled through but prior to final connections, all submersible conductors associated with the submarine duct system shall be tested for continuity and insulation resistance by the Contractor, in the presence of the Engineer, and the test results recorded and submitted for approval.

d. The Contractor shall submit the results of the test to the Engineer for approval before proceeding further with the work. After approval of the insulation resistance continuity tests of the installed but unconnected submersible cables, the Contractor shall connect the cables and test the energized installation as directed by the Engineer.

e. If a fault or defect is found to exist or a cable does not otherwise pass the tests, the Contractor shall identify and tag the faulty cable or conductor in question. The Contractor shall remove all cables and shall furnish and install new cables, subject to all the aforementioned tests and acceptance requirements, all without additional cost to the VTRANS. If it is definitely established that the fault or defect is due to a termination of the cable, the decision to correct or repair the cable or replace that section of cable shall rest with the Engineer.

f. The tests, including test equipment, test methods, and test data shall be as specified hereinafter. All test equipment shall be used within it's calibration interval. In the event the Contractor cannot provide certificates traceable to NIST, the test reports will be rejected.

g. All test reports submitted to the Engineer shall be detailed test reports which indicate test procedures and values obtained.

h. The Inspection Diver and Construction Diver shall submit a report to the Engineer stating that the ducts have been installed in accordance with the Plans. Plans of the as-built ducts locations and depths shall be prepared by the Contractor's Engineer as well as a description of the in-place cable condition. This information shall be submitted to the Engineer as detailed herein these specifications.

(4) Operation and Maintenance Manual

a. See general operation and maintenance manual section of this special provision.

xx. MATERIALS

a) HDPE Ducts:

(1) The ducts shall cross the channel to the north of the movable leafs where shown on the Plans. Where the ducts cross the navigable channel, they shall be buried below the bottom of the channel to a depth as shown on the Plans. The ducts shall be laid side by side without twists or loops in a common trench at the locations shown on the Plans. No duct shall be permitted to cross the other. The route of the ducts may have to be altered to avoid unforeseen obstructions.

(2) The ducts laying shall be performed without any damages to the ducts, existing submarine cables, bridge structure, fenders, pile clusters, or any existing substructure and as directed by the Engineer. Should any structure be removed to accommodate the Work, the affected structure shall be replaced at no additional cost to VTRANS.

(3) During the installation of the ducts, the Contractor shall arrange to have at the site a representative of the duct manufacturer. This representative shall be experienced in underwater duct handling and installation procedures, and shall advise the Contractor and the Engineer in these matters.

(5) The full duct length shall be lowered into position in the trench without loops or kinks and shall be continuously supported by approved means or devices until the duct is in correct position.

(6) After installation of the ducts, the Contractor as specified under section Soundings shall perform soundings. The ducts shall be permitted to settle for 48 hours prior to pulling in conductors and termination of these conductors. After such time and completion of specified field tests, the Contractor shall install the concrete mattress as shown on the plans and backfill the open trench such that the original channel profile is established. The backfill material shall be per VDOEC permit requirements.

(7) The ducts shall be allowed to settle for a period of a minimum of 48 hours after the last duct has been placed, before any rigid connections or attachments are made. The ducts and cables shall be of sufficient length to allow for slack in settlement and to allow for making permanent connections.

(8) The Contractor shall provide proper equipment for lifting or lowering the ducts at the piers. The Contractor shall exercise proper care so as not to over stress, score, or damage the ducts, or otherwise damage the cables installed within.

(9) The Contractor shall determine the proper type of lifting or lowering device for the ducts, subject to approval by the Engineer, and shall include considerations for the quantity and size of conductors in the ducts and distances involved.

(10) Prior to pulling any cables, the contractor shall test the ducts to verify the ducts are not damaged during the installation and the ducts are completely dry before pulling the conductors.

(11) After conductors are pulled, the contractor shall seal the end of each duct to assure the ducts will remain water tight after the conductors have been installed. The spare ducts shall be sealed on each end.

(12) The duct manufacturer shall have manufacturing and quality control facilities that are capable of producing and assuring the quality of the conduit or casing required by these specifications. The manufacturer’s production facilities shall be open for inspection by the Engineer.

(13) The duct manufacturer shall have a documented quality management system that defines product specifications and manufacturing and

quality assurance procedures that assure conformance with customer and applicable regulatory requirements.

(14) Materials used for the manufacture of polyethylene conduits (ducts) and casing shall be high-density polyethylene in accordance with ASTM F2160 requirements. UV protection is required due to portions of the ducts being routed where exposed to sunlight. Non-black materials shall not be used.

(15) The manufacturer shall have documented proof that the HDPE conduits are made in the United States and shall be UL Listed 651A.

(16) The wall thickness (SDR) of the new HDPE duct shall conform to ASTM to withstand all of the forces that will be imposed on the pipe during the tunneling installation, as well as the final in-place loading conditions. The HDPE duct shall have a SDR rating shall be SDR 9 with a pressure rating of 200PSI or better. The Contractor shall submit SDR to Engineer for approval prior to ordering the new HDPE duct.

(17) Contractor shall appropriately weigh down the HDPE duct in order to prevent the duct from floating upwards after installation. 6 inch of backfill material shall be installed between the HDPE duct and concrete mattress.

(18) Ovality in coiled HDPE duct due to packaging shall not exceed 10%. If greater than 10%, ovality shall be corrected in the field by processing the roundable conduit through re-rounding and straightening equipment during installation. This shall be at no additional conduit to VTRANS.

(19) Straight lengths of conduit shall have ovality of 5% or less.

(20) In addition to solid wall colors, permanent color identification shall be available either as stripes or as a coextruded skin. In either case the color layer shall be permanently bonded to the main body and exhibit the same chemical and mechanical properties as the underlying material. Colored ducts shall maintain its color for a period of 2 years when stored outside, or as otherwise agreed to by the Engineer and producer.

(21) Striped ducts shall have a minimum of 3 equally spaced stripes of sufficient width and color intensity to be easily distinguished from a distance of 10 feet and from any angle.

(22) Solid yellow or black with yellow stripes shall not be used for identification of conduit due to risk of misidentification with gas pipe.

(23) Friction reduction shall be available in the form of lubrication and/or interior ribbing. Ribbing shall not be sharp or severe.

(24) Factory pre-lubrication shall be performed with materials or agents that provide a permanent stable treatment and result in a coefficient of friction </= 0.15. Lubricants shall be compatible with both conduit and cable jacket materials.

(25) Pull media shall be pre-installed into the HDPE duct.

(26) Media shall consist of high tensile fiber tapes or rope. Tapes shall be pre-lubricated with sequential length marks. Sufficient slack shall be available in the tapes to prevent binding when paying the conduit out of the coil.

(27) HDPE ducts shall be permanently marked in accordance with ASTM F 2160.

(28) Manufacturers that are qualified and approved are listed below. Products from unapproved manufacturers may be submitted for approval at the discretion of the Engineer.

a. Dura-Line Corporation

Suite 300, 11400 Parkside Drive

Knoxville, TN 37934

b. Blue Diamond Industries, LLC

3399 Tates Creek Rd #110

Lexington, KY 40502

c. JM Eagle Co

9 Peach Tree Hill Rd

Livingston, NJ 07039

(29) Joining

a. HDPE ducts shall be one continuous length, joining shall not be permitted. Ship ducts in large reels to prevent joining of each individual duct run.

