

Town of Barnstable Proposed Bridge Rehabilitation Bridge Street Over West-North Bay



Specifications October 2025



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INTRODUCTION

Project Description

The work will consist of furnishing all labor, materials and equipment necessary to rehabilitate the Oyster Harbors Bridge (Bridge Street over West-North Bay) in the Town of Barnstable. The project will consist of a Base Bid and additional Bid Alternates, as described below.

Rehabilitation work for the Base Bid includes: Removal and replacement of existing sidewalk joint plate on the north sidewalk joint at the east end of Span 2; Concrete repairs to the underside of deck, curbs, sidewalks, counterweight, and bearing support; Installation of a steel repair to 7 deteriorated stringers in Span 1; Removal and replacement of the truss FB6 in Spans 3, including use of Temporary Shoring; Installation of a steel repair to the webs of the counterweight link arms; Installation of a steel repair to the bottom flanges of one end floorbeam and all 3 interior floorbeams in Span 2, Installation of a steel repair to the bottom flanges of 38 stringers in Spans 1 and 3; Installation of a steel repair to the web of 1 stringer in Span 2, Replacement of the machinery support platform and hangers, Rebalancing of the counterweight; Removal and disposal of the existing span drive machinery up to and not including the intermediate open gear sets; Installation of new span drive machinery; Installation of new span lock machinery; Shimming of the live load supports; Cleaning and painting of all new and existing to remain machinery systems; furnishing, installation, testing, and placing in satisfactory operating condition of the complete bridge electrical system for control and operation of the bascule span, control house, and operating machinery electrical facilities.

Rehabilitation work for Bid Alternate 1 includes: Installation of a post-tensioned steel repair to the bottom flange of the 4 girders in Spans 1 and 3.

Rehabilitation work for Bid Alternate 2 includes: Installation of a steel repair to the web and bottom flanges of the 8 interior floorbeams in Spans 1 and 3.

Referenced Standard Specifications

MassDOT Standard Specifications

The Specifications contained in this document reference and amend the MassDOT Standard Specifications for Highways and Bridges dated 2025. Division I GENERAL REQUIREMENTS AND COVENANTS of the MassDOT Standard Specifications for this project are not applicable.

Modifications to Standard Specifications for Division II and III and Special Provisions for Division II and III of those sections applicable to this project are included in this document.

All references in the Standard Specifications to the “Department” or “Engineer” shall be replaced with “The Town of Barnstable or their designated Representative”.

COMMON PROVISIONS

DESCRIPTION

General

Work shall include furnishing, installing, adjusting, testing, painting, and placing in operating condition in accordance with the Plans and Special Provisions, the following items of work:

- Item 100.5 Movable Bridge Electrical System
- Item 107.11 Span Drive Machinery
- Item 107.12 Span Lock Machinery
- Item 107.13 Bascule Span Balance
- Item 107.14 Removal of Machinery
- Item 107.15 Live Load Shoe Adjustment
- Item 107.16 Acceptance Testing
- Item 901.01 Concrete Repairs – Deck Underside
- Item 901.02 Concrete Repairs – Curbs
- Item 901.03 Concrete Repairs – Sidewalk
- Item 901.04 Concrete Repairs – Counterweight
- Item 901.05 Concrete Repairs – Bearing Supports
- Item 950.1 Temporary Shoring
- Item 960.01 Trunnion Column Repairs
- Item 960.02 Steel Repairs – Deteriorated Stringers
- Item 960.03 Steel Replacement – Span 3 Truss Floorbeam
- Item 960.04 Steel Repairs – Link Arm
- Item 960.05 Steel Retrofit – Spans 1&3 Floorbeams
- Item 960.06 Steel Retrofit– Spans 1&3 Girders - Post-Tension Repair
- Item 960.071 Steel Retrofit – Span 2 End Floorbeams
- Item 960.072 Steel Retrofit – Span 2 Interior Floorbeams
- Item 960.08 Steel Retrofit – Spans 1&3 Stringers
- Item 960.09 Sidewalk Joint Plates Replacement
- Item 960.10 Steel Replacement – Machinery Support Platform

All access equipment, tools and other equipment used to perform the work shall be included as part of the work items. Mobilization costs shall also be included as incidental to the work items.

Special attention is called to the requirements in the Standard Specifications relating to approval of submittals by the Engineer as not operating to relieve the Contractor of any of his responsibilities under the Contract nor for errors in dimensions, details or quantities or for nonconformance with details of the original approved design.

Applicable Standards

Portions or all of certain recognized industry or association standards referred to herein as being a requirement of these specifications shall be considered as binding as though reproduced in full herein unless supplemented and/or modified by more stringent requirements in this specification. Unless otherwise stated, the reference standard shall be the standard which is current as of the date of issuance of these specifications. Reference may be made to standards either by full name or, for the sake of brevity, by letter designation as follows:

1. American Concrete Institute (ACI)
2. American Association of State Highway and Transportation Officials (AASHTO)
3. American Iron and Steel Institute (AISI)
4. American National Standards Institute (ANSI)
5. American Society for Testing and Materials (ASTM)
6. American Welding Society (AWS)
7. Occupational Safety and Health Administration (OSHA)
8. Steel Structures Painting Council (SSPC)
9. Massachusetts Department of Transportation – Highway Division (MassDOT) publications, including:
 - a. Standard Specifications for Highways & Bridges – 2025 English Edition
 - b. Standard Special Provisions
 - c. 2024 Bridge Manual – Hundredth Edition

The work shall meet the requirements of all other codes and standards as specified elsewhere in the individual pay items. 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.

Rules, Regulations and Ordinances

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, the most stringent requirement shall apply.

Submittals

Submittals shall be in accordance with Massachusetts Department of Transportation – Highway Division publications, and shall include but not be limited to the following:

Submit shop drawings in accordance with MassDOT Standard Specifications that include all materials, member sizes, relevant dimensions and details, including connection details, layout of rebar, coatings, and any other applicable information.

Submit verification that the cement concrete to be used for all repairs is in accordance with a MassDOT approved concrete mix design and all applicable submittals for concrete design per Subsection 901 of the Standard Specifications.

Submit a detailed shoring plan and supporting calculations signed by a professional engineer for the support of the stringers in span 3 during replacement of portions of the superstructure.

Submit relevant field measurements or field verified dimensions to the Engineer for review and approval in the shop drawings prior to the submittal of any other shop drawings, erection drawings, supplemental plans or detail drawings.

Submit all welding procedures and qualifications to the Engineer for review and approval.

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 approval. No departures from Contract Documents shall be made without the Engineer's approval.

If the Contractor has any objection to any feature of the design depicted or requirements indicated in the Contract Documents, he shall state his objection in writing to the Engineer at the time of transmitting the related submittal or prior thereto; otherwise his objection will not be considered.

Verification of Dimensions

Dimensions shown are based on existing drawings and are intended for guidance only. Dimensions shall be field verified prior to fabrication and installation of new components. All variations from the nominal dimensions shown shall be noted on the shop drawings. Refer to the “Submittals” section herein for additional requirements.

Schedule

Construction work that impacts the traveled roadway, any boat navigation, or the ability for the draw span to operate will only be authorized from November 1st through April 30th, and is subject to all federal, state, and local permits including authorization of the Town and Coast Guard as applicable. No work will be authorized on weekends or Town-observed holidays, unless otherwise approved in writing by the Town.

MATERIALS

Fasteners

Fasteners and fastening systems and their requirements shall be as specified in the Standard Specifications or the individual special provisions.

Structural Steel

Unless otherwise indicated in the individual special provisions, structural steel shall conform to the requirements of the MassDOT Standard Specifications.

CONSTRUCTION METHODS

Welding

Requirements for welding shall be as given in the individual items. Where no specific requirement is provided on the plans or in an individual item, the requirements of AWS D1.5 for compression members shall apply. Welding joint types, sizes and details shall be shown on shop, assembly and/or working drawings. Distortion during fabrication shall be kept to a minimum by the use of welding fixtures and proper welding procedures.

Inspection and Testing

Provide no less than ten working days’ notice to the Town of the beginning of work at shops so that inspection may be arranged. No materials shall be fabricated or machined before the Engineer has been notified where the orders have been placed.

Furnish all facilities for the inspection of material and workmanship in shops. The Inspector designated by the Town 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 that do not fulfill the requirements of these Provisions.

Furnish the Engineer a copy of all orders covering work performed by subcontractors or suppliers.

Shop Assembly

The Town reserves the right for the Engineer or designated representative to make visual inspection of shop assembled components, and to witness shop fit-ups and other tests.

Substantial Completion

Substantial Completion of the project shall be granted by the Town when all of the following have been satisfied:

- (a) All work items have been completed to the satisfaction of the Town and the Contractor has thoroughly cleaned the work site and demobilized.
- (b) Normal two-way traffic has been restored across the bridge.
- (c) Drawbridge operation has been restored in full compliance with USCG regulations and any temporary Notice to Mariners has been lifted.

Construction over Water

If any construction materials fall into the water during demolition or construction, it shall be retrieved from the water immediately.

COMPENSATION

Method of Measurement

The requirements given in this section are not to be measured.

Basis of Payment

Payment for the work of this Section will be included in the lump sum amounts of the individual items. Mobilization shall be considered incidental to the lump sum items.

END OF SECTION

SPECIAL NOTE: WORK IN THE NAVIGABLE WATERWAY

GENERAL

The Contractor's attention is directed to the navigable channel which the Oyster Harbors Bridge crosses. It shall be the sole responsibility of the Contractor to conduct operations to comply with all the regulations and requirements of the U.S. Coast Guard, the U.S. Army Corps of Engineers, the Massachusetts Department of Environmental Protection, and local agencies, in connection with but not limited to, the maintenance of navigation and water pollution control.

The Contractor shall submit multiple copies of the plan and schedule of operations to the Town for approval at least 21 calendar days prior to commencing any work in or over the navigable waterway. Two copies of the Contractor's approved plan and schedule shall then be submitted by the Contractor to the U.S. Coast Guard for their approval at least 14 calendar days prior to commencement of work.

The plan and schedule or sequence of operations shall include:

- sketch of the waterway
- location of any restrictions that shall be placed in the waterway
- location and height above mean high water of any scaffolding or netting
- placement, type and dimensions of cofferdams, dolphins, spars, etc., if used
- projected dates and durations of each operation
- hours of the day the operations will take place
- whether or not equipment will be removed from the waterway at night

The Contractor shall be responsible for all fees, costs and/or effort associated with:

- issuance of any "Notice to Mariners"
- temporary relocation of any existing navigational aids, if needed
- services performed by the U.S. Coast Guard, as required, such as special surveys in connection with displaced material in the waterway or making dumping inspections

The Contractor shall coordinate his activities with local mariners and accommodate their needs to the fullest extent practical. The Contractor shall be responsible for all U.S. Coast Guard fines associated with the bridge being in an inoperable condition during the work without having provided prior notice and obtained required approval. In addition, the Contractor may be held liable for user costs associated with such a condition.

Approvals issued by the U.S. Coast Guard may be revoked and/or fines imposed for failure to ensure these provisions and other applicable stipulations and regulations issued by the U.S. Coast Guard and other regulatory agencies having jurisdiction are adhered to or if the way in which the work is performed is determined to be a hazard to or an impairment of navigation. The Contractor shall be responsible for the costs associated for all such fines and schedule delays associated with the manner in which the work is performed and the means and methods employed.

METHODS OF CONSTRUCTION

Maintenance and Protection of Navigation

All work shall be so constructed that the free navigation of the waterway is not unreasonably interfered with and the present navigable depths are not impaired. The construction of pilings, falsework and other obstructions, if

required by the means and methods to be employed by the Contractor, shall be accomplished in accordance with plans developed by the Contractor and submitted to and approved by the Town and the U.S. Coast Guard. At no time during construction shall restrictions be placed upon navigation without first coordinating these restrictions with local mariners and without receiving approval from the Town and the U.S. Coast Guard.

If permanent bridge navigational lighting cannot be maintained as operational during any phase of this project, temporary battery/power lights must be installed at the same locations. These temporary lights must be visible for a distance of 2,000 yards on 90% of the days of the year. Generally, a lamp of 20 footcandles will meet these requirements. Plans for temporary lighting, if needed, shall be developed by the Contractor and submitted to the U.S. Coast Guard for approval.

VHF-FM marine radios set to the bridge communications channels 16/13 or the designated channel for the bridge must be maintained at the project site by the supervisor in charge. Additional marine radios monitoring the above channels must also be maintained at the main control of any floating equipment or barges on station.

Notice to Mariners

The Contractor shall notify the U.S. Coast Guard and the Town 30 calendar days in advance of work completion so that appropriate notice can be given to mariners. The Contractor shall keep all interested parties apprised of conditions existing at the site which relate to navigation so that marine traffic may be notified accordingly on a timely basis.

Misplaced Materials

Preventative measures must be taken to prevent any hot work, debris or construction material from entering the waterway. This includes sandblasting material, paint, wastewater from machinery cleaning or purging operations, and any concrete work by-products. Welding and burning must cease upon the approach of a vessel and shall not start again until the vessel has passed the bridge.

Should the Contractor, during the progress of the work, lose, dump, throw overboard, sink or misplace any material, plant, machinery or appliance which may be dangerous or obstruct navigation, the Contractor shall promptly recover and remove the same. The Contractor shall give immediate notice of such obstruction to the U.S. Coast Guard, to the Engineer, and to all users of the channel. The Notice shall give a description and location of any such object and the action taken or being taken to protect navigation. Until removal can be effected, the object(s) shall be properly marked in order to protect navigation. Should the Contractor neglect to report, remove, or refuse to promptly remove any such obstruction, the Engineer shall have the same removed and charge the cost against monies due to the Contractor or recover under his Bond.

Spillage of oil or hazardous substances is specifically prohibited by Section 311 of the Clean Water Pollution Act, as amended. Approved spill containment equipment and absorbent material must be located at the project site in the event of a spill into the waterway or the shoreline. The U.S. Coast Guard must be notified immediately in the event a spill occurs. The Contractor shall bear the full responsibility for any costs associated with fines, cleanup activities, disposal and user costs associated with a spillage as a result of their work or activities.

Obstruction of the Channel and Waterway

Should the Contractor's plant obstruct the channel or waterway so as to endanger the passage of vessels, as defined in the most recent River and Harbors Act, it shall be promptly moved to the extent necessary to afford a practicable passage. Upon completion of the work, the Contractor shall promptly remove the plant, including ranges, buoys, piles, anchors and other markers placed by the Contractor.

All barges placed in the waterway must be lighted with constant burning white lights on all four corners of the barge. The Contractor is required to comply with all provisions of the U.S. Coast Guard Navigation Rules, International-Inland, regarding the use of work barges or floating equipment in the waterway.

Placement of barges in the navigable channel shall be done so as to provide a minimum horizontal clearance reduction. Barges must be moved out of the navigable channel during darkness, or after working hours unless approved in writing by the U.S. Coast Guard 30 calendar days in advance. Barges held in place by anchor lines must be marked by anchor buoys which should be lighted.

COMPENSATION

Method of Measurement

The requirements given in this special note are not to be measured.