(30) Construction and Installation:

a. Underground installations using open cut and burial techniques shall be performed in accordance with ASTM D2321 or as specified by the Engineer. The contractor shall observe all appropriate safety requirements in accordance with local, state and federal codes and regulations.

b. Conduit sizing and placing shall be consistent with the recommendations provided by Chapters 10 (Marine Installations) and 14 (Duct and Conduit) of the PPI Handbook of Polyethylene Pipe.

b) Armored Submersible Cables

(1) The submersible cables shall be rated for 600 volts multiconductor power and control cables suitable for underwater installations. The cables shall be suitable for installations in wet or dry locations such as underwater, direct earth burial, or where additional protection is required. These cables shall be sunlight (UV) and weather resistant.

(2) Cables shall be designed and manufactured in accordance with:

a. ANSI/NEMA WC 70 / ICEA S-95-658 (14 AWG & larger).

(3) Standard Test Methods are in accordance with:

a. ANSI/ICEA T-27-581 / NEMA WC 53

(4) General

a. The General configuration shall consist of multiple conductor stranded copper conductors, cross-linked polyethylene (XLPE), cabled with fillers as necessary, binder tape, high density polyethylene (HDPE) inner jacket, galvanized steel armor wire (coated with HDPE), and a high density polyethylene jacket overall.

(5) Construction

a. The conductor wires shall be annealed uncoated copper in accordance with ASTM B-3. Conductors shall be stranded in accordance with ASTM B-8, class "B" stranding and Section 2 of ANSI/NEMA WC 57 / ICEA S-73-532 or ANSI/NEMA WC 70 / ICEA S-95-658.

b. The insulation shall be a chemically cross-linked polyethylene (XLPE) compound meeting the requirements of:

i. ANSI/NEMA WC 70 / ICEA S-95-658, Table 3-8 (14 AWG & larger), XLPE, Class X-2

(6) Physical and Aging Requirements

a. The XLPE insulation shall meet the following physical and thermal aging requirements:

b. UNAGED

i. Tensile Strength –minimum, psi: 1800

ii. Elongation – minimum, %: 250

c. AGED

After air oven 168 hours @ 121C

i. Tensile Strength and elongation at rupture-min. % of unaged: 75

ii. Hot creep at 150C: Hot creep elongation, max %: 100

iii. Set max %: 5

(7) Water Absorption Requirements

a. The XLPE insulation shall meet the following accelerated water absorption requirements when tested in accordance with ANSI/ICEA T-27-581 / NEMA WC 53, Electrical Method EM-60

(8) Insulation Thickness

a. The insulation thickness shall comply with:

i. ANSI/NEMA WC 57 / ICEA S-73-532, paragraph 3.3 and Table 3-1 and

ii. ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 3.3 and Table 3-4 for cables as follows:

(9) Strippability

a. The insulation shall be readily removable from the conductor. To enhance strippability, a separator shall be employed between the conductor and the insulation. The separator shall be colored so as to be distinguishable from the conductor once the insulation is removed.

(10) Color Coding

a. Color Coding of the insulated conductors shall be accomplished by surface printed legends consisting of numbers and words (1-ONE, 2-TWO, 3-THREE…19-NINETEEN… 37-THIRTY SEVEN, etc.).

b. Color coding sequence shall be in accordance with ANSI/NEMA WC 57 / ICEA S-73-532, Annex E, Method No.4.

c. Sequence shall begin from the inner conductor layer and progress to the outer conductor layer. For ease of identification during installation, numbering sequence may be reset to 1-ONE for each group of different size conductors.

d. Contrasting color print shall be employed and be legible after normal handling during installation.

(11) Cable Assembly

a. The cable components shall be cabled into a tight concentric configuration. The direction of lay for adjacent layers of cable conductors shall be reversed. Maximum lay lengths and lay directions shall conform to Section 5 of ANSI/NEMA WC 57 / ICEA S-73-532 or ANSI/NEMA WC 70 / ICEA S-95-658.

b. Fillers shall be employed as necessary within the cable core to produce a substantially circular cross section. Fillers shall be non-hygroscopic.

c. The cabled conductors shall be covered with a 0.002" corrugated polyester binder tape. The tape shall be applied helically with a minimum overlap of 25 percent.

d. The cabled core assembly shall be covered with a homogeneous layer of high density polyethylene (HDPE) in accordance with:

    i. ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 4.1.7, & Table 4-1 for HDPE jackets

e. The jacket shall be sunlight (ultraviolet) and weather resistant.

f. The inner and outer jacket thickness shall be in accordance with ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 4.1.18, and Table 4-5.

g. Cable Armor

    i. The cable armor shall consist of galvanized steel wires in accordance with ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 4.3.5.

    ii. Each armor wire shall be coated with a layer of high density polyethylene (HDPE) in accordance with ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 4.1.7, & Table 4-1 for HDPE jackets.

    iii. The coating shall be sunlight (ultraviolet) and weather resistant.

    iv. The size of the armor wires shall be in accordance with ANSI/NEMA WC 70 / ICEA S-95-658, Table 4-18

    v. The coated armor wires shall be applied at a lay angle of 17 to 25 degrees and provide a coverage of 92 to 98 percent. The armor wires shall be applied in a left lay helix.

    vi. The armored layer shall then be covered with a 0.002” corrugated polyester tape, 25% minimum overlap followed by a 0.002” adhesive polyester tape, 25% minimum overlap. These tapes allow the

outer high density polyethylene jacket to be easily removed during termination.

vii. The armored core assembly shall be covered with a homogeneous layer of high density polyethylene (HDPE) in accordance with: ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 4.1.7, & Table 4-1 for HDPE jackets

viii. The jacket shall be sunlight (ultraviolet) and weather resistant.

(12) Arrangement and Connection of Cables:

a. Slack shall be provided for the conductors in the submarine terminal cabinets. After the conductors have been installed in place and are awaiting termination, the ends of the conductors shall be test-capped and the ends of the cables sealed to prevent entry of moisture.

b. Conductors inside the terminal cabinets shall be neatly formed into cables and laced with approved cable ties, with the individual conductors leaving the ducts at their respective terminal points. These conductors shall be looped to allow not less than 3 inch of free conductor when disconnected.

c. Both ends of every single length of conductor in the ducts shall be permanently and clearly tagged in accordance with the same numbers or designations appearing on the wiring diagrams. For conductors of Size No. 10 AWG and smaller, all wire ends shall be provided with compression-type, ring-tongue wire connectors suitable for connection to screw-type terminals.

d. Tags shall be preprinted heat shrink sleeves or approved equal. Tags shall be oriented to be legible without moving wires or the use of visual aids.

e. Terminal blocks shall be marked to show the wire number or designation of each conductor connected thereto. The markings 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.