Basis of Payment

Payment for the work of this Special Note will be included in the lump sum amounts of the individual pay items.

END OF SECTION

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901.05	CONCRETE REPAIRS – BEARING SUPPORTS	SF
950.1	TEMPORARY SHORING	LS
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ITEM 100.5

MOVABLE BRIDGE ELECTRICAL SYSTEM

LUMP SUM

The work under these Items consists of the furnishing, installation, testing and placing in satisfactory operating condition of the complete bridge electrical system for control and operation of the bascule span, control house and operating machinery electrical facilities. Included are control consoles, motor control panel, drive controllers, main drive motors, brakes, position transducer and indicator, lighting, generator receptacle, field start up service, spare parts, limit switches, conduit, wiring and all required provisions for interlocking, all other electrical equipment as shown on the contract drawings and other accessories as specified herein.

The control system specified herein shall be coordinated as required, with the work of all other Sections of the Specifications and the Plans, so that all installations shall operate as designed.

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1. COMMON PROVISIONS

General

The information provided in this section relates to work materials, construction methods, and standards that may be common to multiple areas of electrical work throughout construction. Consequently, these items are to be included for payment within the various pay items to which they apply, as indicated elsewhere.

The electrical work specified herein shall be coordinated, as required, with the work of all other disciplines, sections of the specifications, and the plans, so that all installations are properly staged and shall operate as designed.

Any apparatus, device, circuit, appliance, material, or labor not herein specifically mentioned or included, but that may be found necessary to complete or perfect the installation and equipment in a manner acceptable to the Engineer, shall be furnished and install by the contractor as if specifically included in these specifications, and without additional cost to the Town.

All labor, material, equipment, and services shall be provided by the Contractor to perform operations required for the complete installation and related work as specified in the subsections that follow. All pay items shall be complete with all accessories as specified herein and as shown on the Plans. Any such work included in any other section of these specifications that is not specifically described therein shall comply with the requirements of this section.

The prospective contractor shall bid on all equipment, materials and construction and installation methods as described in this specification. Should the prospective Contractor wish to propose an alternate construction or installation method, he/she may do so in addition to responding to the scheme as shown in this document and the associated Plans.

STANDARDS AND CODES

Portions or all of certain recognized industry or association standards referred to herein as being a requirement of these specifications shall be considered as binding as though reproduced in full herein unless supplemented and/or modified by more stringent requirements in this specification. Unless otherwise stated, the reference standard shall be the standard which is current as of the date of issuance of these specifications. Reference may be made to standards either by full name or, for the sake of brevity, by letter designation as follows:

AASHTO American Association of State Highway and Transportation Officials

ANSI American National Standards Institute, Inc.

ASME American Society of Mechanical Engineers

AWG American Wire Gauge

ASTM American Society For Testing And Materials

EPA Environmental Protection Agency of The United States Government

FHWA Federal Highway Administration

IES Illuminating Engineering Society
ICEA Insulated Cable Engineer's Association
NEC National Electric Code
NEMA National Electric Manufacturers Association
NESC National Electrical Safety Code
NFPA National Fire Protection Association
MUTCD Manual On Uniform Traffic Control Devices
OSHA Occupational Safety And Health Administration
UL Underwriters' Laboratories, Inc.

The electrical installation shall comply with all applicable laws and ordinances in effect at the construction site, with applicable regulations of the NEC, and with regulations of the utility companies furnishing power and telephone services to the site.

2. BASIC ELECTRICAL REQUIREMENTS

Description

It is the intent of this Specification that only individuals of high competence and experience be utilized to perform the work of this Section. It is not the intent of this Specification and Contract Plans to identify all necessary methods, means, equipment, or appurtenances that will be required in order to accomplish the work of this Specification and the Contract Plans. Unless otherwise specified, all manufactured items, fabrications, components, pieces, assemblies and appurtenances that are to be removed, salvaged, repaired, rehabilitated, furnished new, installed or reinstalled under this Specification and Plans is classified as electrical construction.

Prepare the detailed electrical and control system designs as required to fabricate and furnish the control equipment, define the installation and interconnection of the electrical equipment including all required interconnections with equipment furnished under other Sections, and test and verify that the completed electrical system's installation and performance is satisfactory with respect to the requirements of these Specifications.

Prepare detailed design plan drawings of electrical and control system conduit and wiring to provide the functionality specified in the Contract Documents. Provide signed and sealed drawings if proposed system differs from the Contract Documents, proposed system must comply with latest AASHTO LRFD Movable Bridge Manual and all local codes.

Furnish and install all wire, cables, conduits, wiring, wiring devices, light fixtures, motors, controllers, motor control cabinet, panelboards, relays, control equipment, safety switches, and all other apparatus and accessories indicated, specified, or required for a complete power and lighting system for the bridge as depicted on the Contract Documents. Furnish and install the connections to motors and to other equipment furnished and installed under other Sections of these Specifications.

Wiring and Conduit work includes runs to all light fixtures, Variable Speed Drives, drive motors,

transfer switches, motor control equipment, air horns, limit switches, system grounding scheme, and any other component necessary for a complete operating system.

Locate operating and control equipment to provide easy access and arrange electrical work with adequate access for operation and maintenance as per the latest National Electrical Code (NEC) requirements.

Comply with all local codes, all laws applying to electrical installations in effect and with the regulations of the latest edition of the NEC, where such regulations do not conflict with the laws in effect and with the requirements of the utility company.

Protection of Electrical Equipment

Protect electrical equipment from water damage, rain, condensation, and water dripping or splashing on equipment and wiring, at all times during shipment, storage and construction (prior to final acceptance).

Provide climate-controlled environment for the storage of control equipment/ assemblies during construction.

Protect equipment from damage from mishandling, dropping, or impact. Do not install damaged equipment. Immediately replace damaged equipment at no additional compensation from the Town.

When applicable, provide spare parts in sealed, uniform-sized cartons, with typed and clearly varnished labels to indicate their contents, and stored in a portioned lockable box. Also provide a directory of permanent type describing the parts including the name of each part, the manufacturer's number, and the rating of the device for which the part is a spare. Mark the spare parts to correspond with their respective item numbers as indicated on the elementary wiring diagram. Ensure spare parts are available at time of Functional Checkout. Replace spare parts used during Functional Checkout.

Coordination of Electrical Work

Contract documents do not contain all necessary requirements and procedures required to obtain a successful installation. Use experienced personnel in the type of work required by the provisions of this Section and the Plans, and, through the process of field surveys, shop drawing, and procedure submittals, refine and supplement to complete the requirements in such a manner to provide a complete and satisfactory fitting and fully operational installation at no additional cost to the Town.

The contract documents are diagrammatic in showing certain physical relationships which must be arranged within the electrical work, and which must interface with other work including utilities and mechanical work.

Schedule and arrange electrical work in a neat, well-organized manner that will allow the switchovers between the various phases of the project without disruption of traffic or interference with the work scheduling of other trades. Coordinate electrical work with the work of other trades to eliminate conflicts. Advise other trades of openings required in their work for the subsequent move-in of large units of electrical equipment.

Materials and Equipment to be Installed

Use only new materials that conform to the standards of the UL in every case where such a standard has been established for the particular type of materials and its intended application.

Submit, prior to purchase of any materials or equipment required to be furnished and installed under this Section, a complete list of all such materials and equipment including manufacturer's catalog numbers, catalog data sheets, illustrations, and shop drawings, to the Engineer for approval.

Furnish and install all new conduit, wiring, disconnect switches, smoke detectors, panelboards, controls and relays, wiring devices, transformers, boxes, terminal blocks, electrical identification, motor controls, and supporting devices for a complete electrical installation on the bridge.

Ensure all electrical equipment used outside of the conditioned spaces of the Control House is suitable for use in a marine (salt atmosphere) environment.

Electrical Journeymen

Designation of Electrical Journeymen: Designate a listing of pre-qualified electrical journeymen to perform the electrical work in accordance with the provisions of this Section. Perform all such work either by, or under the immediate supervision of an electrical journeyman. For this project, "under the immediate supervision" means that the journeyman is in the immediate vicinity and physically involved in performing the electrical work. The journeyman's knowledge, talents, and skills in performing certain critical work will be judged and approved by the Engineer and then the journeyman will do the actual work utilizing those talents and skills. Helpers are expected to aid the journeyman in the performance of the work and not to act as non-credentialed surrogates of a remote journeyman. Non-approved helpers may only perform tasks of a support nature that do not directly involve responsibility for the installation, connection, or adjustment of electrical materials.

Control Systems Engineer

Designate an individual (such as the Control System Supplier) to act as the Project's Control Systems Engineer and to serve as sole representative for the detail design, development, coordination, and testing of the leaf drives, interface to the electrical control system, the electrical control system including the Motor Control Cabinet, the control console, and interfacing with the leaf drive system. Ensure the Control Systems Engineer is qualified in developing and coordinating these types of Specialty Items and is approved by the Engineer. He

will serve as a single point of contact prior to, during, and after construction, and must be available for consultation during all phases of the project, including Shop Drawing submittal and review.

The Control System Engineer is responsible for the review of shop drawings, prior to submission to the Engineer, to ensure that all components of the bridge operating system submitted for use are compatible in every respect and that all components meet or exceed the specific requirements and intent of the project. The total bridge operating system will be subject to the approval of the Engineer, based on the specified project requirements.

Ensure the Control Systems Engineer is on site and directing all testing and commissioning of the bridge operating equipment and systems.

Process any approved changes associated with the bridge electrical system through the Control Systems Engineer, he/she maintains the responsibility for coordination of the work.

Pre-qualify and approve the Control Systems Engineer with the Engineer before preparing detailed design drawings and specifications. The pre-qualification submittal must include preliminary details of the proposed control system for review of conformance with the project requirements. Include with the pre-qualification submittal documents that substantiate compliance with the requirements set forth in Section 105 of the Standard Specifications for Road and Bridge Construction.

The Control Systems Engineer must be a registered Professional Engineer licensed in Massachusetts, through examination taken in the electrical engineering discipline. The Engineer will review the pre-qualification submittal of the Control Systems Engineer, and will be the sole judge of the adequacy of the information submitted. Inadequate proof of this ability and experience, or insufficient details, may be cause for disqualification.

Tools and Procedures

Manufacturer Requirements: Install, apply, or adjust all electrical equipment and materials in accordance with the manufacturer's recommendations including the usage of the manufacturer specified tooling. When such materials are UL, or other 3rd party, listed or recognized, the tooling used for field installation must be the same as, or the manufacturer's approved equivalent to, the tooling utilized in the approval testing.

Quality Assurance:

Tooling Identification: When applicable, the approved tooling will provide a suitable identification to the work to allow verification that the appropriate tool was used to perform the work. For example, use crimping dies that contain identification marks that emboss the crimps made with them with an identification embossment.

Quality Isolation: Where possible, the requirement to provide a level of workmanship quality will be transferred to the tooling rather than the skills of the workman. As examples, but not

limited to:

- Conductor Stripping: Depend upon the use of approved non-nicking strippers rather than the operator's skill with knife edged stripping tools to prevent wire nicking.
- Crimp Tightness: Proper crimping will depend upon the exclusive use of controlled cycle crimping tools that require the proper degree of compression before releasing the work rather than upon the operator's judgment of how hard the tool handle is being squeezed.
- Tie Tightness: Determine proper tensioning of cable and wrap ties by the use of the manufacturer's specified calibrated tensioning tool rather than the operator's judgment of what is "tight enough."
- Fastener Torque: Tighten fasteners with a recommended torque, where the proper tightness is important to the performance of the function (which includes all electrical terminals), with a calibrated torque (limiting) screwdriver or other torque-indicating tool.

Tool Verification

Whenever any other Article of this Section requires material submittals, when tooling is associated therewith, submit the manufacturer's tooling requirements and procedures, including catalog and calibration information, on the tooling that is proposed.

Document all tooling that is used as to the method of use and the calibration requirements and procedures. Provide calibrations that can be traced to the National Institute of Standards and Technology (NIST) or other recognized standards laboratory. Equipment that requires repetitive calibration (e.g. terminal crimpers often require daily verification by pull testing sample crimps) must be supported, on site, by the required calibration verification instruments. Ensure that operating manuals for all specialized tooling are available on the site for reference by the Engineer at any time.

Tool Application

The journeyman electrician intending to operate a specialized tool must demonstrate his knowledge of, and skill in using, the tool including the knowledge and ability to judge the results produced by the tool and to recognize failure of the tool to perform satisfactorily.

Verification Testing

Whenever verification testing is required in the performance of the work of other Sections, perform the tests and measurements in accordance with these requirements.

Test Equipment

Provide test and measurement instruments suitable to perform the required tests including ratings and measurement accuracy as specified by the manufacturer. Clearly indicate the exact make and model of instrument to be used and include manufacturer's specification data indicating the suitability of the instrument's specifications in all procedure submittals.

Do not use any test instrument unless it has been calibrated and certified by an independent

certification laboratory to the required accuracy and in accordance with the instrument manufacturer's requirements within a maximum interval of the preceding twelve (12) months. Certify all calibrations as traceable to the National Institute of Standards and Technology (NIST) or other recognized standardization authority.

Test instrument operating manuals and certification certificates must be available on the project site for reference by the Engineer whenever the instrument is being used or evaluated.

Test Result Reporting

Where test or inspection data submittal is required by the provisions of other Articles of this Specification Section, ensure the form(s) to be used for recording and submitting the data are approved prior to performing the tests. Record the test results directly upon the approved forms as the tests are performed, recopying the data onto the forms from informal field notes is not acceptable. Record all data with ballpoint pen or other non-erasable and non-water-soluble writing media, strike-thru and initial errors or corrections in such a manner that the original is still readable.

Identify each measurement item or group of items with the measurement date and approximate measurement time to the nearest quarter hour.

Where the environment has an effect upon the measurements, such as insulation measurements, record the weather conditions including approximate temperature, rain/fair, and approximate relative humidity, on the form at appropriate intervals as determined by the changing meteorological conditions. Record wind velocity and direction for leaf related tests where the wind loading is a factor in the performance or results.

Identify each measurement item or group of items with the signature or initials of the approved measurement technician performing the tests. A separate sheet cross-referencing the signatures or initials to the printed name of the technician will accompany the submittal of the test results to identify the technician. The use of manuscript initials will be treated the same as the full signature and will constitute the technicians certification that the tests were performed in accordance with the submitted and approved procedures, utilizing approved test instruments, and that the results recorded are a true and accurate representation of the test conditions and results.

Record test instrument identification, including traceable serial number, for each measurement group. Include a copy of the Certificate of Calibration for the particular instrument in the submittal.

Have the Control Systems Engineer review and approve all test data submittals prior to submittal to the Engineer.

Test Performance

The journeyman electrician, or other proposed test equipment operator, must demonstrate knowledge of the test equipment operating and testing procedures to the Engineer's satisfaction

before performing tests. Only test results signed by such approved testing technician will be acceptable under the requirements of this Section.

Submittals

Submit qualification information for Control Systems Engineer, qualification information for Electrical Journeymen and Certificates of Calibration for test instruments.