(13) Testing

a. The individual insulated conductors shall be AC (rms) voltage spark tested in accordance with ANSI/NEMA WC 70 / ICEA S-95-658, Table 3-4 and ANSI/ICEA T-27-581 / NEMA WC 53, paragraph 2.2.4

b. The finished cable shall withstand between each conductor and all other conductors, an AC (rms) voltage in accordance with:

i. ANSI/NEMA WC 70 / ICEA S-95-658, table 3-4, par. 3.6.2 & 6.10.1.1 (14 AWG & larger) ANSI/ICEA T-27-581 / NEMA WC 53, paragraph 2.2.2

c. The insulation resistance shall be measured after the completed cable AC voltage tests. The measurement method shall be in accordance with:

i. ANSI/NEMA WC 57 / ICEA S-73-532, paragraphs 3.5 & 6.18 (20-16 AWG)

ii. ANSI/NEMA WC 70 / ICEA S-95-658, paragraphs 3.6.3 & 6.10.2 (14 AWG & larger) ANSI/ICEA T-27-581 / NEMA WC 53, paragraph 2.3

d. The insulation resistance constant (IRK) for XLPE insulation shall be 10,000 in accordance with ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 3.6.3, and Table 3-8 for insulation Class X-1.

e. The dc resistance of each conductor in the completed cable shall be measured and comply with:

i. ANSI/NEMA WC 57 / ICEA S-73-532, paragraph 2.3.4 (20-16 AWG)

ii. ANSI/NEMA WC 70 / ICEA S-95-658, paragraph 2.3 (14 AWG & larger)

iii. ANSI/ICEA T-27-581 / NEMA WC 53, paragraph 2.1

(14) Packaging

a. Packaging of the finished cable shall be on suitable non-returnable reels capable of supporting the weight during transportation and normal handling.

b. Cable ends shall be suitably sealed to prevent moisture from entering the conductor core area during shipment and storage only.

c) Sounding:

(1) Soundings shall be taken to determine the existing elevations of the lake bed, the location in plan and elevation of the ducts in the trench after installation, and the elevations of the lakebed after backfilling. A licensed Land Surveyor in the State of Vermont shall perform the soundings. This information shall be submitted to the Engineer for his review and shall be shown on the as-built record drawings. The soundings shall also be submitted to

the U.S. Coast Guard/Corps of Engineers. All cost for surveying shall be included under this item.

(2) The as-built record drawings shall attest to the actual location and depth and elevation to which the new ducts have been installed, and drawings shall be certified by the licensed Land Surveyor. Depths shall be at 5 foot intervals.

d) Trenching and Backfilling

(1) This work shall be bid in conjunction with items related to work with lake material.

(2) The excavation of the trenches in the channel bottom and the backfilling of said trenches after installation of the ducts shall be performed under this item. All excavated material shall be properly disposed in accordance with Vermont Department of Environmental Conservation (VDOEC) Requirements. Any new fill material shall be in compliance with the VDOEC permit

(3) The method of trenching shall be in conformance with the State of Vermont Department of Environmental Conservation permit and approved by the Engineer. The existing lake bottom shall be excavated by clam-bucket, or similar, method. All construction activities in the lake shall meet the Vermont Department of Environmental Conservation and United States Army Corps permit conditions. The trench shall be excavated so that the ducts can be installed at the required depth.

e) Diver

(1) The Engineer shall contract for the services of an experienced independent Inspection Diver, who is also a licensed Vermont State Professional Engineer, to inspect the trench, inspect the duct installation, and determine the elevation and depth of the ducts. The Contractor shall employ all personnel required to install the submarine HDPE ducts and pull the conductors after the ducts and cabinets have been installed, including any Diver required for the installation of the submarine HDPE ducts system or other construction purposes.

(2) The Contractor shall furnish the necessary Construction Divers and diving equipment to assure that the ducts trenches are properly excavated and that the ducts are properly laid and spaced therein. The Inspection Diver shall perform the necessary inspections. In making these inspections, the Inspection Diver shall operate as directed by the Engineer and shall report directly to him.

(3) The Construction Diver shall be provided by the Contractor for the necessary number of days to perform the specified excavation and inspections of the trenches and placement of the ducts therein. The cost of supplying the Construction Diver and

necessary diving equipment shall be included in this pay item price.

xx. METHOD OF MEASUREMENT

a) The quantity of Special Provision (Submarine Cable System) specified to be measured for payment shall be on a lump sum basis. The lump sum shall include the cost of all work performed and equipment under the Submarine Cable System

xx. BASIS OF PAYMENT

a) The accepted quantity of Special Provision (Submarine Cable System) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 5 percent of the lump sum price will be made when the all shop drawings have been approved.

(2) The second Payment of 65% percent of the lump sum price will be made upon purchase of the HDPE duct, Submersible cables, concrete mattress, and any other incidental material, fabrication, shop testing, installation at the project site and field testing.

(3) Payment of the remaining amount will be made after final acceptance testing and all punch list items have be resolved

c) Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Submarine Cable System)	Lump Sum

CCTV SYSTEM

xx. DESCRIPTION: The work shall consist furnishing and installing a CCTV System as shown on the contract drawings and specified herein. The CCTV system shall consist of cameras, network switches and all necessary associated equipment. The intent of CCTV system as described herein and on all other contract documents is to provide the bride operator with a view of areas that are not in line of site from the operator's room when operating the bridge.

xx. REFERENCE AND STANDARDS: The CCTV equipment shall be manufactured, installed and tested in conformance to the latest revisions of the following standards:

(1) Telecommunication Industry Association (TIA)/Electronics Industries Alliance (EIA)

a. 170 - Electrical performance Standards - Monochrome Television Studio Facilities

b. 232 - Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

c. 250 - Electrical Performance Standards for Television Relay Facilities

d. 310 D – Cabinets, Rack, Panels and Associated Equipment

e. 422 - Electrical Characteristics of Balanced Voltage Digital Interface Circuits

f. 568 - Commercial Building Telecommunications Cabling Standard

g. 569 – Commercial Building Standard for Telecommunication Pathways and Spaces

(2) National Fire Protection Association (NFPA):

a. 70 - National Electrical Code (NEC).

(3) Institute of Electrical and Electronic Engineers (IEEE)

a. C62.41 - Guide for Surge Voltages in low Voltage AC Power Circuits.

b. 802.3at - Data terminal equipment (DTE) power via the media dependent interface (MDI) enhancements

c. 802.3af - Data terminal equipment (DTE) power via the media dependent interface (MDI) enhancements

d. 802.1x - Port based network access control

(4) International Electrotechnical Commission (IEC)

a. 60529 - Degrees of protection provided by enclosures (IP Code)

b. 62262 - Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

(5) Internet Protocol (IP)

a. IPv4/v6 - Internet Protocol (IP) Version 4, Version 6

(6) Video Coding Experts Group (VCEG)

(7) 264 - Advanced Video Coding (AVC)

(8) National Electrical Manufacturers Association (NEMA)

(9) 1/4X - ICS 6: Industrial Control and Systems Enclosures

(10) Electronic Code of Federal Regulations (E-CFR)

a. 47CFR68 – Connection of Terminal Equipment to the Telephone Network.

(11) APTA SS-SIS-RP-002-08 Recommended Practices for CCTV Camera Coverage and Field of View Criteria for Passenger Facilities.

(1) The Contractor shall submit the required assembly drawings showing all components mounted to supports, erection drawings, shop drawings, certified prints & catalog cuts for the electrical items to the Engineer for review

(2) The Contractor shall submit to the Engineer for his approval prints of all assembly drawings, erection drawings, shop drawings, certified prints & catalog cuts. In case of correction or rejection, the Contractor shall resubmit prints of assembly drawings, erection drawings, shop drawings, certified prints & catalog cuts until they are approved. The Contractor shall bear all costs for damages, which may result from the ordering of any materials prior to the approval of the shop drawings; and no work shall be done until the shop drawings therefore have been approved. After approval of the shop drawings, the Contractor shall supply the Engineer prints of the approved shop drawings as may be ordered.

(3) Product Data and Certifications: Submit the following catalog cuts

a. CCTV Camera

b. CCTV Camera Mounts

c. CCTV Camera Enclosure and all devices

d. CCTV Monitor

e. CCTV Cabinet and all of its appurtenances

f. CCTV Controller Joystick

g. PoE Enabled Network Switch used

h. Wire and Cable associated with the installation of the CCTV system

i. Network Video Recorder (NVR)

j. Cable connectors

(4) Shop Drawings: The sub drawings shall contain the following

a. System Block Diagram

b. Detailed System Wiring Diagrams, indicating all field terminals block numbers.

c. Complete, comprehensive, single-line diagrams, including all equipment, devices, and cabling completely identified.

d. Camera Field of View

e. Screen Shots in the new monitors.

f. Enclosures with layout of locations for all internal devices.

(5) CCTV Performance Test Plan: Prepare and submit to the Engineer for approval a performance testing plan for the CCTV system, a minimum of 45 days in advance of the earliest, approved, scheduled inspection and test date. The CCTV Performance Test Plan shall be divided into the following stages:

a. Inspection of the CCTV components upon arrival.

b. On-site inspection and Field Test immediately following the complete installation of the hardware, to demonstrate compliance with the requirements of this section.

c. A Thirty (30) day Operational Test commencing with the successful completion of the on-site inspection and test, approved by the Engineer.

(6) Record Documents: Prior to the issuance of the Certificate of Final Completion, deliver to the Engineer the following

a. Contract Drawings and Shop Drawings, as required elsewhere.

b. Operations and Maintenance Documentation

(7) The following documents shall be included in the complete documentation package on the hardware which shall be furnished before acceptance:

a. Hardware Documentation: Three complete sets of hardware manuals for each type of equipment furnished and installed by the Contractor shall be submitted explaining all capabilities and options, including but not limited to the installation, set-up, operation, and maintenance of all equipment furnished.

b. Operations Documentation: Two complete sets of manuals shall be submitted which shall consist of the Operations and Maintenance Manual (to be supplied in hardcopy format only)

c. Test Procedures: Recommended test procedures. Tests shall include the following:

1. Field test of hardware as witnessed by the Authority.

2. Thirty (30) day Operational Test in which all installed hardware shall operate without failure. If a failure is encountered, the Thirty (30) day test shall be restarted from the beginning.

(8) Training Documentation including but not limited to training syllabus and User Manuals.

xx. MATERIALS

(1) CCTV Monitor

a. The contractor shall also supply three monitors each 19” maximum, 12” minimum. The monitors shall display the view of areas indicated on the contract drawings.

b. The new CCTV equipment shall be from the same manufacturer and shall be compatible with any equipment connected to it.

(2) CCTV Installation

a. All brackets, housings, etc., shall be installed and connected in accordance with manufacturer's recommendations. It shall also be in accordance with the requirements set forth in other contract drawings and these specifications.

b. All CCTV system wiring shall be installed in separate conduits. The Contractor shall provide the appropriate conductors for the system in the aerial cable

(3) CCTV Field Testing

a. The Contractor shall arrange for and provide all necessary field tests required by the Engineer to demonstrate that the entire CCTV System is in proper working order and in accordance with the contract drawings and specifications.

b. Operational tests of the complete installation shall be conducted by the Contractor under the supervision of the system vendor in the presence of the Engineer to demonstrate to his satisfaction that all components and systems are installed, connected and operate in accordance with the contract drawings, Specifications and approved Shop Drawings. Representatives of the manufacturers of the CCTV equipment shall be made available for adjustment or modification of their equipment, as needed.

c. Should the test show that any piece of equipment, in the judgment of the Engineer, is defective or functions improperly, such adjustments and/or replacements shall be made by the Contractor as to make the installation satisfactory to the Engineer, and at no additional cost to VTRANS.

(4) Manufacturer

a. Components that make up the CCTV system shall be of the same manufacturer. Components shall be manufactured by Pelco, Siemens, RenTech Engineer approved equal.

xx. METHOD OF MEASUREMENT

a) No separate measurement shall be made for work in this section.

xx. BASIS OF PAYMENT

a) Payment for this work to be included in the Bridge Power Equipment.

b) Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Bridge Power Equipment)	Lump Sum

GROUNDING AND BONDING

xx. DESCRIPTION: This work shall consist of furnishing all labor, materials, tools and equipment and performing all operations necessary for Grounding and Bonding indicated on the Contract Drawings and specified herein

Definitions:

1. Grounding Conductor – Conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

2. Equipment Grounding Conductor – Conductor used to connect the non-current-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor, the grounding electrode conductor, or both, at the service equipment or at the source of a separately derived system.

3. Grounding Electrode – Device that establishes an electrical connection to the earth.

4. Grounding Electrode Conductor – Conductor used to connect the grounding electrode(s) to the equipment grounding conductor, to the grounded conductor, or to both, at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at the source of a separately derived system.

xx. REFERENCE AND STANDARDS: ASTM B33, IEEE 81-1983

xx. GROUNDING AND BONDING REQUIREMENTS

1. All conduits, boxes, wiring, cables, and other equipment required to extend the necessary circuits to and from the grounding and bonding system shall be furnished and installed as specified herein. All grounding and bonding system wiring shall be paid for under this Section, and shall conform to the requirements specified herein.

2. All grounding equipment and its installation shall conform to the requirements of the latest revision of the Standard Specifications for Movable Highway Bridges of the American Association of State Highway and Transportation Officials, except as may be otherwise provided herein.

3. Materials and construction shall conform to the requirements of the current National Electrical Code and to any applicable local rules and ordinances. The Contractor shall obtain any required permits and approvals of all Departments or Agencies having jurisdiction.

4. The grounding and bonding system, and all associated equipment and materials shall be new. All equipment, materials, and workmanship shall be first-class in every aspect and shall be manufactured and erected to the satisfaction of the Engineer. The Contractor shall warrantee the in-service working of the grounding and bonding system, and associated equipment for one year following the date of

project acceptance. If the Contractor has any objection to any feature of the equipment as designed and laid out, he must state his objection at once, in writing, to the Engineer. Otherwise, his objection will not be valid as an excuse for operational malfunctioning of the equipment for defective and/or broken apparatus.

5. Equipment ground conductors shall be seven-strand, soft-drawn, bare, tinned, copper wire conforming to ASTM B33 and not smaller than No. 8 AWG.

6. Ground rods shall be made of copper or copper-clad steel and shall not be less than 1 inch in diameter and 10-feet in length unless otherwise specified. A permanent, exothermic weld connection to the permanent steel sheet piling at the bridge towers is an acceptable grounding means at the indicated locations. If the steel sheet piling is not accessible, ground rods shall be used as grounding electrodes. Insulated green ground conductor shall be used when exposed to wet environment.