3. WORKING PLANS AND SHOP DRAWINGS

Description

Submit working plans and shop drawings as prescribed in the Massachusetts Town of Transportation Standard Specifications for Road and Bridge Construction, as expanded in this Section. Clearly mark manufacturer's standard drawings which indicate dimensions and/or options for more than one piece of equipment to clearly indicate what data applies. Provide a separate submittal package for each pay item unless otherwise indicated in this Section. Label each submittal package to indicate the Project Name, Pay Item number, Section number and Article number as listed in the Contract Specifications. Label data sheets for individual components such as motors, limit switches, etc. with the identification numbers shown in the Contract Documents.

Submit all electrical submittal items in an individual separate three-ring loose-leaf binder or binders suitable for letter size sheets with opening/closing mechanism. Provide a separate individual ring binder or binders for each set of submittal items. Include binder title sheet as first page having names of job and Contractor with second page as table of contents listing each submittal item in same sequence as specified.

Do not submit piece-by-piece submissions of individual components, submit all components of an assembly at the same time. Include shop drawings drawn to scale and certified by the manufacturer for major electrical equipment. Where one-line diagrams, wiring diagrams, schematic diagrams, interconnection diagrams, etc. are called for, they are to be site specific. Submittal approval will be handled on an "all or none" basis.

Provide complete resubmittals even if some items on the original submittals may not have been marked deficient. Provide sufficient time in project schedule to allow for the possibility of repetitious submittals without creating delays to the project. Delays caused by repetitious submittals are not the responsibility of the Town.

Shop Drawings

Submit shop drawings for new power services detailing routing with dimensions, pull box locations, expansion joint fitting type and locations, and conduit support assembly details. Include drawing showing electric meter detail and location. Provide documentation showing coordination with the electrical utility company.

Use a set of approved shop drawings (incorporate all review comments if Approved as Noted) and mark, in red, all circuit changes made in the field.

Maintain these construction shop drawings as working drawings for the duration of construction. Required working drawings include conduit routing plans, schematic diagrams, interconnection wiring diagrams, and conduit and cable schedules. Make working drawings available to the Engineer, on request, for review of construction issues.

Maintain a full set of working drawings on the jobsite at all times.

The working drawings must be available at the time of the Functional Checkout. Unavailability of the working drawings is sufficient reason to cancel the Functional Checkout.

Electrical Material Submittals

Manufacturer's standard descriptive leaflets or catalog sheets are acceptable for "off the shelf" items which require no modification for application on this project unless noted otherwise, including control house and pier items such as heat pump/air conditioning, smoke detection and fire alarm panel, leak detection, marine radio, disconnect switches, wiring devices, etc. For fused disconnect switches include outline drawings with dimensions, equipment ratings for voltage, capacity, horsepower, and short-circuit. Provide manufacturers fuse curves (time/current on log/log graph) for each rating of fuse supplied.

Provide a submittal for each type of motor. Include a motor data sheet indicating horsepower, voltage, FLA and LRA current, motor speed, NEMA frame size, insulation class, temperature rise, service factor, and any optional equipment or attachments such as tach-generator, encoder, thermal switch, or space heater in the motor submittals. Provide a motor torque-speed performance graph. Provide dimensioned outline, plan/elevation and wiring interconnect drawings. Include installation instructions and operation and maintenance data with instructions for storage, handling, protection and starting of motors. Include assembly drawings, bearing data with replacement sizes, and lubrication instructions.

Submit catalog data sheets for conduit and fittings, wire, wiring devices, outlet boxes, fasteners, terminal blocks, mounting hardware, and safety switches.

Make a submittal for each type lighting fixture. Include catalog data sheets including outline and dimensions as well as product description with ballast, fuses, mounting adaptors, etc. identified. Submit lamp data sheets for each fixture including photometric data. Include submittal for lighting panel transformer and lighting panel with data sheets for each type circuit breaker. Submit calculations diagram with balanced load schedule.

Provide shop drawings showing outline and support point dimensions, voltage, main bus ampacity, integrated short-circuit ampere rating, circuit breaker arrangement and sizes. Provide manufacturers installation instructions, which indicate application conditions and limitations of use, stipulated by the product-testing agency. Include instructions for storage, handling,

protection, examination, preparation, installation and starting of all products. Record actual locations of all products and indicate actual branch circuit arrangement.

Refer to individual sections for additional submittal requirements.

As-Built Drawings and Operations Manual

At the completion of the project, provide complete as-built drawings as well as operations and maintenance instructions.

Draft as built drawings from the marked up working drawings. Provide the working drawings for checking purposes.

Operations and maintenance manuals will be comprised of a compilation of the manufacturers' catalog data, installation, and maintenance instructions.

No payment item is to be considered complete until the as-built drawings and manuals have been received. Ensure that as-built drawings are essentially the same as the working plans and shop drawings submitted for approval but showing all the changes made during construction.

4. MATERIALS AND EQUIPMENT

Furnish only new materials that conform to the standards of the UL, in every case where such a standard has been established for the particular type of material and its intended application. Prior to purchase of any materials or equipment required to be furnished and installed, submit a complete list of all such materials and equipment including manufacturer's catalog numbers, catalog data sheets, illustrations, and shop drawings to the Engineer for approval.

Wire and Cable

Description:

Verify that field measurements are as shown in the Plans. Wire and cable routing shown is approximate unless dimensioned. Route wire and cable as required to meet project conditions. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

Definitions

Power Conductor: Any wire that feeds power to a field device (i.e. brake motors, span lock motors, etc.).

Control Circuit Conductor: Any wire that goes to a pilot device (i.e. limit switches, pressure switches, etc.).

Field Wire: Any wire that leaves the tender house. Consider the machinery platform to be outside the tender house.

Submittals

Submit catalog data for each type of conductor to be used.

Materials

Single conductor insulated wire. Provide XHHW-2 rated 600 VAC unless otherwise noted. Provide RHW insulated wire for incoming service feeders unless otherwise noted.

Use seven or nineteen strand copper, minimum 98 percent conductivity conductors for field wiring. Furnish connector accessories for copper in sufficient quantities for a complete installation. Do not use aluminum or solid copper conductors. In cases of low level audio or digital signals, use twisted shielded pairs when required.

Use no wire smaller than No. 12 AWG for power and lighting circuits and no smaller than No. 14 AWG for control wiring between cabinets, except that control wiring within a manufactured cabinet may be smaller. Use of wires smaller than No. 18 AWG has to be approved by the Engineer. Multi conductor ribbon cables, between components within a cabinet, are allowed if approved by the Engineer. Install per the requirements of UL 880.

Minimum field wire size is No. 12 AWG for control conductors between cabinets and field devices and No. 10 AWG for motor loads. Pigtails, no longer than 12 inches, are allowed for connection of field devices that cannot accommodate a No. 12 AWG wire. Use No. 10 AWG for 20 A, 120 VAC, branch circuit home runs longer than 75 feet, and for 20 A, 277 VAC, branch circuit home runs longer than 200 feet.

Maximum wire size allowed is 750 kcmil, use parallel runs as needed for larger loads. Splices are not allowed, use terminal blocks in enclosures.

Construction Requirements

Installation includes placement, splicing, terminating, identifying, testing, and verifying each circuit and conductor. No splicing is permitted (except for “pigtail” leads and lighting circuits). Do not mix power and control conductors in the same conduit.

If more than three current carrying conductors are in a conduit, derate the conductors per Table 310.15(B)(2)(a) of the NEC. For derating purposes, consider all power conductors, other than the ground conductors, as current carrying, this requirement does not apply to control wires.

Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor. Neatly train and lace wiring inside boxes, equipment, and panelboards. Place an equal number of conductors for each phase (three phase system) of a circuit in same raceway or cable. Make conductor lengths for parallel circuits equal. Pull all conductors into a raceway at the same time.

Install two spare conductors, minimum, for long field runs to critical devices such as movable span and brake motor-mounted devices, etc.

Use soap base wire pulling lubricant for pulling No. 4 AWG and larger wire. Take precautions to avoid “sawing” through PVC conduit. Use only braided pull ropes. Do not pull bare conductors through PVC conduits. Swab conduit with an approved lubricant prior to pulling the conductors.

Test each circuit for continuity and short-circuits for its complete length before being connected to its load. Verify identification numbers for the entire length of the circuit. Inspect wire and cable for physical damage and proper connection.

Perform insulation resistance test at 1,000 VDC for one-half (1/2) minute. Minimum insulation resistance for new cable will be 100 M-ohms or greater. When insulation resistance must be determined with all motor control cabinets, panelboards, switches, and over current devices in place, the insulation resistance when tested at 500 VDC will be no less than 50 M-ohms. The Engineer will witness the test. Record the test results and submit to the Engineer for review prior to energizing the circuit. Include a Table of the test results with the “as-built” drawings with additional columns left blank for future readings to be recorded.

Grounding

Description:

Ground the electrical power and control system in accordance with NEC requirements. Furnish and install ground rods, and grounding conductors as shown in the Plans. The requirements for the electrical grounding system do not apply to the Lightning Protection system grounding requirements.

Submittals

Provide catalog data, including dimensions and drawings, for each type of ground rod, clamp, well, and associated hardware.

Materials

Use only insulated soft drawn annealed copper grounding conductors unless otherwise noted in the plans.

Use 3/4-inch diameter, 10 foot, copper clad steel ground rods.

Provide ground well 10 inches in diameter, 24 inches long, PVC, with a belled hub and a galvanized steel cover.

Use tin plated, high pressure compression, one hole lug connections for grounding equipment. Use only thermally welded connections to ground rods.

Construction Requirements

Install a dedicated ground conductor, with green insulation in each conduit in which voltage of the current carrying conductors exceeds 50 V.

Size grounding conductors in any conduit in accordance with NEC Table 250.122, or the same AWG as the largest current carrying conductor in the conduit, whichever is larger.

Provide two ground rods at the service entrance main disconnect switch in accordance with the NEC. Locate ground rods within 10 feet of the main disconnect switch mounting support. If the resistance between the two ground rods exceeds 25 ohms, add extensions and drive rods deeper if required.

Provide, as a minimum, a No. 2/0 AWG service entrance grounding conductor from the case ground to the rod. Install the ground rod so that the top of the rod is 1/2 inches above the finished grade and the rod driven to just below the top. Fill with gravel.

If applicable, bond the electrical system to the lightning protection system ground at the lightning grounding electrode (rod) closest to the motor control cabinet in the bridge pier and the ground buss in the motor control cabinet.

Supporting Devices

Description:

Provide hangers and supporting devices as required by the NEC and these specifications, where more stringent requirements are described.

Submittals

Provide catalog data for each type of strut, clamp, insert, and associated hardware; dimensional data for struts; and pullout data for anchors.

Materials

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

Provide PVC coated steel support struts and clamps to support PVC coated conduits.

Furnish products listed and classified by UL as suitable for purpose specified and shown. Provide adequate corrosion resistance and insure that the material selected for the hardware is compatible with the material of the device being supported.

Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. Minimum safety factor is 2.0. Provide stainless steel framework for supporting boxes, switches, and other externally mounted electrical devices.

For U-Channel strut systems utilizing bolted construction, provide stainless steel, 12 gage and 1-1/2 inch width minimum components from the same manufacturer.

Construction Requirements

Do not use powder-actuated anchors; drill or weld structural steel members; or fasten supports to piping, ductwork, mechanical equipment, or conduit.

Use hexagonal bolt heads and nuts with spring lock washers under all nuts.

Fasten hanger rods, conduit clamps, and outlet and junction boxes to structure using proper fasteners. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

Use stainless steel straps or hangers held at not less than two points for attachment to steel or concrete. Provide 300 series stainless steel concrete inserts.

Install surface-mounted cabinets and panelboards with minimum of four (4) anchors. Fasten device boxes to the mounting surface with not less than two anchors.

Do not fasten supports to piping, ductwork, mechanical equipment, or other conduit. In addition, do not allow piping, or other trades to fasten to electrical conduits and supports.

Fasten hanger rods, conduit clamps, and outlet and junction boxes to structure using proper fasteners.

Ensure that cut offs are cut square, ground smooth and de-burred. Where PVC coated steel has been cut or the coating has been damaged, coat the exposed steel with the manufacturer's touch up coating, to the same thickness as the original, prior to installation.

Use stainless steel cast in place inserts for overhead supports.

Conduit and Raceways

Description:

Furnish and install conduit and raceways in the quantities and sizes required to complete the work as shown in the Plans. Where conduit size is not shown in the Plans, determine the size as

required by the NEC. Furnish products listed and classified by UL for purpose specified and shown. Do not use non-metallic flexible conduit, aluminum conduit, or electrical metallic tubing (EMT). Conduit and circuits indicated in the Plans, diagrams, and schedules may be recombined in the field where appropriate and as approved by the Engineer.

Submittals

Provide catalog data for each type of conduit and fitting and conduit layout drawings, showing routing and penetrations. Coordinate structural block outs and embedded conduits with concrete lift drawings.

Materials

PVC Coated Metal Conduit

Hot dipped galvanized, inside and out, rigid steel conduit (ANSI C80.1) with hot galvanized threads and external PVC coating 40 mils thick; meeting the requirements of NEMA RN 1 and fittings and conduit bodies meeting the requirements of ANSI/NEMA FB 1 with steel fittings with internal and external PVC coatings to match conduit. Provide 40 mils thick PVC coating on the outside of conduit couplings and a series of raised longitudinal ribs to protect the coating from tool damage during installation.

Ensure the bond between the PVC coating and the conduit surface is greater than the tensile strength of the coating. Verify this bond by testing described in NEMA Standard RN-1, section 3.8.

Uniformly and consistently apply a nominal 2-mil thick urethane coating to the interior of all conduit and fittings. Conduit or fittings having pinholes or areas with thin or no coating are unacceptable. Protect all factory-cut threads on conduit, elbows, nipples, and fittings by application of a urethane coating. The PVC exterior and urethane interior coatings applied to the conduit must afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30 degrees F.

Furnish right angle beam clamps and U bolts specially formed and sized to snugly fit the outside diameter of the PVC coated conduit. All U bolts will be supplied with plastic encapsulated nuts that cover the exposed portions of the threads.

Ensure that only tools designed and approved by the conduit manufacturer for use on PVC coated materials are used and the workmen performing the installation are trained and certified in the installation and use of PVC coated conduit and fittings by the manufacturer.

All PVC coated conduit, fittings, and accessories must be supplied by the same manufacturer.

Liquid-Tight Flexible Metal Conduit

UL 360 listed, interlocked galvanized steel construction, with integral ground continuity and

PVC jacket. Use only PVC coated fittings, meeting the requirements of ANSI/NEMA FB 1.

Non-Metallic Conduit

UL listed schedule 80 PVC conduit meeting the requirements of NEMA TC 2 and Fittings and Conduit Bodies meeting the requirements of NEMA TC 3.

Conduit

UL listed for electrical use schedule 80 conduit meeting the requirements of NEMA TC 7. Use only UL listed fittings.

Construction Requirements

Use one inch minimum size Schedule 80 PVC for underground installations when installation is more than 5 feet from bascule pier wall. Use one inch minimum size Schedule 80 PVC conduit for underground installations when installation is within 5 feet from bascule pier wall.