7. Exothermic welds shall be used to connect ground conductors to ground rods and ground bus bars. The resistance to ground shall be 5 ohms or less. Exothermic welds shall be molded fusion, type as required, as manufactured by Cadweld, Thermoweld, Metalweld, or approved equal. Execution

8. Submittals: Submit manufacturers technical data and catalog cut of the following

    a. Grounding Conductors

    b. Ground Rods

9. See standard specification 753.05 for additional requirements

xx. PRODUCTS

1. The bridge steel work on each side of the channel shall be solidly bonded and grounded to ground rods installed at the piers, using No. 4/0 AWG bare, stranded, tinned copper cable.

2. Traffic signal poles, warning gates, Resistance Gates, standby generator neutral conductor and engine block, grounding conductors in conduits, navigation lighting units, all metal framing, cases, and enclosures of the electrical equipment, such as motors, control desk, relay cabinets, boxes, and all other metal parts in the proximity of current carrying conductors or equipment shall be bonded together and solidly connected to a ground bus in the switchboard room, and ground bus in the generator room. All electrical equipment ground busswork shall be connected to the closest main ground bus.

3. The utility service neutral conductor, the bridge grounding conductor and grounding electrode conductors shall all be exothermically welded together.

4. Ground system terminals shall be solderless lugs and shall be secured by means of hexagonal-head, copper plated, steel machine bolts with lock washers or lock nuts. Ground system conductors shall be continuous unspliced connections between terminal lugs. Paint, rust, and scale shall be removed over the contact area. All connections shall be made up as tightly as possible, and any bare metal or paint undercoat remaining exposed shall be spot painted to restore the surface with the same coating and number of coats as applied to the adjacent metal. Bolted connections shall be restricted to removable items (e.g., motors).

5. A minimum of two ground rods per pier shall be installed to establish the bridge grounding system.

6. The utility service neutral conductor shall be grounded in accordance with the utility company's standard requirements.

7. Upon completion of installation of electrical grounding and bonding system for continuity on all cables and connections, test ground resistance with ground resistance tester per IEEE Standard 81-1983. Where tests show resistance-to-ground is over five (5) ohms, reduce resistance to five (5) ohms or less, by driving additional grounding electrodes. The test shall be repeated to demonstrate compliance.

xx. METHODS OF MEASUREMENT

a) No separate measurement shall be made for work in this section.

xx. BASIS OF PAYMENT

a) Payment for this work to be included in Bridge Power Equipment.

b) Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Bridge Power Equipment)	Lump Sum

COMMISSIONING & START UP

xx. DESCRIPTION: The work of this Section includes supplemental requirements for implementation of final commissioning of systems, subsystems, and equipment being furnished within these specifications. Individual technical describe detailed requirements for factory, functional and field testing for electrical and mechanical equipment. The requirement of this specification section shall in no way relieve the Contractor or his vendors from performing inspections and tests required elsewhere in these specifications. The Engineer has the authorization to witness all integrated system commissioning. Notify the Engineer a minimum of 20 working days in advance of initiating any integrated system commissioning. The contractor shall provide all material, test instruments, equipment, labor, and technical supervision required to perform commissioning. The intent of the Integrated System Commissioning is to verify that electrical, mechanical equipment, systems and subsystems are operational within industry and manufacturer's tolerances, and are installed in accordance with these specifications. The contractor shall submit a commissioning procedure to the Engineer for review and approval prior to the start of commissioning.

xxi. REFERENCES AND STANDARDS

(1) Specifications and Special Provision

(2) Contract Drawings

(3) Vendor/Contractor Submittals and As-Built Drawings.

(4) General Observation and Guidelines:

a. All of the commissioning involves operation of multiple systems at once. The Contractor’s proposed system commissioning procedures shall identify all systems included as part of each test and expected system response.

b. Each system involved in the identified procedure must perform correctly for the commissioning test to pass as a whole.

c. If a problem is detected while conducting commissioning, the problem will be identified and reported to the contractor for diagnosis and correction.

xx. TESTING EQUIPMENT

(1) The testing of the bridge electrical equipment will necessitate the use of the following calibrated recording and testing devices:

a. A computerized, data acquisition system providing simultaneous sampling every 0.1 second of span position, pump motor power, current, voltage, and motor

RPM. Data shall stream to disk at a rate of 10 hertz. The data shall be transferred to graphing software

b. Recording Ammeter/Voltmeter

c. Power Factor Readout/Watt Recorder

d. Portable Tachometer

e. Portable Megometer

f. Amp-probe

g. Infrared Scanner

h. Measuring Tape

i. Stop Watch (Timer)

(2) The contractor is responsible for providing any additional equipment required to monitor, adjust or replace items during the testing procedure.

(3) All meters shall be calibrated per NIST guidelines within 6 months of the testing

xx. GENERAL TESTING REQUIREMENTS

(1) The Contractor shall furnish all labor, materials, plant, and equipment and shall do all work necessary, such as adjustments or corrective measures, to properly test all systems included in the field testing and final acceptance testing

(2) All test results, parameters, data specified herein to be recorded shall reference the appropriate paragraph number and shall be presented in legible, tabular format, listing associated parameters and conditions. For example, motor current shall reference speed (rpm), span height (feet-inches), raise or lower mode, etc.

(3) The results of the tests shall be presented in a matrix form on an Inspection Report Data Sheet. The proposed format of these sheets shall be submitted to the Engineer for acceptance prior to the actual testing. Any parameter value, which falls beyond the recommended range, would require the readjustment or replacement of the defective device.

(4) The table of the test results shall have references to the specific sections of the testing procedure. The precision of the results will depend on the accuracy of recording equipment, the observer and weather conditions. For each stage of testing of the bridge equipment, the name of the person who will perform the test, instruments used with calibration data if required, the exact date, time and weather conditions shall be recorded.

(5) Some devices such as the light, CCTV system, HPU heaters, pier navigation lights and air horn, can be tested without performing any bridge opening operation.

(6) The bridge main parameters shall also be observed and visually compared to the control desk indicating meters. Any discrepancy between results should be recorded. A discrepancy between critical measurements like span height shall be resolved prior to continuing the tests.

(7) The testing shall be accomplished sequentially, following the bridge operation instructions for normal and emergency operation. The major bridge systems shall be monitored while the bridge operates. All monitored parameters shall be kept for future reference, and a printout copy shall be attached to the Operating and Maintenance (O & M) Manual for reference. Printout copies shall also be provided to the Engineer.

(8) The Contractor shall arrange for and provide all the necessary field tests and provide a testing procedure subject to the approval of the Resident, to demonstrate that the entire electrical and mechanical system is in proper working order and in accordance with the Plans and Specifications. The tests shall include, but not be limited to operational testing of traffic signals, traffic gates, Resistance (Barrier) Gates, span locks, movable span, navigation lights, traffic signals and HPU equipment.

(9) Should the tests show that any piece of equipment or cable or wiring connection, in the judgment of the Engineer, is defective or functions improperly, such adjustments and/or replacements shall be made by the Contractor as to make the installation satisfactory to the Engineer and at no extra cost to VTRANS.

(10) During testing of the electrical systems, it may be found that minor deviations from the performance specification are required for optimum bridge operation. All hardware required for these modifications shall be included in the control system integrator/HPU vendor scope of work at no additional cost to VTRANS.