Use one-inch minimum size Schedule 80 PVC in slab above grade (embedded).

Use one-inch minimum rigid galvanized steel (PVC coated) for outdoor locations, above grade and exposed in dry locations.

Use 3/4" minimum rigid galvanized steel for indoor dry locations.

Use 3/4" minimum size Schedule 80 PVC for wet and damp locations (fender).

If applicable, use armored cable for submarine cable installation only.

Install conduit in accordance with NECA Standard Practice and in accordance with manufacturer's instructions.

Do not use plastic straps or plastic hangers. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary support.

Group related conduits; support using conduit rack. Construct rack using stainless steel channel; provide space on each end for 25 percent additional conduits.

Use pull boxes wherever necessary to facilitate the installation of the conductors. Use conduit hubs to fasten conduit to sheet metal boxes. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system. Install all conduits so that they drain properly and provide drainage tees at low points where required.

Do not use condulets for pulling more than ten conductors or for making such turns in conduit runs or for branching conductors, except for indoor wiring to lighting fixtures and receptacles. At any point where a conduit crosses an expansion joint, or where movement between adjacent

sections of conduit can be expected, install bronze or alloy expansion fittings. Arrange conduit to maintain headroom and present neat appearance. Route exposed conduit parallel and perpendicular to walls. Maintain adequate clearance between conduit and piping. Maintain minimum 6 inches crossing and 12 inches paralleling clearance between conduit and surfaces with temperatures exceeding 40 degrees C.

Use of flexible metal conduit is allowed only for the connection of motors, limit switches, and other devices that must be periodically adjusted in position. Make connections between the rigid conduit system and all movable motors and movable limit switches with flexible metal conduit with couplings and threaded terminal fittings. Use only fully interlocked flexible metal conduit. Do not use flexible metal conduit extensions longer than two (2) feet in length and provide with bonding jumpers. Install flexible metal conduit as to drain away from the device it serves.

Provide both ends of each conduit run with a brass tag having a number stamped thereon in accordance with the conduit diagrams. Use bare copper wire to fasten these tags securely and permanently to the conduit ends.

Wherever possible, run conduits in the control room and bascule piers exposed and not concealed in the walls, ceiling, or floor. Where conduits pass through the floors or walls of the control room, provide Schedule 80 PVC conduit sleeves for free passage of the conduits. After the conduits are installed, caulk openings with an approved UL listed fire stop material for airtight fits. Provide escutcheon plates on the interior walls, ceilings, and floors.

Connect conduit sections to each other with approved couplings, do not use aluminum couplings. Install conduits so as to be continuous and watertight between boxes or equipment. Protect conduits at all times from the entrance of water and other foreign matter by being capped or well plugged overnight and when the work is temporarily suspended. Set conduits mounted exteriorly on parts of the steel work not less than 1-1/2 inch clear from the supporting structure to prevent accumulation of dirt. Space parallel horizontal conduit one inch apart and securely clamp to the steel work to prevent rattling and wear. Provide conduit supports at no more than 5 foot spacing between supports and no more than 12 inches from box or fixture.

Cut conduit square using saw or pipe-cutter; de-burr cut ends. Clean and swab conduit after threading. Bring conduit to shoulder of fittings; fasten securely. Long running threads are not permitted. Tighten conduits until all threads are concealed by the cuff of the PVC coated fitting or coupling.

Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum. Provide embedded conduit stub-outs with threaded 316 stainless steel couplings.

Install no more than the equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than two inches. All field bends will be long sweep, with a radius 12 times the diameter, and free of kinks to facilitate the drawing in of conductors without injury to the

conductors. Make conduit runs with as few couplings as standard conduit lengths will permit.

Do not fill control wire conduits to more than 25% fill.

Use suitable caps to protect installed conduit against entrance of dirt and moisture. Upon completion of the conduit installation, clear each conduit with a tube cleaner equipped with a mandrel of a diameter not less than eighty (80) percent of the nominal inside diameter of the conduit, and draw in the conductors. Provide suitable pull string in each empty conduit.

Boxes

Description:

Provide pull boxes and junction boxes as shown in the plans, at locations where more than 8 conductors are gathered, and as required by the NEC.

Submittals

Provide catalog data sheets, including dimensioned drawings, materials, and approvals.

Materials

Provide PVC coated cast metal wall mounted boxes for wiring devices (toggle switches, duplex receptacles, GFCI receptacles).

Ensure pull boxes, junction boxes, and all other miscellaneous housings used for pulling wires, terminating wires, or otherwise used to install electrical equipment, are NEMA 4X stainless steel. Provide drip proof enclosure opening with a rolled edge and cover held closed with clamps.

Provide enclosures larger than 12 inch in any dimension with a continuous stainless steel hinged cover with a glued in neoprene gasket.

Provide sheet metal enclosures with O-ring sealing hub connectors, drain fittings, and not less than four mounting lugs.

Construction Requirements

Install insulated bushings on conduit ends projecting into all boxes and enclosures. Do not drill box or enclosure for more conduits than enter it.

In locations exposed to weather make side or bottom conduit entries boxes only.

Use of wireways (metallic or non-metallic) and/or sheet metal troughs with hinged or removable covers is not acceptable.

Size boxes per NEC requirements for the size and number of conduits. Additionally, size boxes to include provisions for terminal block wiring clearance. Do not use boxes smaller than 8 by 8 by 4 inches.

Terminal Blocks

Description

Provide terminal blocks for internal circuits, circuits crossing shipping splits and where equipment parts replacement and maintenance will be facilitated and to connect the temporary systems to the permanent systems during phased construction. Provide disconnect type terminal blocks for conductors requiring connection to circuits external to the control house.

Submittals

Provide catalog data sheets for each type and rating of terminal blocks, include voltage and ampere ratings, materials, and dimensioned outline drawings.

Materials

Furnish and install terminal blocks rated at 600 V. Furnish channel mounted screw cage box clamp type terminal blocks for No. 8 AWG and smaller conductors, with vibration proof nonferrous screw. Provide terminal blocks in groups of 12 with interlocking “finger safe” type barriers with white marking strips.

Furnish power distribution terminal blocks for No. 6 AWG and larger conductors, three-pole, suitable for copper conductors, UL rated for amperage equal to the largest conductor it accommodates and made of copper.

Provide all current carrying components with corrosion resistant plating on nonferrous hardware. Do not use aluminum components if installed outside of the conditioned spaces of the Tender House.

Provide terminal blocks with wire protectors to physically isolate the conductor from the terminal screw.

Do not use terminal blocks that require special tools.

Construction Requirements

Group terminal blocks for easy accessibility unrestricted by interference from structural members and instruments.

Provide 2 inches minimum on each side of each terminal block and between terminals and wire duct to allow an orderly arrangement of all leads to be terminated on the block and to allow for wire labels.

Do not terminate more than two (2) wires on any one terminal position.

Permanently label each terminal block, device, fuse block, and both ends of each conductor to coincide with the identification indicated on the schematic and wiring diagrams. Terminal blocks and devices already numbered on the plans must be so numbered on the equipment supplied.

Electrical Identification

Description:

Provide identification for each electrical component including, but not limited to, conduit, wire, panels, boxes, motors, motor controllers, disconnect switches, and control devices.

Submittals

Provide catalog data for each type of identification device. Provide an engraving schedule for all laminated name plates.

Materials

Nameplates

Provide legend nameplates for all major pieces of equipment named on the plans, and for all control devices.

Provide legend nameplates for devices that show the device designation and name used on the schematic wiring diagram. Provide fuse legend nameplates that show the type, ampere, and voltage rating of the fuses.

Provide typewritten directories, with covers and directory pockets, for all panelboards. Provide identification for each branch circuit in a panelboard.

Provide nameplates of minimum letter height as scheduled below:

- Panelboards, Switchboards, and Motor Control Cabinet: 1/4 inch; identify equipment designation. 1/8 inch; identify voltage rating and source.
- Individual Circuit Breakers, Switches, and Motor Starters in Panelboards, Switchboards, and Motor Control Cabinet: 1/8 inch; identify circuit and load served, including location.
- Individual Circuit Breakers, Enclosed Switches, and Motor Starters: 1/8 inch; identify load served.
- Transformers: 1/4 inch; identify equipment designation. 1/8 inch; identify primary and secondary voltages, primary source, and secondary load and location.
- Switches, control relays, timers and other control devices: 1/8 inch; identify load and source and tag identification number.
- Control Panel switches, pushbuttons, indicating lights, meters: 1/8 inch; identify function (Raise, Lower, Pull, Drive, etc.). Provide these nameplates in addition to the lettering

provided on the switch, button or light face.

Conduit Markers

Provide adequate marking of primary conduits that are exposed or concealed in accessible spaces, to distinguish each run as either a power or signal/communication conduit. Except as otherwise indicated use orange banding with black lettering.

Provide snap-on type plastic markers. Indicate voltage ratings of conductors where above 240 volts. Locate markers at both ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduits pass through walls, floors or into non-accessible construction, and at spacing of not more than 50 feet along each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than 1 inch.

Provide both ends of each marked conduit run with a brass tag having a number stamped thereon in accordance with the conduit diagrams. Fasten these tags to the conduit ends securely and permanently with bare copper or stainless-steel wire.

Conductor Identification

Furnish vinyl cloth labels, split sleeve, or tubing type wire and cable markers.

Use numbers as indicated in the plans or the approved shop drawings, if numbers are not shown in the plans.

Provide wire labels on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Provide wire markers on each conductor at terminal blocks.

Underground Warning Tape

Provide 4-inch wide plastic tape, colored yellow with suitable warning legend describing buried electrical lines in every conduit trench.

Construction Requirements

Degrease and clean surfaces to receive nameplates and tape labels. Install nameplates and tape labels parallel to equipment lines. Secure nameplates to equipment fronts using stainless steel screws.

Secure nameplates to inside of recessed panelboard doors in finished locations. Use embossed tape only for identification of individual wall switches and receptacles, control device stations.

Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection

diagrams or equipment manufacturer's shop drawings for control wiring. Where equipment already has manufacturer's wire number, place plan wire number label adjacent to the manufacturer's number.

Dry-Type Transformers

Description:

Furnish and install dry type ventilated transformers as indicated in the Plans.

Submittals

Catalog data sheets including voltage, ampere, and kVA ratings, materials, and weight; dimensional data and outline drawings; and electrical connection diagrams.

508-1.1.1.1. Delivery, Storage, and Handling

Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow.

Materials

Ventilated dry type transformers designed according to the latest revision of ANSI/NEMA ST-20 and for continuous operation at rated kVA, 24 hours a day, 365 days a year, with normal life expectancy. Required performance must be obtained without exceeding 150 degrees C. average temperature rise by resistance or 180 degrees C. hot spot temperature rise in a 40 degrees C. maximum ambient and 30 degrees C. average ambient. Maximum coil hot spot temperature not to exceed 220 degrees C. Provide transformers with proven 220 degrees C. UL tested insulation system. Use copper wound coils. Ensure that materials in the transformer are flame retardant and do not support combustion as defined in ASTM D635. Final insulation treatment will be total immersion in a 220 degrees C. insulating varnish that maintains superior bond strength, high dielectric strength, and power factors at temperatures normally associated with 220 degrees C. system. After immersion, cure the varnish thoroughly at normal operating temperatures to assure the scouring of all volatiles in the varnish solvent.

Provide transformers constructed with core materials of high quality and low loss characteristics to minimize exciting currents, no-load loss, and interlaminar vibrations. Incorporate built-in vibration dampening systems in the design to minimize and isolate sound transmission. Mechanically brace the core-coil assembly to withstand short circuit tests as defined in NEMA TR-27. Coil construction and mechanical bracing members must prevent mechanical degradation of the insulation structure during the short circuit. Provide self-bracing transformer enclosure with drip-proof and rodent-proof protection. Include convenient knockouts for conduit entrance. Locate terminal compartment in bottom of transformer, below the core-coil assembly, for side or bottom conduit entrance. Temperature rise in terminal compartment must not exceed 5 degrees C. above ambient.

Provide transformers with 2 - 2-1/2 percent full capacity taps above rated voltage and 2 - 2-1/2 percent full capacity taps below rated voltage. Minimum basic impulse level (BIL) allowed is 10 kV. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap. Provide transformers 75 kVA and less suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA suitable for floor or trapeze mounting. Ensure coils are continuous windings with terminations brazed or welded. Include factory nameplate with transformer connection data and overload capacity based on rated allowable temperature rise.

Conduct the following tests at the factory: Applied voltage test (one minute) 4 kV; induced voltage test - two times normal for 7,200 cycles; and ratio and phase relation. Test reports on electrically duplicated units will certify that the following tests have been completed on the first rating of any design: no load losses, Induced voltage, total losses, sound level, applied voltage, impulse test, and temperature rise. Submit copies of test results to the Engineer for approval.

Construction Requirements

Run line and load conductors in separate conduits. Provide two (2) inch high concrete sill pad for floor mounted transformers. Provide wall or trapeze mounted units with sufficient space above and around the transformer for cooling per manufacturer's recommendations.

Panelboards

Description

Furnish and install, where indicated, a dead-front panelboard incorporating switching and protective devices of the number, rating, and type noted in the Contract Documents.

Submittals

Include catalog data for panelboard and circuit breakers including dimensioned drawing for panel enclosure, detailing mountings and door hardware, voltage, ampere, and short circuit ratings for all circuit breakers and the overall panel board assembly.

Provide a circuit directory listing each branch circuit and the circuit breaker rating. Submit load balance calculations showing proposed load currents are evenly distributed across the phases. Provide replacement parts list.

Materials

Provide only circuit breaker equipped panelboards. Provide panelboards with general purpose enclosures and surface mounted except where noted. Provide panelboards rated for the intended voltage and in accordance with NEMA PB 1. Provide a factory nameplate listing panel type and ratings. Label panelboards that are to be used as service entrance equipment. Ensure the manufacturer is a company specializing in manufacturing the product specified with a minimum of five years documented experience.

Provide factory assembled interiors complete with switching and protective devices, wire connectors, etc. Use terminals suitable for copper wire of the sizes indicated. Design interiors so that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors and that circuits may be changed without machining, drilling, or tapping. Arrange branch circuits using double row construction. Use copper bus bars for the mains and size in accordance with NEMA standards. Unless otherwise noted, include full size neutral bars. Arrange bus bar taps for panels with single pole branches for sequence phasing of the branch circuit devices. Furnish assembled panelboard rated for 22 kA minimum in accordance with NEMA standards and their test verification. Provide full height phase bussing without reduction. Use copper cross and center connectors. Provide neutral bussing with a suitable lug for each outgoing feeder requiring a neutral connection. Bus spaces for future switching and protective devices for the maximum device that can be fitted into them.

Furnish boxes made from galvanized code gauge steel and of sufficient size to provide a minimum gutter space of 6 inches on all sides. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, size the box to include this wiring space. Provide this wiring space in addition to the minimum gutter space specified above and increase the limiting width accordingly. Provide at least four (4) interior mounting studs.