(11) The bridge field tests are intended to confirm each major sub-component acceptance factory tests, and that the subsystem is operational, as well as the complete system. Confirmation of correct operation of sub-components will be demonstrated through successful operation of the particular component. However, the Contractor is still responsible for the factory acceptance tests as required per contract specifications. Examples of subsystems are the, control and power wiring, limit switches, starters, etc.

(12) This acceptance test is intended to show and/or demonstrate that all systems are operational, trouble free, operating with all

interlocks properly functioning, and in compliance with the requirements of the contract plans and specifications.

(13) The bridge acceptance tests are not intended to substitute each sub-component acceptance factory and field tests. Confirmation of correct operation of sub-components shall be demonstrated through successful operation of the total control system. However, the Contractor is still responsible for the factory and field tests acceptance tests as required per contract specifications. For example, it is not the intent to manually operate and test each limit switch. This will have been accomplished by the contractor prior to demonstration of the system under test. The contractor shall be able to prove that the results of the sub-component tests are in conformance with the contract plans and specifications. The recommended values of various device parameters can be found in the appropriate manufacturer's catalog cuts and instruction manuals. Correct operation of the sub-components, and control circuit wiring connections will be verified through the successful completion of the entire bridge control and power systems tests.

(14) This testing procedure will evaluate performance and confirm correct and proper operation of all major subsystems and devices including the control desk meters , control switches and pushbuttons, traffic signals, traffic gates, span locks, HPU system, bypass switches, etc. Visual inspections and physical measurements of some equipment are required for the purpose of recording valid parameter values. Bridge run printouts shall be provided for each test, and kept for the record together with all other recorded data.

(15) The Engineer must be in possession of the approved preliminary operation and maintenance (O & M) manuals prior to system commissioning commencing.

(16) During the system commissioning testing period, the Contractor shall arrange to have at the site representatives of the manufacturer of all major pieces of equipment or systems. The representatives shall be capable of supervising all adjustments to the equipment; of locating faults or defects and correcting them if possible; and of obtaining from the manufacturers, without delay, new parts or replacements for apparatus which, in the opinion of the Engineer, does not perform satisfactorily.

xx. FINAL ACCEPTANCE TESTING

(1) Results and observations shall be carefully recorded throughout the various tests

(2) The bridge shall be balanced and cylinder pressure conditions verified by the Contractor prior to any final acceptance testing of the span control system.

(3) Prior to performance of these tests, all temporary bypasses, jumpers, switches, etc., installed during any previous testing must be removed. The control circuits shall be in the state presented in the originally As-Built control wiring diagrams (restored to normal).

(4) All tests and verifications shall be for equipment at both piers. In addition to all devices listed below, all associated devices should also be tested.

(5) Tests To Be Performed

a. Relay Logic System

1. The bridge primary control system is provided by the Relay Control Panel and MCC. All major control components are directly connected to the Panels, and the control desk metering information is provided via standard analog instruments. Prior to any other test, visually verify the wiring connection integrity of the major components including but not limited to:

a. All resolvers

b. All limit switches

c. Relay Cabinet components

d. MCC components

e. Traffic signals, barrier and warning gates, interlocked heating and ventilating devices, etc.

f. Control desk indicating lights

g. Control desk meters are zeroed and provide correct indications.

2. Control Desk

The control desk devices (switches, pilot lights, desk meters) will be used throughout the tests, and all irregularities observed shall be noted during and after the tests from the notes and printouts. Special attention shall be given to the desk meters accuracy verification.

Provide desk voltmeters and ammeters verification as follows:

a. For a determined bridge span opening, at an exact start recording [Time stamp] time, an assigned test technician shall measure and record every 5 seconds, on paper, the voltage and ampere readings at each MCC.

b. The manually recorded values shall be filed. The results shall be compared with the values obtained at the meters on the control desk.

3. Air Horns

Test that the air horn produces a tone acceptable to the Engineer. If necessary, the air horn sound tone shall be re-tuned to an acceptable pitch and level.

4. Traffic Signals Control

Test that the traffic signals change state upon activation of the desk selector switch. The duration time of the amber light shall be of an acceptable time to the Engineer. If necessary, the TSR timing relay shall be re-set to an acceptable time delay.

5. Warning Gates Control

Testing of the gates shall demonstrate the balance condition of the gate arms such that a stationery arm remains in the same position when the brake is released.

Proper manual operation and proper normal operation upon activation of the desk selector switches shall be demonstrated.

a. Lower individually, group raise commands, lower/raise sequencing checks

b. Follow the ”Sequence of Operation”

c. Verify that the warning gates are lowered in the right sequence and the gongs de-activated at the appropriate time

6. Group raise the Gates and verify that they are fully raised

7. Interlock checks:

a. Set the "Sequence of Operation” to first step.

b. Verify that manually moving any gate from its fully raised position shall turn on the red traffic signals, warning lights, and gongs.

c. Verify that the warning gates cannot be operated electrically unless the red traffic signals have been turned on, the Resistance Gates are raised.

d. Verify that the span cannot be operated electrically.

8. Bypass checks:

    a. Verify that when the “Bypass Warning Gate Interlocks” keyswitch is enabled, the interlocks listed above are overridden

9. Group / Individual Control Operation Interlocks:

10. Verify that when all warning gates are raised using the group raise control switch, and if any of the following conditions occurs:

    a. Gate housing door opened;

    b. Handcrank inserted;

    c. Gate motor disconnect switch opened;

    d. Gate motor overloaded;

    Verify that any of the warning gates, will stop warning gates group raise operation.

    Verify that any individual warning gate raise/lower operation on that warning gate is disabled by any of the above conditions.

11. Resistance Gates Control

    a. Lower individually, group raise commands, lower/raise sequencing checks

    b. Follow the “Sequence of Operation”.

    c. Verify that the Resistance Gates are lowered and the gongs de-activated at the appropriate time.

    d. Group raise the Resistance Gates and verify that they are fully raised.

12. Interlock checks:

    a. Set the ”Sequence of Operation” to first step

    b. Verify that manually moving any gate from its fully raised position shall turn on the red traffic signals, warning lights, and gongs

    c. Verify that the Resistance Gates cannot be operated electrically unless "Stop" traffic signals have been turned on, the warning gates are down

    d. Verify that the span cannot be operated electrically

13. Bypass checks:

    a. Verify that when the “Bypass Resistance Gate Interlocks” keyswitch is enabled, the interlocks listed above are overridden.

14. Group / Individual Control Operation Interlocks:

    Verify that when all Resistance Gates are raised or lowered using the group raise / lower control switch, and if any of the following conditions occurs::

    a. Gate housing door opened;

    b. Handcrank inserted;

    c. Gate motor disconnect switch opened;

    d. Gate motor overloaded;

    Operation of the Resistance Gates will stop

    Verify that any individual Resistance Gate raise / lower operation on that Resistance Gate is disabled by any of the above conditions.

15. Span Control

    a. Drive/pull commands:

        1. Pull and drive the span locks using the control desk span lock group switch, and verify that all span locks are operating accordingly

    b. Interlock checks:

        1. Verify that the Resistance Gates and warning gates cannot be raised electrically unless the span locks are driven

        2. Verify that the traffic signals cannot be turned to green

        3. Verify that the span cannot be operated electrically unless the span locks are pulled

    c. Bypass checks:

        1. Verify that when the “Bypass Span Locks Interlocks” keyswitch is enabled, the interlocks listed above are overridden.

    d. Interlocks

1. Verify that when the span locks are operated and any of the following conditions occurs on one of the span locks:

   i. Manual handcrank inserted;

   ii. Lock motor disconnect switch opened;

   iii. Lock motor overloaded;

   The span lock operation for that particular span lock is disabled.