Provide all panel trims with hinged doors covering all switching device handles, except that panelboards having individual metal clad externally operable dead front units may be supplied without such doors. In making switching device handles accessible ensure doors do not uncover any live parts. Provide doors with cylinder lock and catch, except that doors over 48 inches in height must have auxiliary fasteners at top and bottom of door in addition to cylinder lock and catch. Furnish keyed alike locks and directory frame and card with transparent cover on each door. Provide the trims fabricated from code gauge sheet steel. Properly clean all exterior and interior steel surfaces of the panelboard trim and finish with gray ANSI-61 paint over a rust-inhibiting phosphatized coating. Provide trims for flush panels that overlap the box by at least 3/4 inch all around. Provide surface trims that have the same width and height as the box. Provide trims that are mountable by a screwdriver without the need for special tools.

Protect electrical circuits, excluding circuits shown on the plans, with molded case circuit breakers. Each pole of these breakers must provide inverse time delay and instantaneous circuit protection. Provide breakers operated by a toggle type handle with a quick-make, quick-break over-center switching mechanism that is mechanically trip free from the handle. Include provisions so that the contacts cannot be held closed against short circuits and abnormal currents. Show tripping because of overload or short circuit by the handle automatically assuming a position midway between the manual ON and OFF positions. Grind and polish all latch surfaces. On multi-pole breakers construct all poles so that they open, close, and trip simultaneously.

Ensure breakers are completely enclosed in a molded case, bolt-on type construction. Plug-in type or tandem type circuit breakers are not acceptable.

Seal the covers of non-interchangeable trip breakers; seal the trip unit of interchangeable trip breakers to prevent tampering. Ensure ampere rating is evident and molded into the operating handle. Provide contacts made of non-welding silver alloy. Arc chutes, consisting of metal grids

mounted in an insulating support, must accomplish arc extinction.

Provide circuit breakers that conform to the applicable requirements of NEMA Standards, and meet the appropriate classifications of Federal Specifications W-C-375b. Provide circuit breaker ratings, modifications, etc., as shown on the Plans. Provide molded case breakers as follows:

- Thermal magnetic standard type that provides inverse time delay overload and instantaneous short circuit protection by a thermal-magnetic element.
- Magnetic only standard MCP (Motor Circuit Protector) that provides instantaneous only short circuit protection by a front adjustable magnetic only element. The adjustment button(s) will have main setting points and mid-setting points following a linear scale so that each point has a significant value within calibration tolerance.
- Ambient compensating standard that provides inverse time delay overload and instantaneous short circuit protection by a thermal magnetic element. Accomplish compensation by a secondary bi-metal that will allow the breaker to carry rated current between 25 and 50 degrees C. Provide with tripping characteristics that are uniform throughout this temperature range.

Provide multi-pole breakers with a single operating handle. Plate all copper parts to prevent corrosion. Provide all 100 A frame breakers with an interrupting rating of 10 kA (minimum), all larger frame size breakers with an interrupting rating of 22 kA (minimum). Provide a main breaker section that includes a molded case circuit breaker with an adjustable trip unit. Furnish a breaker frame and trip rating as shown in the Plans.

Construction Requirements

Install panelboards in accordance with NEMA PB 1.1. Install panelboards plumb. Install recessed panelboards flush with wall finishes. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 6 inches above floor. Provide filler plates for unused spaces in panelboards. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads. Identify each branch circuit in a panelboard. Provide panelboards with covers and directory pockets and typewritten directories. Identify mounted electronic components by marking with contrasting colored ink beside the component.

Provide engraved plastic nameplates.

Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the running phase loads to within 10 percent of each other. Maintain proper phasing for multi-wire branch circuits. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses. Take care to maintain proper phasing for multi-wire branch circuits. Prior to energization of the panelboard, Megger check phase-to-phase and phase-to-ground insulation for proper resistance levels and check panelboard electrical circuits for continuity and for short-circuit. The Engineer may witness this test.

Wiring Devices

Description:

Provide catalog data sheets for each type of wiring device. Include voltage and ampere ratings, dimensions and outline drawing or photograph in the catalog data.

Submittals

Provide catalog data sheets for each type of wiring device. Include voltage and ampere ratings, dimensions and outline drawing or photograph in the catalog data.

Materials

Toggle Switches: Provide heavy-duty use, totally enclosed type with bodies and handles of thermosetting plastic, supported on a metal mounting strap. Provide switches with screw type wiring terminals, side-wired. Back-wired, clamp-type terminals are not allowed. Provide snap type switches with toggle handle, rated quiet type, AC only, 20 A, 120/277 V, single pole.

Receptacles: Provide heavy-duty use, duplex grounding type rated 20 A and 125 V. Provide thermosetting plastic composition bodies, supported on a metal mounting strap. Provide side wired receptacles with binding-type terminals. Back-wired, clamp-type terminals are not allowable. Ensure that the grounded pole is connected to the mounting strap.

Ground Fault Circuit Interrupter (GFCI) Receptacles: Provide duplex, feed-through type, convenience receptacle with integral ground fault current interrupter. Provide devices rated for 20 A and capable of detecting a current leak of 5 mA. Connect receptacles to protect the local load without disruption of the rest of the circuits.

Construction Requirements

Install switches and receptacles as shown in the plans. Install switches 42 inches above the finished floor and receptacles 14 inches above floor unless otherwise noted. Install switches with OFF position down.

Furnish and install three-way switches as indicated in the Contract Documents.

Install surface mounted devices in weatherproof boxes. Inside the control house and other environmentally controlled rooms, provide 1/16 inch thick satin finished Type 302 stainless steel cover plates.

Use GFCI type receptacles in all outside locations, rest room, and sink area.

For exterior locations, provide weather proof, corrosion resistant, plates with spring loaded snap covers. Consider the machinery floor area as an outside location.

Disconnect Switches

Description:

Furnish and install, where indicated, heavy-duty disconnect switches having electrical characteristics, ratings, and modifications shown on the drawings. Furnish and install fuses for fused disconnect switches.

Submittals

Provide catalog data, installation instructions, and replacement parts list for each type switch. Include voltage and ampere ratings, construction material, NEMA classification, and dimensioned outline drawing in the catalog data. Include, as part of the installation instructions, a replacement parts list.

Materials

NEMA Type 4X (stainless steel) enclosures. Units installed in the Operator Room can be NEMA 12. Enclosures requiring louvered vents may be NEMA 4 stainless steel.

Equip with metal factory nameplates, front cover mounted, that contain a permanent record of switch type, catalog number, and Hp rating.

Equip with visible blades, reinforced fuse clips, non-feasible, positive, quick make-quick break mechanisms with a handle whose position is easily recognizable and is pad-lockable in the OFF position. Switch assembly plus operating handle as an integral part of the enclosure base. Provide switches that are HP rated and meet NEMA Specifications. Provide switches with defeatable door interlocks that prevent the door from opening when the operating handle is in the ON position. Provide heavy-duty switches with line terminal shields.

Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class R fuses.

Non-fusible Switch Assemblies of NEMA KS 1 construction Type HD with quick-make, quick-break and load interrupter enclosed knife switch. Handle lockable in OFF position. Furnish non-fusible switches with one N.C. (normally closed) and one N.O. (normally open) set of auxiliary contacts.

Furnish time delay, current-limiting type fuses with 200 kA interrupting rating at 600 VAC. Use only rejection type fuses, UL listed to minimize short circuit damage and be applied as follows: UL Class RK1 - Service entrance, transformer feeder and panelboard feeder; UL Class RK5 - Motor branch circuit.

Service Entrance: Furnish service rated disconnect switch.

Construction Requirements

Install disconnect switches where indicated in the plans or where required. Install switches plumb at a height with the top not exceeding 6 feet above the floor.

Do not use switch enclosure as a pull box for wiring other than the load it serves. Use separate conduits for line and load conductors.

5. MOTORS

Description

Furnish and install 3 phase motors for the main span, span locks, and brakes as indicated on the Contract Plans. Rewire existing gate motors to a 3-phase configuration.

Submittals

Catalog sheets with descriptive data, plan and elevation drawings with dimensional data, nameplate data performance data including torque-speed and current graphs, schematic diagrams.

Provide certified motor drawings to the machinery fabricator for coordination.

Materials

Furnish motors designed for continuous operation in 40 degrees C. environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

Provide stamped, stainless steel nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model and serial number, design class and service factor.

Provide conduit connection boxes, threaded for conduit. For fractional horsepower motors, where connection is made directly, provide conduit connection in end frame.

Furnish and install a span motor as depicted on the mechanical drawings and outlined on the mechanical specifications.

Provide bolted compression lugs connections.

Furnish and install one (1) new 7.5 Hp span motor, 1200 RPM, 3PH, 460Volts, 60 Hz vector duty, NEMA Design B, 30 min duty, super H insulation, 40 degs. C max ambient temperature TENV, marine duty rated per IEEE #45. Span motors shall be equipped from factory with a rear-mounted encoder as part of the motor package.

Three Phase Motors

Start-Ups: 12 per hour. 2 per ten-minute period.

Power Output, Locked Rotor Torque, Breakdown or Pullout Torque:

- NEMA Design B Characteristics for pumps and span drive motors.
- NEMA Design D for mechanical locks and gate operators.

Insulation System: NEMA Class F or better.

Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B and D Motors.

Test in accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Perform additional testing to determine speed/torque curve relationship.

Motor Frames: NEMA Standard T-frames of steel or cast iron (no aluminum frames allowed) with end brackets of cast iron with steel inserts. Furnish totally enclosed non-ventilated construction for motors 5 Hp and larger; main span motor will be non-ventilated.

Thermistor System (Motor Sizes 5Hp and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.

Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

Sound Power Levels: To NEMA MG 1.

Nominal Efficiency: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

Nominal Power Factor: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

Service Factor: 1.0 for mechanical drives and 1.15 for hydraulic pump motors. Reference horsepower ratings from a 1.0 service factor.

Storage

Provide temporary power connection to internal motor heaters, or provide external heater, to maintain constantly elevated internal temperature to assure prevention of condensation or moisture accumulation. Manually rotate the rotor every thirty (30) days to prevent flattening of bearings. If the storage arrangement permits, rotate the entire housing 90 degrees every sixty (60) days. The storage period is assumed to continue after the motors are installed until they are

placed into actual repetitive service that will produce heat from operation.

Construction Requirements

Install motors per manufacturers' instructions. Utilize millwright for field installations, base modifications, and shaft alignment with the machinery and the brakes.

Provide motor mounting bases as required to accommodate motors. Properly align motor shaft with speed reducer shaft before connecting motor coupling. Make sure brake drums are properly aligned with brakes. Align if required.

Coordinate motor shaft diameter and length with requirements for machine, service brakes, and tachometer. Verify alignment of motor shafts with machinery and brakes prior to installation of shaft couplings; correct as required to provide proper alignment within coupling misalignment tolerances.

Quality Control

Perform a no-load spin test and megger tests on main drive motors to verify compliance with the manufacturer's specifications prior to make-up of machinery couplings.

6. DRIVE/STARTER CABINET

Description:

Furnish and install a Drive/Starter Cabinet as shown in the Contract Documents including three phase circuit breakers, contactors, overload relays, transformers, etc.

Deliver Drive/Starter Cabinet individually wrapped in factory fabricated fiberboard type containers and with lifting angles on each Drive/Starter Cabinet supporting structure. Handle Drive/Starter Cabinet carefully to prevent internal component damage and denting or scoring of enclosure finish. Do not install damaged Drive/Starter Cabinet. Store Drive/Starter Cabinet in a clean, dry space. Protect unit from dirt, fumes, water, construction debris and traffic.

Furnish and install, where indicated or required, motor controls having the electrical characteristics, ratings, and modifications shown in the Plans.

Drive/Starter Cabinet, 12-gage stainless steel enclosure with double doors in the front. Doors shall be made with heavy gage stainless steel continuous hinge on one side with oil-resistant gasket all around.

Submittals

One-line and three line diagrams.

Schematic diagrams (including field wiring with wire numbers).

Wire and interconnection diagrams including terminals. Assign wire numbers for each wire.

Elevation and dimensioned outline drawings detailing arrangement of wireway and conduit entry.

Equipment schedule (Bill of Materials) detailing all components (with manufacturer's part no.).

Descriptive data for all components (CBs, starters, OL relays, lights, etc.).

Furnish instruction manuals describing theory of operation, maintenance information and schematics of motor starter units.

Manufacturer

Furnish Motor Control Cabinet that is the end product of an established manufacturing company. Do not use a value-added reseller as a source.

Materials

Circuit Breakers

Provide 3-pole, heavy duty, 600 VAC, quick-make, quick-break molded case circuit breakers and MCPs. Provide a molded case type main breaker.

Magnetic Across the Line Starters

Furnish 120 VAC magnetic starter coils. Equip all magnetic starter coils with a combination R/C-MOV surge suppressor across the coil circuit to prevent inductive switching transients from damaging any connected circuitry.

Furnish motor starters of the Combination Motor Starters type (across-the-line non-reversing or reversing combination starters for motors up to 100 hp, 600 VAC). Provide a Motor Circuit Protector (MCP), or MCP with Current Limiter, as disconnecting means. Build and test motor starters in accordance with the latest NEMA standards. Equip combination motor starters with three NEMA Class 20 overload relays. Provide neatly typed label for each motor starter identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

Furnish AC magnetic controllers designed for full voltage or across-the-line starting of induction motors rated in horsepower. Furnish starters with provision for field installation of up to 3 N.O. and 4 N.C., 10 A., auxiliary contacts in addition to the hold-in interlock. A minimum of two Normally Open and two Normally Closed contacts will be supplied with each magnetic motor starter. Provide additional contacts if required. Provide starters with encapsulated coils and enclosure as required to meet conditions of installation. Overload relays should be block-type with a push-to-test feature. Provide an isolated, field-mountable alarm contact.

Provide 3-pole, 480 VAC, full voltage, NEMA type, magnetic combination type starters. Provide motor starters that are a combination circuit breaker and NEMA controller with overload relay protection. Where specified, provide control voltage transformers with fused secondary.

Furnish Non-Reversing Starters (Across-the-line magnetic starters for motors up to 100 hp, 600 VAC) built and tested in accordance with the latest NEMA standards. Equip non-reversing starters with three NEMA Class 20 overload relays.

Provide reversing Starters (Reversing magnetic starters for motors up to 100 hp) built and tested in accordance with the latest NEMA standards. Equip reversing starters with three NEMA Class 20 overload relays.

Overload Relays: Provide block-type with a push-to-test feature; isolated, field-mountable, alarm contact which closes on relay overload trip.

Non-fusible Switch Assemblies: Provide quick-make, quick-break, and load interrupter enclosed knife switch with externally operable handle.

Motor Circuit Protector: Provide circuit breakers with integral instantaneous magnetic trip in each pole.

Construction Requirements

Install Drive/Starter Cabinet, where indicated, in accordance with applicable NEC standards, Manufacturer's written instructions and recognized industry practices, to comply with requirements and serve intended purposes.

Prior to energizing the Drive/Starter Cabinet, Megger check phase-to-phase and phase-to-ground insulation for proper resistance levels. Prior to energizing the circuitry, check Drive/Starter Cabinet electrical circuits for continuity and for short-circuits. Subsequent to wire and cable hook-ups, energize Drive/Starter Cabinet and demonstrate functioning in accordance with requirements.

Provide overload relay heaters sized to the full load current of the actual motor nameplate.

7. SPAN MOTOR AND VECTOR CONTROLLED ADJUSTABLE SPEED DRIVE (ASD)/VARIABLE FREQUENCY DRIVE (VFD)

Description:

General

Furnish and install a matched motor and drive system as described in this article. Furnish a factory engineered span drive motor and vector-controlled drive which are the end product of a single manufacturer. Do not use value added resellers or control system contractors as a source

for this item.

Submittals

Motors

Catalog sheets with descriptive data.

Plan and elevation drawings with dimensional data.

Nameplate data.

Performance data including torque-speed and current graphs.

Schematic diagrams.

Provide certified motor drawings to the machinery fabricator for coordination.

Adjustable Speed Drive

One-line, three line, and schematic diagrams (including field wiring with wire numbers).

Wire and interconnection diagrams including terminals. Assign wire numbers to each wire.

Elevation and dimensioned outline drawings detailing arrangement of sections, cubicles, wireway and conduit entry.

Manufacturer's Field Reports: Indicate start-up inspection findings.

Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

Maintenance Data: Include routine preventive maintenance schedule.

Instruction Manuals: Furnish instruction manuals with manufacturer's information and recommendation covering.

Vector controlled drive characteristics such as: ratings, conditions for applications and service, control functions, protective functions, and options available or included.

Safety precautions and procedures before and during installation, starting adjustments, and maintenance.

External control and power wiring, including grounding.

Recommendations to optimize immunity to electrical noise.

Listings of phenomena external to the Adjustable Speed Drive that can cause malfunctions or dangerous conditions, with suggested corrective actions.

Troubleshooting procedures with symptom/cause-effect/and corrective recommendations, based on manufacturer's recommended SRUs (Smallest Replaceable Units).

Warning Labels: Include suitable warning labels inside and outside the enclosure in those cases where it is possible for the maintenance electrician to wire circuits into the enclosure that are not disconnected by the disconnect device.

Materials

Span Drive Motor

Ensure the motor is provided by drive manufacturer to assure compatibility and drive system integration.

Provide TENV, NEMA Design B motors, stainless steel shaft.

Provide a closed keyway on the machinery end of the shaft. Coordinate motor coupling and installation details with the machinery manufacturer. Provide approved shop drawings to the machinery manufacturer for their use in the machinery assembly drawings.

Provide motors rated for inverter duty and suitable for use in a sensor-less vector controlled variable speed drive application.

Start-Ups: 12 per hour, 2 per ten minute period.

Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B Characteristics.

Insulation System: NEMA Class F or better.

Testing Procedure: In accordance with IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Perform additional testing to determine speed/torque curve relationship.

Motor Frames: NEMA Standard T-frames of steel or cast iron (no aluminum frames allowed) with end brackets of cast iron with steel inserts.

Thermistor System (Motor Sizes 5Hp and larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.

Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate

bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
Sound Power Levels: To NEMA MG 1.

Nominal Efficiency: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with IEEE 112.

Ship motors to a facility for dynamometer testing with the variable speed drives.

Adjustable Speed Drives (ASD)

This is a functional specification and horsepower rating is deliberately not specified. Ensure that the manufacturer sizes the motors and drives to provide the torque and speed requirements as shown in the plans.

Design the ASD system to provide reversing, continuous speed adjustment with acceleration and deceleration control, of three-phase motors without exceeding the specified maximum motor and machinery torque. Provide an ASD system capable of supplying power to the motor(s) for the required motor torques. Provide a control capable of providing selectable current limit settings. Provide a drive that is able to withstand output terminal line-to-line short circuits without component failure, be insensitive to input line rotation, and be capable of power ride-thru of 15 ms at full load.

Furnish the drive with internal over temperature protection.

115 VAC input control logic board option. Provide inputs that include, enable, run, reverse, and full speed. Provide a drive that responds to inputs with preset direction and speed to accelerate and decelerate the bridge leaf to follow a trapezoidal speed curve as shown in the Plans.

Contact outputs: 4 form “c” min. (functionally programmable). Provide outputs that include overload alarm, drive fault, and brake release.

Provide dynamic braking function (with power resistors) capable of 100 percent braking of full load motor torque for 3 minutes.

Provide drives capable of converting incoming three-phase, 460 VAC (-10 percent of min. +10 percent of max.) and 60 Hz (+/-2 Hz) power to a variable potential DC bus level. Invert the DC voltage to pulse width modulated waveform with an adjusted 0 to 420 Hz frequency output.

Ensure displacement power factor ranges between 1.0 and 0.95, lagging over the entire speed range.

Provide an ASD capable of operating, without derating, in an ambient temperature of 0 to 40 degrees C, an altitude of up to 3,300 feet above sea level, and humidity of 5 to 95 percent, non-condensing.

Furnish a line reactor for each unit.

Include the following items in the ASD's enclosures:

- Feeder disconnect. Input AC circuit breaker or fused switch with an interlocked, pad lockable handle mechanism accessible without opening the drive door and capable of breaking under load.
- Isolated process follow input and output.
- Motor mechanical brake contactor.
- Brake chopper module for control of Dynamic Braking Resistors. Mount resistors externally.
- Electronic over current trip for instantaneous and inverse time overload protection.
- Human interface module with START-STOP pushbuttons, power ON indicating light, with alphanumeric display of run, stop, forward, reverse, fault, over frequency, instantaneous over current, AC under voltage/loss of phase, emergency stop, overload, over-temperature, inverter pole trip, and stand-by modes, door mounted.
- Run, fault indicator lights and drive reset push button, door mounted.
- Electrical isolation between the power and logic circuits, as well as between the 120 VAC control power.
- Line transient voltage protection.

Provide the following independent adjustments on the ASD:

- Output frequency range: 0 to 400 Hz.
- Programmable current limits from 20-160 percent of rated current.
- Acceleration time: 0-3600 sec. with two independently programmable timers.
- Deceleration time: 0-3600 sec. with two independently programmable timers.
- Start boost control.
- Volts per Hertz - programmable for start boost, run boost, slope, and custom operation.
- Slip compensation speed regulation to 0.5 percent.

Enclosure Construction: Furnish minimum two ground lugs or as indicated on the Contract Plans, one for incoming line power and one for outgoing motor ground connections. Provide enclosures no less than 16-gage steel and finished in standard manufacturer's finish.

Extra Materials

Furnish the following additional parts for the Adjustable Speed Drive motor controller:

- 1 main control board
- 1 power interface board
- 1 gate board driver
- 1 diode power block
- 3 incoming line fuses
- 3 control power fuses

Construction Requirements

Factory Demonstration: Before shipping, conduct a factory Design Proof Test on the first assembly with a calibrated dynamometer to verify that the performance requirements have been

met. The test may be witnessed by the Engineer. Provide 30 day advanced notice and submit description of the test stand to document the accuracy of the torque readings. This design verification operational test is required on one motor, chopper, resistor, and drive. The manufacturer must certify that all other units are reasonably similar.

Supply test results to confirm that the ASD has been tested to substantiate designs according to applicable ANSI and NEMA Standards. The tests must verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting and rigidity.

Shop Testing of Adjustable Speed Drives

Perform shop testing on the adjustable speed drives to ensure compliance with the performance requirements of this Article before acceptance of Adjustable Speed Drive-Motor combinations. The Engineer may witness the testing based on approved shop drawings and test procedures.

Testing procedures will be as follows:

- Apply load equal to the torque specified for TCV (Maximum Constant Velocity Torque per AASHTO 5.4.2) to motor shaft. Run motor at 100 percent speed for 3 minutes (driving). Motor-drive combination should be capable of driving the load without excessive heating.
- Apply overhauling load equal to TCV torque to motor shaft. Run motor at 100 percent speed for 3 minutes (dynamic braking). Motor-drive combination should be capable of dynamically braking the load without excessive heating.

Demonstrate that motor drive can produce TS (Maximum Starting Torque per AASHTO 5.4.2) torque at no less than or equal to 50 percent speed for one minute.

Demonstrate that motor drive can dynamic brake TS torque at no less than or equal to 50 percent speed for one minute without excessive heating.

Demonstrate that motor drive cannot produce or exceed the Never-Exceed torque value at zero or any other speed. NOTE: Zero speed is defined as 0-20 RPM maximum.

Installation:

Install motors per manufacturers' instructions.

Install motor mounting bases as required to accommodate motors. Properly align motor shaft with driven shaft before connecting motor coupling. Align if required. Megger motors before final connection. Record these readings and submit with "As-Built" drawings.

Adjusting: Make final adjustments to installed drive to assure proper operation of fan system if so equipped. Obtain performance requirements from installer of driven loads.

Cleaning: Touch up scratched or marred surfaces to match original finish.

Demonstration: Demonstrate operation of controllers in automatic and manual modes.

8. INTEGRATED BRIDGE CONTROL SYSTEM

Description:

General

Furnish and install a relay based integrated bridge control system comprising a control desk (housing the control relays), Drive/Starter Cabinet and field control devices. Perform the detailed design of the control system using information in the Contract Documents as required for the equipment being provided.

Submittals

Manufacturer's data sheets for all components (terminal blocks, relays, timers, fuses, circuit breakers, sensors, etc.). Provide instructions for adjusting and resetting time delay relays and timers. Ensure all manufacturers' data and recommended preventative maintenance procedures and materials are provided.

Dimensioned fabrication details for top of control desk, main control panel, and other enclosures including, to scale, equipment layouts, punch outs, nameplate schedules, and bill of materials. Label all components, for which identification numbers have been provided in the Contract Documents, with that number.

A bill of materials. Provide some means of cross referencing the item identification numbers to the materials list; either by schedule or labeling the applicable catalog data sheets.

Engraving schedule for nameplates.

Schematic diagrams including field wiring. Assign wire numbers for each wire and include in the schematic and wiring diagrams.

Dimensioned details for mounting of limit switches and field control devices.

Procedures for shop test and functional acceptance testing.

Materials

Cabinets

Control Console, stainless steel 10-gauge to. Brush the top after punching for control devices.

Wiring

Provide interconnection wiring between all electrical devices mounted in the panels and

enclosures. If the devices are to be connected to external equipment use terminal blocks. Install all interior wiring neatly and carefully, and terminate on UL approved terminal blocks as per manufacturer's instructions.

Individually bundle wiring to each control switch and install with a "drop loop" of sufficient length to allow its removal for maintenance without disconnecting the wiring. Use plastic wireways (open slot type) for routing all internal wiring in the control desk. Internal wiring in factory prewired electronic system cabinets may be installed according to the Manufacturer's standard as to wire size, insulation, and method of termination on internal equipment. Segregate all low voltage signal wiring, such as data, audio, and video lines, from AC lines. Do not splice low voltage signal and data lines.

Terminal Blocks

Provide terminal blocks for conductors requiring connection to circuits external to the specified equipment, for internal circuits crossing shipping splits, and where equipment parts replacement and maintenance will be facilitated. Furnish rail mounted, tubular screw clamp type terminal blocks. Group terminal blocks for easy accessibility unrestricted by interference from structural members and instruments. Provide sufficient space (2 inch minimum) on each side of each terminal block to allow an orderly arrangement of all leads to be terminated on the block. Do not terminate more than two wires on any one terminal position.

Permanently label each terminal block, device, fuse block, terminal, and both ends of each conductor to coincide with the identification indicated on the manufacturer's wiring diagrams. Number terminal blocks and devices on the equipment supplied using the same numbers shown in the Contract Documents. Identify mounted electronic components by marking with contrasting colored ink beside the component. Permanently identify individual conductors using a sleeve not less than 1/2 inch long. Mark each sleeve so that the identifications are permanent and waterproof. Adhesive type labels are not acceptable.

Position Indicators

Display leaf position at the control console on an analog meter as shown in the Plans. Provide meter powered by 120 VAC and that accepts a 0-10 VDC input signal with an input impedance of not less than 200K ohms. Provide meter with 1 percent resolution, 0.5 percent accuracy of full scale, and 0.4 percent linearity of full scale.

Ammeter

Provide 3-1/2 digit LED rectangular, control console mounted indicator for a 0-5 ampere input.

Contact Blocks

Provide contact blocks rated at 10 A, NEMA Class A600. Use clear, oil-tight, blocks to allow visual inspection.

Legend Plates

Square or rectangular, manufactured out of laminated plastic or any similar non-metal corrosion resistant material. Provide white plates with black lettering.

Relays

Control Relays and Plug-In Relays

- Contacts: NEMA ICS 1, Form C. 2 or 4 pole.
- Contact Ratings: NEMA ICS 1; Class C300, 7 amps.
- Coil Voltage: 120 VAC, 60 Hz.
- Provide indicating lamp or LED across coil.
- Provide push-to-test button.
- Clear dust cover and spade terminals.
- Socket mounted, provide track mounted socket.
- Furnish and install plug-in surge suppressor on each coil.

Industrial Control Relays: Contacts rated at 10 A, NEMA Class A600, with replaceable contact cartridges. Coil voltage as indicated in the Plans. Furnish and install surge suppressor on each coil.

Contactors: Lighting type contactors, open type, and electronically held. 20 A contacts min., (field convertible) other rating as show in Plans. Coil voltage as shown in Plans.

Time Delay Relays

NEMA Class B600 solid-state time-delay relay with adjustable time delays as indicated in Plans with contacts rated 5 amps minimum, 600 VAC. Coil voltage as indicated on the Plans. Furnish and install surge suppressor on each coil.

Control Power Transformers

NEMA ST 1 rated machine tool transformer with isolated secondary winding with power rating as required for application. Voltage Rating: Line volts primary; 240/120 VAC secondary, or secondary voltages as shown in the Plans or required by specific device.

Control Fuses

Provide control fuses with current rating as shown in the Plans to isolate the individual control circuits and to provide selective overcurrent and short-circuit protection. Provide indicating type fuses for control circuits, ceramic or fiberglass body, midget type, rated 250 VAC, 10 kA interrupting, UL listed for control circuit application. Automotive type, glass body fuses are not acceptable. Provide terminal block style, with isolating feature, fuses blocks to house the control fuses. Provide rail mounted fuse block, rated 600 VAC, 30 A maximum for midget type fuses. Provide a hinge type cover for isolating and automatic fuse extraction from circuit when cover is lifted.

Lever-Arm Limit Switches

Provide oil-tight, die-cast aluminum housing, double sealed limit switches. Provide electro-mechanical, lever-operated limit switches for span lock position indication. Provide each lever type limit switch with snap action double pole, double throw, contact blocks rated 10 A at 120 VAC with high snap-through force to minimize contact bounce. Heavy duty, NEMA Type 4X construction with sealed bodies and pig-tail leads. Provide lever arms with length required for application.

Proximity Limit Switches

Provide oil-tight, magnetically actuated, lever-less limit switches with corrosion-resistant enclosures for over travel indication and other switches as indicated in the electrical plans. Each limit switch shall have a double-pole, double-throw (DPDT) contact arrangement rated at 10 A, 120 VAC. Limit switches shall be of heavy-duty construction, NEMA Type 4X, with sealed bodies and factory-installed 6 feet of pig-tail leads as a minimum. The limit switches shall be GO Switch Model 81 series or approved equal.