16. Span Normal Operation

   a. Several bridge openings may be required to demonstrate that all the operational parameters are acceptable and interlock functions safe. Subsequent runs will be required to simulate failures, and to test interlocking and bypass functions. The normal sequence of operation as described in the ”Sequence of Operation” section of the general specifications shall be followed up to the indicated operational step of the equipment to be tested.

   b. Interlocks

      1. Verify the span cannot be operated in the following conditions:

         iv. Critical Hydraulic fluid temperature as shown on the contract drawing.

         v. Critical Hydraulic fluid level as shown on the contract drawings.

         vi. Span cannot be raised when it reaches the fully open/over travel position.

         vii. And as shown on the contract drawings.

17. Emergency Operation

   a. Emergency operation shall be performed using the emergency generator. The sequence of operation shall be similar to the normal span operation but with two out of the four HPU pumps enabled. The spans shall operate at a slower speed when the emergency generator is in use.

xx. METHOD OF MEASUREMENT

a) The quantity of Special Provision (Commissioning & Start Up) specified to be measured for payment shall be on a lump sum basis. The lump sum shall include the cost for all document required and all work performed under this section

xx. BASIS OF PAYMENT

a) The accepted quantity of Special Provision (Commissioning & Start Up) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 30 percent of the lump sum price will be made after the testing is complete.

(2) Payment of the remaining amount will be made after the test reports have been approved by the Engineer. and all punch list items have been resolved.

c) Payment will be made under:

Pay Item	Pay Unit
900.645 Special Provision (Commissioning & Startup)	Lump Sum

AS-BUILT DOCUMENTATION/OPERATION & MAINTENANCE MANUALS

xx. DESCRIPTION: Under this item, the Contractor shall provide Operator and Maintenance Manuals. This work will include acquiring, coordinating, assembling, organizing and editing all information required for inclusion in the manuals. The Contractor shall coordinate this work with all system commissioning. The Contractor shall make all manufacturers, sub-contractors, etc. fully aware of the materials, data and information required of them for submission with and inclusion in the Operating and Maintenance Manuals prior to the start of all work. This item shall be coordinated with all electrical and mechanical work specified in the Contract Documents.

xx. GENERAL REQUIREMENTS

(1) The Operator & Maintenance Manuals shall follow all applicable requirements contained in the related sections. Any discrepancies within the mentioned sections shall be brought to the attention of the Engineer for resolution.

(2) Maintenance Manuals shall contain descriptive material, catalog cuts with non-pertinent data blocked out, as-built drawings, spare parts list, troubleshooting techniques and any and all information necessary for successful maintenance of the bridge functional systems and each piece of equipment furnished by the Contractor. Bridge functional systems shall be understood to include all operating machinery, lock machinery, electrical service equipment, electrical and control systems, and all other equipment for which periodic maintenance and operation is desirable. Subsequent to acceptance of the bridge by VTRANS following successful completion of acceptance testing, errata or addenda to the manuals should address any revisions required.

(3) Operator and maintenance manuals giving complete instructions relative to assembly, installation, operation, adjustment, lubrication, maintenance, disassembly and carrying complete parts list shall be furnished by the Contractor for every item of equipment furnished by the Contractor.

(4) Manuals may include manufacturer's standard publications provided that they comply with specified requirements relative to quantity and quality of information and data and the additional requirements stated herein in these Specifications.

(5) Operator and maintenance manuals shall each be individually and separately bound volumes; not combined.

(6) Operator Manuals shall contain written descriptions of the functional systems of the movable bridge, step-by-step operating instructions for each of these systems and any and all information and directions required for their successful operation. Subsequent to the break-in period, errata or addenda to the manuals should address any revisions required.

(7) All printed matter, data, drawings, diagrams, etc., shall be accurate, distinct and clearly and easily legible. Illustrations shall be clear; and printed matter, including dimensions and lettering on drawings, shall be legible. If reduced drawings are incorporated to manuals, the original lines and letters shall be darkened as necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to page size.

(8) All printed matter, data, drawings, etc., shall be produced by methods to result in permanence and durability; no materials shall be used which will adversely affect this permanence and durability.

(9) All printed matter, data, drawings, etc., shall possess characteristics of clarity, legibility and capacity to be capable of reproduction by microfilm.

(10) Once all work in System Commissioning has been completed, the Contractor shall have a maximum of 90 days to provided final operation and maintenance manuals as specified herein.

(11) Materials Manuals: Manuals shall be prepared from the following materials.

a. Maintenance and Operation Manuals shall be bound in heavy-duty nickel-plated three-hole binders with three trigger positions: lock, unlock and open. Binder shall have metal hinges. Locking mechanism shall allow sheets to lie flat (i.e. channel lock). Covers shall be stiff heavy- duty plastic or other approved material. Type binder shall be either elliptical ring, round ring, screw post, or post with channel lock, as directed by the Engineer.

b. Multiple binders shall be provided as needed so that all sheets lie flat when manual is open and pages may be turned without restriction or damage.

c. The material shall be bound into each book between rigid covers. The instruction books shall be approximately 9 inches by 12 inches to contain the drawings without excessive folding so that they may be easily opened. Each Binder shall not exceed 3 inches. The books shall be neatly entitled with a descriptive title, the name of the project, the location, year of installation, the name of the manufacturer, the engineering firm and the Contractor. Copies of drawings shall be in black on white background and shall be legible. The arrangements of the books, the method of binding, material to be included and the text shall all be submitted to and approved by the Engineer.

d. 8 1/2 by 11 inch loose-leaf, on 60-pound, punched paper, acid free of a quality suitable for archival use with minimum hole diameter of 5/16 inch, reinforced with plastic or cloth, standard three (3) hole spacing.

e. Foldout diagrams and illustrations, shall be 5/16 inch minimum diameter punched holes, reinforced with plastic or cloth, standard three (3) hole spacing.

(12) Materials for Drawing: Books shall be prepared from the following materials.

a. Machinery drawings shall be reproduced by photographic process to a size not to exceed 18 inches x 24 inches and shall be complete and legible in all respects. Drawings shall be black on white paper and vacuum-sealed in transparent plastic, chemically inert, material of minimum 5 mils thickness, impervious to moisture and oil and resistant to abrasion. The plastic material shall not affect the permanent legibility of the drawings.

b. All printed matter, text, data and other matter shall be legible, accurate and distinct and shall be produced by method(s) to be permanent, as approved by and in the sole discretion and opinion of the Engineer.

c. Other formats which are equal in clarity, sharpness, durability and permanence will be considered. Contractor shall submit proposed method with specific details to the Engineer for review and approval.

d. Preliminary volume of the Operating and Maintenance Manuals shall be completed and made available to the bridge site for use during the field-testing period specified elsewhere in this Item.

e. The final bound volume of the Operating and Maintenance Manuals shall contain all corrections required by field changes.

xx. SUBMITTALS:

(1) Work on preliminary operation and maintenance manuals will begin immediately after all shop testing has been completed