Rotary Cam Limit Switches

Provide rotary, cam-operated limit switch housed in NEMA Type 4X stainless steel enclosure. The switch shall be driven by gearing furnished with the operating machinery, which shall rotate the input shaft.

The Span Rotary Cam Limit Switch shall have five (5) circuits, each individually micro-adjustable, with provisions for internal vernier adjustments. The switch shall provide contact operation repeatability within $\pm 1/4$ degree. Each contact shall be a double-pole, double-throw (DPDT), precision-type, snap-action switch with a minimum continuous current carrying rating of 15 A AC inductive and 15 A DC resistive. The Span Rotary Cam Limit Switch shall include a built-in resolver with a minimum 10-bit resolution and a 4–20 mA analog output to be integrated to the Span position indicator in the new console.

All rotary cam limit switches shall be Ametek Series 1980 or approved equal. Any required gear reducer shall be coordinated with the mechanical design such that the cam shaft rotates less than 360 deg over the full operating range of the equipment.

Plunger-Type Limit Switches

Provide plunger limit switches for the Fully Closed leaf position, switch shall be a weather-sealed design, with neoprene gaskets between exterior bolted connections. Cover shall be designed to positively retain the gasket. Drain plugs and a breather shall allow condensation to evaporate or drain from housing. Housing shall be constructed of aluminum or stainless steel. Construction shall be heavy duty, durable and suitable for marine environment. All materials shall be non-corrosive. Finish shall be painted aluminum or safety orange. Plunger extension shall permit at least .75" field adjustment and shall have a ball end. Design shall also allow for simple field swapping of service cover hand. Plunger shaft shall be stainless steel. Pre-travel

shall be approximately 1.75'' with a minimum over-travel of 1.25''. Trip plate shall be spring loaded with an over-center mechanism to provide simultaneous, positive, accurate, and repeatable snap-action activation of all switches. Trip point shall be field adjustable by simple adjustment of plunger extension. The number of circuits shall be as specified (6 circuits max in standard assembly). Each circuit shall provide independent normally open and normally closed sets of contacts (1 NO and 1 NC). Heavy-duty snap-action microswitches shall be double-break type to increase contact life. Individual switches shall be rated for 4A make/15A break at 120V. Switches shall have clearly labeled screw-type compression wire connections and corrosion-resistance contacts. A 1'' conduit hub shall be provided for wire entry. Housing shall be pre-drilled to permit switching the hub to either side of the housing. Second opening shall be sealed with an O-ring and cover plate.

Limit Switch Nomenclature

Nearly Open is defined as that position where the bascule leaf is approximately thirteen (13) degrees from Fully Open. Nearly Closed is defined as that position where the bascule leaf is approximately eight (8) degrees from Fully Closed. Final settings/degrees position for nearly open and nearly closed shall be field adjusted based on drive speed, bridge inertia and operation times.

Span Position Resolver

Mount span position resolver to the output shaft of the rotary cam limit switch. Both devices shall be housed in the same NEMA 4X SS enclosure and provided as a single unit by the same manufacturer. Position resolver shall have a minimum 10-bit resolution, powered with 24VDC power supply and provide a voltage or current analog output signal, 4 to 20 mA as required to properly interface with the angle indicator mounted on the control desk. Provide position transmitter that can be adjusted and calibrated without having to physically move the NEMA enclosure. Provide position transmitter with temperature drift of no more than 0.01 percent per degree C. and have suitable vibration resistance and dampening for a bridge leaf application. Ensure non-linearity is less than 1×10^{-3} full scale and transverse sensitivity less than 1 percent 45 degrees tilt.

Construction Requirements

Top of Control Desk and Panels

Arrange bascule leaf operation controls to allow the operator to open the bascule leaf using the "Bridge Operation Sequence" as detailed in the Plans. Control console will contain switches, and indicators to perform normal operations. The relays, timers, surge suppressors and other equipment necessary to interface with the motors and exterior peripheral equipment, will be located in the Drive/Starter Cabinet, as described in the Plans

If a bypass of a fault is permitted, a momentary key-operated selector switch should be enabled indicating the availability of the operation. Provisions must be made for full safety interlock protection.

A red, illuminated (when depressed), mushroom head, latching, pull-to-release emergency push-button is located on the control desk. Engaging this control, stops (i.e., EMERGENCY STOP) and locks the bascule leaf in whatever position it is in at the time. The emergency push-button must be manually retracted in order to restart the operation. To restart the lower or raise operation of the bascule leaf, select lower or raise on the leaf control selector switch. The emergency stop push-button will operate similarly on all moving bridge components (e.g., gates and locks).

Training

Include in the bid, the cost of a minimum two-day training session for five Town personnel. Include basic trouble shooting and maintenance techniques related to the bridge relay control topics. Furnish notebooks and manuals as required. Ensure manuals include all technical information covered in the class. Submit class outline to the Engineer for approval two weeks before class is held. Ensure that a qualified manufacturer's representative conducts the class.

Shop Inspection and Testing

Ensure that prior to shipment, the complete control system (including fully functional control console, Drive/Starter Cabinet and ASD interfaces) are functionally tested together to assure completeness and correct operation of the entire bridge control system. It is the responsibility of the Control Systems Engineer to coordinate the assembly and staging of equipment at one facility. The Engineer may witness the testing as a complete control system. Ensure testing includes simulation of all control, diagnostics, and maintenance functions. Simulate inputs with toggle switches and outputs with indicator lights. Perform simulations and sequencing at a pace set by the Engineer or his representative. Forcing of contacts or unapproved jumpers will not be accepted during the witnessed test and will be cause for rejection.

Prepare and submit a complete set of test procedures and schedules for approval. Sufficient notice of 30 days prior to testing will be given to the Town so that arrangements can be made. The procedure includes a step-by-step description of all actions or simulations and the expected control response, output, or sequence of outputs.

Include exercising the entire control system simulating failures including loss of utility power, equipment failures, and Emergency Stops in the procedures. Ensure the actual testing demonstrates conformance to the requirements and intent of the Contract Documents.

Correct all discrepancies or other non-conformance issues, as determined by the Engineer or his representative, at no cost to the Town prior to shipment. If retesting is required, perform it at no additional cost to the Town. Furnish a full set of "As-Shipped" schematic drawings to the Engineer prior to shipment to the Bridge site.

Field Devices

Install limit switches in accordance with manufacturer's instructions. Provide all mounting

hardware and supports as required. Install limit switches to allow for field adjustment at construction and for future maintenance. Terminate all limit switches on terminal blocks. Install drainage “T” below takeoff for limit switches on all applicable conduit runs. Submit limit switch target materials, shapes, and mounting methods to the Engineer, for review, prior to installation.

After installation, test switches, in the presence of the Engineer, to determine if operation is as intended. Switches should relay signal to the control console at intended “point of operation.” Switches should provide positive indications with no intermittent signals or flickering of lights on control console. Adjust position of switches as required.

9. BRAKES

Description

General

Provide motor and machinery brakes of mill duty quality, conforming to the ratings, sizes and mounting arrangements as shown on the Plans. For mounting and alignment of the brakes refer to mechanical plans and specs. Note that there are a total of two brakes that are identical. Either/or brake may be designated as the motor or machinery brake.

Provide drum and shoe brakes of 460 Volt/3 phase/60 Hertz, spring applied, and electrohydraulic released thruster type, with external torque tube and associated factory calibrated scales.

All brakes shall be provided by a single manufacturer, with a minimum of 10 years of experience supplying brakes to the movable bridge industry.

Required Features

The brake thrust actuator enclosures shall be of cast aluminum alloy, NEMA 4, and fitted with double shaft seals. The rated stall force of each thruster shall not be less than 135 percent of the thrust actually required to release the brake with the torque adjusted to the continuous rated value. Brakes shall set automatically when power is removed from the thruster motor. Provide thruster motors rated for inverter duty operation.

The thruster hydraulic oil shall specifically be recommended by the manufacturer with an ambient operating temperature range between -13 degrees and +122 degrees Fahrenheit.

Brake shoes shall be designed for easy replacement from either side without disassembling the brake.

Brake-wheels shall be furnished with the brakes by the brake manufacturer. The bores shall be left undersized, and the brake-wheels shipped to the machinery manufacturer, who shall finish-bore and key-seat the brake-wheels and install them on the primary enclosed gear reducer extended input shafts. If the machinery manufacturer prefers to have the bores and keyways finished by the brake manufacturer, all related dimensions and fits shall be coordinated and

submitted to the Designer-of-Record for review prior to machining. The brake-wheels shall have a hub diameter at least 1.8 times the shaft diameter. The brake-wheel hub/shaft connection shall be an ANSI Class FN2 shrink fit. The keyway shall extend the length of the brake-wheel hub. Chrome plated brake-wheels shall not be accepted.

Submit certified prints from the manufacturer to the Engineer for review and approval, as well as descriptive literature.

Provide thruster actuator with an independent internal time delay valve constructed of stainless steel, adjustable between 0 and 5 seconds for setting the brake. Provide for step-less adjustment between the minimum and maximum settings, adjustable with the brake in full service.

Provide brake wheels of ductile iron of a grade recommended by the brake manufacturer, pilot bored for finish boring and keying at the machinery supplier. Submit intended finish bore and key-seat dimensions with the shop drawing submittals from the brake supplier. Check, document and submit “run-out” measurements for all brake wheels. Dynamically balance all brake wheels 16” diameter and larger.

Provide a manual release lever and a device for holding the brake in the released position. Mount the hand release attachment permanently on the brakes, arrange such that the brake can be released easily and quickly without the use of tools or apparatus not permanently attached to the brakes. Provide a hand release that can be released without removing the brake cover. Ensure the mechanism latches in both the released and non-active positions and provides, at a minimum, 90% of the power release stroke and does not inhibit the working stroke of the actuator when fully retracted. Provide release mechanisms that do not require more than 50 lbs of force to release the brake manually. Manual release levers shall be located on the side of the brake away from the adjacent gear reducer.

Limit switches - Three limit switches for each brake; one switch to indicate when the brake is fully set, one to indicate when the brake is fully released, and one to indicate when the brake is hand released.

Coat all items with the manufacturer’s special paint and application process required for corrosive atmospheres

Provide nameplates on the brakes/thrust actuator with the following minimum information:

- Manufacturer
- Model number
- Thrust capacity of the actuator
- Stroke length of the actuator
- Volts, phase, Hz, watts
- Braking torque (both the recommended setting and the maximum torque rating)
- Brake lining material
- Type of hydraulic fluid required in the thrust actuator reservoir

For each brake, provide a removable NEMA 3R enclosure constructed of 12 gauge type 304 stainless steel. Provide hinged lids that permit easy inspection of all brake components and easy

operation of the hand release. Use bolts to fasten the each enclosure to the brake support.

For each brake, provide a thermostatically controlled space heater for corrosion protection which is mounted and wired so as to not interfere with brake enclosure removal.

Motor Brakes

Motor brakes shall be provided with wheels of the diameters as required on the Plans and be factory set to the torque values as shown on the Plans. Physically field verify the brake torque setting to be within +10% and -0% of the factory set torque prior to shipment. Adjust setting as needed in the field to achieve the bascule span operating performance characteristics desired by the Engineer. Note that there are a total of two brakes that are identical. Either/or brake may be designated as the motor or machinery brake.

Machinery Brakes

Machinery brakes shall be provided with wheels of the diameters as required on the Plans and be factory set to the torque values as shown on the Plans. Physically field verify the brake torque setting to be within +10% and -0% of the factory set torque prior to shipment. Adjust setting as needed in the field to achieve the bascule span operating performance characteristics desired by the Engineer. Note that there are a total of two brakes that are identical. Either/or brake may be designated as the motor or machinery brake.

Construction Requirements

Brakes should not be set at torque values more than 90% of their continuous rated capacity for normal operation. They should be factory set to the torque shown on the drawings.

Sequence the brakes on the leaf using time delays initially set as follows:

- One of two brakes to be set with 1-2s time delay
- One of two brakes to be set with 3-4s time delay

Final delay settings shall be based on field testing and at the discretion of the Engineer.

Refer to the mechanical plans and specifications for additional construction requirements for the brake assemblies.

10. SURGE SUPPRESSION SYSTEM

Description

Furnish and install surge suppression equipment as described in this article and shown in the Plans. Transient voltage surge suppression as outlined herein applies to all the electrical power, control, and utility, systems and circuits, which are provided or connected to as part of this contract.

Materials

General

Provide Surge Protective Devices (SPD) that are UL listed and labeled for the location in which they are to be installed.

Suppressors for Electrical Services

Install Transient Voltage Surge Suppressors i.e. Lightning Arrester, on each normal and emergency service entering and leaving the tender house. Bridge house service entrance points are typically remote from the power source and thus are to be considered delta configuration for transient protection purposes. Furnish suppressors that provide clamping phase to phase and from each phase conductor to ground.

Provide suppressors that meet the following criteria: Single impulse withstand rating of 25,000 Amp (8 by 20 μ S waveform) per phase; Pulse lifetime rating (10,000 A - 8 by 20 μ S plus power-follow) of 1000 occurrences; Maximum clamping voltage (voltage with input current of 10,000 A - 8 by 20 μ S) of approx. 400 percent normal voltage and energy rating of 10,000 joules.

Suppressors for Feeders and General Purpose Branch Power Circuits

Install transient Voltage Surge Suppressors rated for Type 2, on each power feeder, general purpose branch circuit, and non-motor load circuit (including lighting and signaling circuits) entering or leaving the tender house. Provide multi-stage hybrid shunt-series-shunt design power circuit suppressors inserted in series with all conductors of a circuit (including neutral) and clamping between all conductors and from each conductor to ground.

Rate suppressors for dedicated loads for a minimum of 125 percent of their continuous load. Rate suppressors for utility circuits on the basis of the circuit overload protection. Provide visible indication of suppressor failure. Arrange shunt TVSS elements to fail open.

Provide power circuit suppressors that meet or exceed the following minimum criteria: Single impulse withstand rating of 10,000 A (8 by 20 μ S waveform) plus power-follow per wire; Pulse lifetime rating (3,000 A - 8 by 20 μ S plus power-follow) of 1,000 occurrences; Worst case response time of 5 η S; Maximum clamping voltage (voltage with input current of 3,000 A - 8 by 20 μ S plus power-follow) of approx. 400 percent normal voltage and minimum energy handling capability of 1,500 joules.

11. MANUAL TRANSFER SWITCH

Description

Contractor shall furnish, deliver, install and test the manual transfer switch as specified herein and in accordance with the drawings. The purpose of the Manual Transfer Switch is to manually transfer power to an alternate source. The most common application is transferring power from a generator to the load during utility failures

Quality Assurance

Manual transfer switch shall be UL listed and labeled under the UL 1008 standard. Manual transfer switch manufacturer shall provide a complete factory assembled, wired and tested manual transfer switch, and shall submit UL 1008 certification of authenticity.

Manual transfer switch shall be factory Hi-pot tested for a period of not less than 60 seconds and shall meet all applicable NEC standards.