(2) The minimum information to be included in the preliminary volumes of the operator and maintenance manuals shall be:

a. Table of Contents, in numerical page order.

b. Index, in alphabetical order.

c. Manufacturer's literature describing each piece of equipment and giving complete identification including manufacturer's model number and drawing number. A set of descriptive leaflets, bulletins and drawings covering all items of equipment used in the bridge machinery. The catalog number of each piece shall be given, to be used in case it becomes necessary to order replacement parts from the original manufacturer.

d. Detailed, technical operating instructions, which cover normal and emergency span operation.

e. Operation instructions, including step-by-step preparation for starting, operation, shutdown and draining of all machinery components. Operation instructions shall note all precautions required for correct and safe operation.

f. Description of control, which shall describe in full the functions of all protective devices, limit switches, contactors, relays, PLC and associated equipment and all other electrical equipment used, both in the power service and in the control system, in connection with each step in the operating sequence.

g. Sequence of operation and how each component and interlock effects the operation of other components.

h. Complete schematic wiring diagrams, including all power and control connections.

i. Layout drawings and internal connection diagrams of the control consoles.

j. A schedule of electrical apparatus which lists each electrical device by its designation as shown on the schematic wiring diagram and states for each device its rating, number of poles or contacts, function, catalog number, and location.

k. Complete interconnection diagrams for all electrical apparatus and equipment used in the normal and emergency operation of the span its auxiliaries.

l. A complete schematic conduit diagram or diagrams showing the interconnection of all devices and equipment

m. Material listing and specifications for HPU controller, including all HPU controller cards, programming if any, and equipment for interfacing.

n. Any other drawings, which may, in the opinion of the Engineer, be necessary to show the work.

o. Maintenance and lubrication instructions for the machinery components.

p. Lubrication schedule indicating method and frequency of lubrication.

q. Schematic indicating what items should be cleaned and painted on a regular basis.

r. Complete details and procedures for adjusting all items that may wear.

s. Anticipation of possible breakdowns and repairs for trouble-shooting.

t. Manufacturer's parts list of functional components, control diagrams and wiring diagrams where required, giving manufacturer's model number and part number. List shall include split bearing seals needed for replacement.

u. Steps for cursory inspection that should be carried out annually.

v. Steps for in-depth inspection that should be carried out every 2 years.

w. List of nearest local suppliers of all components parts, including their addresses.

x. Name, address and telephone number of the manufacturer's representative and Service Company, for each machinery component so that service or spare parts can be readily obtained.

y. Spare parts data as follows.

    1. Complete list of parts and supplies with sources of supply.

    2. List of parts and supplies that are either normally furnished at no extra cost with purchase of equipment, or specified herein to be furnished as part of this Contract.

    3. Replacement parts must come from original equipment manufacturer.

z. Any corrections resulting from the field tests shall be incorporated into the manuals for the final volumes.

aa. In case of correction or rejection, the Contractor shall resubmit the required numbers of manuals until the manuals are approved and such procedure shall not be considered for delay

bb. Submit Final Operation and Maintenance Data in accordance with all related sections in this special provision. The general contractor shall take full responsibility for furnishing operation and maintenance manuals for all major portions of all systems for this bridge, including work performed by sub contractors.

cc. Submit the required Operating Diagrams with Operation and Maintenance Manual

1. As approved by and in the sole discretion and opinion of the Engineer.

(3) Sections to be included in the final operation and maintenance manual shall include the items developed in the preliminary document (of which some are listed below), but not limited to:

a. Table of Contents.

b. General Overview: Shall include an overview description of each component and Principle of operation

c. Detailed Overview: Shall include a description of control, which shall describe in full the functions of all protective devices, limit switches, contactors, relays, valves and associated equipment and all other electrical equipment used, both in the power service and in the control system, in connection with each step in the operating sequence. Use wire and apparatus numbers appearing on the wiring diagrams in this description for identifying the various devices and circuits.

d. Detailed description of all control equipment including instructions to achieve optimum settings of all limit switches, encoders, etc.

e. Reference drawings showing locations of equipment. Include a layout of control apparatus in the machinery rooms. Cross-reference all descriptions with reference drawings.

f. Detailed, technical operating instructions, which cover span operation.

g. Safety precautions: personnel and environmental safety. Safety emergency procedures. Electrical hazards. Safety precaution during troubleshooting and maintenance.

h. System operation (main and emergency): sequence of operation. Interlocking. Bypass switches. Emergency stopping.

i. Maintenance instructions for the electrical and mechanical equipment, including warnings and precautions to be observed during maintenance actions. All preventive

maintenance procedures are to be outlined and a chart listing all maintenance procedures in chronological order shall be provided.

j. Maintenance procedures: overview. Precautions. Recommended tools list. Periodic inspections. Reactive maintenance. Preventive maintenance. Predictive maintenance. Maintenance record keeping. Maintenance schedule indicating weekly, monthly, annual and five year tasks. Technology tools. Contamination. Cooling devices. Operating mechanisms. Maintenance and inspection description for each component. Maintenance schedule. Inspection checklists.

k. Set of descriptive leaflets, bulletins, maintenance instructions, and drawings covering all existing equipment and equipment furnished and installed under the contract.

l. Relay logic, HPU controller input/output hardwire diagram.

m. Control console and control panel layouts and wiring diagrams.

n. Composite schedule of electrical apparatus.

o. Test data, equipment, criteria, and performance curves for all HPU pump motors.

p. Conduit layout and installation drawings.

q. Manufacturer data sheets: manufacturer catalog cuts for all components.

r. Contact list: names, addresses and telephone numbers of manufactures, suppliers, and warrantee service.

s. Spare parts: a comprehensive spare part list with catalog numbers and cross reference.

t. Diagnostic and troubleshooting: diagnostic and troubleshooting procedures for all components.

u. Repair procedures: repair procedures for all components.

v. A full bill of material for all components for all electrical and mechanical systems shall be included with all catalog information and information required for reordering spare or replacement parts. Where catalog information describes multiple versions of a similar product, these pages shall be marked so that it is clear which specific version was actually installed.

w. Reduced size prints of as built Drawings, including all schematic wiring diagrams, control console and control panel layouts and connection diagrams.

x. Test data, equipment, criteria, and performance curves for all HPU pump motors.

y. Repair and maintenance procedures for all components.

z. Instructions to the instructor on how to properly deploy the system during training session.

aa. Appendixes.

bb. Any other drawings, which may, in the opinion of the Engineer, be necessary to show the electrical and mechanical work.

xx. METHOD OF MEASUREMENT

a) T he quantity of Special Provision (As-Built Documentation / Operation and Maintenance Manual) specified to be measured for payment shall be on a lump sum basis. The lump sum shall include the cost for all document required and all work performed under this section

xx. BASIS OF PAYMENT

a) The accepted quantity of Special Provision (As-Built Documentation/Operation and Maintenance Manual) will be paid for at the contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work.

b) Partial payments will be made as follows:

(1) The first payment of 10 percent of the lump sum price will be made when a draft of the Operators and Maintenance Manual is submitted.

(2) Payment of the remaining amount will be made after the all recommendation have been incorporated and all final edits/adjustments have been made and final document is submitted to the VTRANS

c) Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (As-Built Documentation/Operation and Maintenance Manual)	Lump Sum