Submittals

Contractor shall submit manufacturer's drawings and data of manual transfer switches for Engineer's approval prior to start of fabrication. Drawings and data shall include, as a minimum, dimensioned general arrangement drawings and wiring diagrams, UL listing information including UL control or file number, OSHPD "OSP" certification number, short circuit rating or withstand rating, component data, mounting provisions, conduit entry locations and installation instructions.

Upon installation of manual transfer switches Contractor shall submit manufacturer's Operating & Maintenance Manual which shall include as a minimum:

- Certified as-built General Arrangement drawings and Wiring Diagram.
- Materials / Component List including part numbers.
- Maintenance and service requirements.
- Certificate of Compliance and hi-pot test data.

Warranty

Manual transfer switches shall be covered by manufacturer's warranty for a minimum period of (1) one year after shipment from manufacturer.

Products

General

All equipment shall be new. Manual transfer switch manufacturer must have produced and sold UL 1008 Listed manual transfer switches as a standard product for a minimum of (3) years.

Manual transfer switches shall be molded case circuit breaker, knife switch or fused switch type.

Contractor shall be responsible for the equipment until it has been installed and is finally inspected, tested and accepted in accordance with the requirements of this Specification.

Manufacturers: Schneider Electric, Eaton General Electric or approved equal.

Manual Transfer Switch

Manual Transfer Switches shall have an external handle for switching, shall be interlocked with the enclosure door to prevent opening while in either “ON” position and shall be padlockable in every position

Manual transfer switch enclosure shall be NEMA Type 4X SS, constructed of continuous seam-welded, powder coated galvalume steel. Portable generator receptacle at the the bottom of enclosure. A cap shall be provided to cover the receptacle opening when not connected. Rating of receptacle shall be equivalent to the rating of the manual transfer switch.

Manual transfer switch shall be suitable for use as service equipment in the USA as defined by the NEC.

Manual transfer switch shall include permanently affixed operation instructions.

Construction Requirements

Installation

Prior to installation of the manual transfer switch, Contractor shall examine the areas and conditions under which the manual transfer switch is to be installed and notify the Engineer in writing if unsatisfactory conditions exist.

Manual transfer switch shall be installed as depicted on the drawings and per the manufacturer's written instructions. In addition, the installation shall meet the requirements of local codes, the National Electrical Code and National Electrical Contractors Association's "Standard of Installation".

Conduit entry into the manual transfer switch shall be by Contractor; Contractor shall furnish and install UL listed watertight conduit hubs, as manufactured by MYERS, T&B or other for each conduit entry on the manual transfer switch. The incoming hub size shall match the conduit size for feeders and ground as shown on the drawings. The outgoing hub size shall match the conduit size for loads and ground as shown on the drawings.

Any conduit penetrations that are above live parts must be properly sealed to prevent moisture intrusion from the conduit. A UL Listed or Classified expanding foam sealant (such as Rainbow Quick Seal 79547), or other sealing product meeting local codes and NEC requirements should be used to seal the interior of the conduit around the cables. The product selected must be able to permanently seal around all wires and the conduit (common "Duct Seal" is not acceptable for this application). The sealing shall be done at the entry into the enclosure so the seal can be verified and inspected from inside the enclosure. Failure to seal may allow water to drip on live parts and will void warranty. Hubs shall be properly installed and tightened to maintain Type 4X integrity of the manual transfer switch enclosure.

Contractor shall terminate feeder conductors, load conductors and ground per the manufacturer's instructions. All field wiring terminations shall be torqued as required per the instructions on the manual transfer switch's power distribution block & ground lug.

Field Testing

Prior to energizing manual transfer switch, the Contractor shall perform the following checks and tests as a minimum:

- Verify mounting and connections are complete and secure.
- Verify internal components and wiring are secure.
- Perform continuity check of all circuits.
- Perform 1,000 VDC megger test on feeder, load and ground cables.
- Verify dead front is secure.
- Confirm operation of generator receptacle by connecting a portable generator and operating bridge on generator power.

END OF SECTION

107.11

SPAN DRIVE MACHINERY

LUMP SUM

DESCRIPTION:

The work for Span Drive Machinery consists of replacement of the span drive operating machinery at the approach pier below the operator's house, up to and excluding the intermediate open gearing, as indicated in the Plans. This work shall include installation and alignment of associated electrical indication equipment. This work includes installation of new machinery support framing.

The work shall be coordinated with any bridge roadway and waterway outage schedule as needed.

Contractor shall field verify all indicated measurement herein at the bridge site prior to submitting shop drawings.

Contractor shall ensure coordination and sequencing of this work with all other work and disciplines.

GENERAL REQUIREMENTS:

(1) Submittals

- (a) Bridge site field measurements report and drawings to document existing dimensions and locations of all interface points between existing surfaces. Indicate field verified dimensions that will be shown on shop drawings. Attention is called specifically here to verifying the form and spacing of existing steel framing and fit up of new supports and equipment to the existing structure.
- (b) Manufacturer's data and/or shop drawings shall be submitted for all manufactured and purchased items of machinery.
 - 1. Shop drawings shall show all parts completely detailed and dimensioned. Reproduction of the Plans shall not be used as foundation sheets for assembly or erection drawings. Shop drawings shall include assembly drawings.
 - 2. The Contractor shall prepare and submit shop drawings to the Department for acceptance prior to fabricating the material.
 - 3. Shop drawings shall include, but not be limited to, field measurements, installation plans, material lists and material designations. The weight of the detailed elements shall be included on the shop drawings.
 - 4. Materials and material specifications shall be stated for each part. Where standard specifications are used, the applicable designation of such material specifications shall be given.

5. Submit catalog cuts of new components.

- (c) Work Procedure: Submit a detailed list of the work procedure to be followed.
- (d) Task Schedule: Schedule of work that requires interruption to movable span operation and track usage or channel navigation. Provide work activities for each day and the duration of the restriction.
- (e) Certified material test reports: Include all chemical and mechanical properties for each material that is part of the Work.
- (f) Test Reports: All measurements after field adjusting and testing.

(2) Delivery and Storage

- (a) Machinery parts shall be cleaned of dirt, chips, grit, and all other injurious materials prior to shipping. 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. this coating shall be removed from all surfaces prior to lubrication of machinery.
- (b) At any interface between stainless steel or aluminum and steel, the steel shall be coated with primer prior to assembly.
- (c) Machinery parts shall be completely protected from weather, dirt, and all other injurious conditions during manufacture, shipment, and storage.
- (d) 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.
- (e) Assembled units shall be mounted on skids or otherwise crated for protection during handling and shipment.
- (f) Spare parts as defined in the Plans shall be protected for shipment and prolonged storage by coating, wrapping, and boxing. All spare parts shall be durably tagged or marked with a clear identification showing the designation used on the approved shop drawing. Boxes for spare parts shall be clearly marked on the outside to show their contents.

(3) Guarantees and Warranties

- (a) Manufacturer's warranties or guarantees on equipment, materials or products purchased for use on the Contract which are consistent with those provided as customary trade practice, shall be obtained by the Contractor and, upon substantial completion of the contract, the Contractor shall assign to the owner, all manufacturer's warranties or guarantees on all such equipment, material or products furnished or installed.
- (b) The Contractor shall warrant the satisfactory in-service operation of the mechanical equipment, material, products, and related components. This warranty shall extend for a period of one year following the date of final acceptance of the Project.

(4) Quality Assurance

- (a) Products used in the work shall be produced by manufacturers regularly engaged in the manufacture of the specified products.

- (b) For the fabrication, installation, and testing of work required by the machinery items, 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 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 machinery.
- (c) The Contractor shall provide all reasonable facilities, necessary tools and instruments required for the proper performance of the personnel engaged in the execution of the specified work.

(5) Codes and Standards

- (a) Work shall comply with, but not be limited to, all applicable requirements of the following codes and standards and their abbreviations used in this Specification:
 - 1. American Association of State Highway and Transportation Officials (AASHTO)
 - 2. American Iron and Steel Institute (AISI)
 - 3. American National Standards Institute (ANSI)
 - 4. American Society of Mechanical Engineers (ASME)
 - 5. American Society for Testing and Materials (ASTM)
 - 6. American Welding Society (AWS)
 - 7. National Lubricating Grease Institute (NLGI)
 - 8. Society of Automotive Engineers (SAE)
 - 9. Steel Structures Painting Council (SSPC)
 - 10. United States Military Specifications (MIL)
 - 11. Anti-Friction Bearing Manufacturers Association (AFBMA)
 - 12. National Fluid Power Association (NFPA)
 - 13. National Lubricating Grease Institute (NLGI)
 - 14. Occupational Safety and Health Administration (OSHA)
 - 15. Society of Automotive Engineers (SAE)
 - 16. National Electric Code (NEC)
 - 17. National Electrical Manufacturers Association (NEMA)
 - 18. Underwriters Laboratory, Inc. (UL)
- (b) 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 attention to them; it is not intended to imply that any other codes and standards shall be assumed to be omitted if not mentioned.

(6) Measurements and Verification

Dimensions indicated on the Contract Drawings are nominal based on limited field verification and availability of existing "As-Built" drawings. Contractor is to field verify all indicated measurements herein and on the plans at the bridge site. Field verification may include partial or complete disassembly of existing components. The contractor is urged to schedule any disassembly and reassembly prior to any other work as early as possible where field verification may be needed to finalize new parts and/or assembly details. Attention is called specifically to components replaced in-kind, and specifically to any existing mounting bolt holes in the existing structure to be re-used. New flanges, hubs or other fits, including turned bolt fits, shall be adjusted based on measuring the existing structure, including any cleanup needed to restore surface conditions. In all such cases, the sizes shown on the plans shall be the minimum sizes. Final sizes and/or custom fit tolerance ranges shall be submitted for approval on the shop drawings.

In general, the machinery removals shall be performed prior to this work, as well as cleaning of all rust, grease and dirt from the areas and materials to be reused.

Notice shall be given to allow the Engineer to witness and review field verification efforts on site.

(7) Substitutions

- (a) The terms "approved equal", "of equal quality" and "or equal" which may appear on the Contract Drawings and in these Specifications are intended to allow the Contractor to submit for review other manufacturers and model numbers of products of equal quality and rating for those specified.
- (b) Prior to the Contractor's ordering of any substitute product, the Engineer's acceptance 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.
- (c) Acceptance 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.
- (d) Where a 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 made by another manufacturer may be submitted for review for the specified product subject to the acceptance of the Engineer; however, all necessary changes required by the substitution in related machinery, structural, architectural and electrical parts, and scheduling shall be made by the Contractor at no additional cost to the Town.

(8) Inspection

- (a) The Contractor shall give no less than ten (10) working days' notice to the Department of the beginning of work at foundries, forge, and machine shops so that inspection may be provided. No materials shall be cast, forged, or machined before the Department has been notified where the orders have been placed.

- (b) 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 Department 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.
- (c) The Inspector will have the authority to reject materials or workmanship which does not fulfill the requirements of these Specifications.
- (d) Inspection at the foundries, forge, and machine shops is intended as a means of facilitating the work and avoiding errors. It is expressly understood that inspection will not relieve the Contractor from any responsibility regarding material or workmanship and the necessity for replacing defective materials or workmanship which are delivered to the job site.
- (e) The Contractor shall furnish the Department with a copy of all orders covering work performed by subcontractors or suppliers.

(9) Defective Materials and Workmanship

- (a) The acceptance of any material or finished parts by the Department shall not prohibit their subsequent rejection if found defective. Rejected material and workmanship shall be replaced or made acceptable by the Contractor at no additional cost to the Department.
- (b) All machinery rejected during inspection and testing shall be removed from the work site and replaced at no additional cost to the Department.
- (c) Delays resulting from the rejection of material, equipment or work shall not be the basis of any claim.
- (d) All defects found during the warrantee/guarantee period resulting from faulty material, components, workmanship, or installation shall be corrected by the Contractor at no additional cost to the Department. The Department reserves the right to make necessary corrections with its own forces and charge the resulting costs to the Contractor.

(10) Work Procedures

- (a) All labor, materials, tools, equipment, services, testing, insurance, and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these Specifications shall be provided by the Contractor. The Contractor shall be prepared to work all shifts and weekends throughout the course of this project.
- (b) Prior to beginning work, the Contractor shall review conditions at the site for verifying measurements, assessing existing conditions, and safety reasons. In addition, the Contractor shall instruct all workers in all aspects of personal protection, work procedures, movable bridge operation, emergency evacuation procedures and use of equipment including procedures unique to this project.
- (c) Shut down and lockout/tagout operating machinery electrical power while working on equipment.
- (d) Whenever the contractor is not at the bridge site the span is to be operational unless work is done during an approved navigation or track outage.

- (e) Provide temporary supports, rigging, or access as needed to facilitate all work.
- (f) Submit a schedule of all work that requires interruption to movable span operation and restrictions to either track outage or channel navigation for review and acceptance. Provide work activities for each day and the duration of the restriction.

MATERIALS:

(1) New R1 Gear Reducer

- (a) The R1 gear reducer shall be as shown on the Plans. This shall entail an enclosed gear reducer, rated for 11.25HP at 70RPM input speed at an AGMA service factor of 1.0, minimum output torque rating of 205 inch-kips. The unit shall have an approximate ratio of 21:1. There shall be double extended input and output shafts with shaft extension details as shown on the plans and as meets the fit requirements for the connected components (brake wheels and couplings).
- (b) The reducer shall be similar to a Nuttall type TDS size D12 gearbox. This is used to establish basic requirements and form of the box. The actual furnished box shall be a custom design by the manufacturer made to order. All details shall be submitted on shop drawings for approval.
- (c) The unit shall meet all material requirements as provided herein.

(2) Couplings

- (a) Provide new C1, C2, C3, and C4 couplings as shown on the plans. These shall be standard manufacturer's products.
- (b) The couplings shall meet all material requirements as provided herein.
- (c) The C1 couplings include a shaft locking device assembled at one half with a standard rigid coupling hub. The shaft locking device shall be as shown on the plans. This shall be a manufacturer's proven product, such as a Lovejoy SLD2600 or approved equal. The performance and capacity shall be certified by the manufacturer. Coordinate the tolerances at the shaft journal, shaft locking device bore and outer diameter, and rigid hub bore.

(3) B1 Bearings

- (a) Provide new B1 bearings as shown on the plans, two identical assemblies.
- (b) Bearings shall be bronze bushed, split bushings in custom split pillow block housings as shown and meet all material requirements as provided herein.

(4) Shafts

- (a) Provide new line shafting as shown on the plans. Shafts shall be ASTM A668 Class G forgings unless otherwise noted and otherwise meeting the materials requirements herein.
- (b) Shafts shall be machined to the required fits at each coupling and bearing.

(5) Gearmotor

- (a) Provide one new primary span drive operator gearmotor as shown on the plans. This shall be an integral gearmotor of standard manufacture. The motor shall be vector duty 7.5HP, 460V, 3PH, 60HZ, Nema design D rated.
- (b) Provide a rear mounted encoder with the motor.
- (c) Provide a rear shaft extension on the motor, through the encoder, that shall be cut square to accept a manual drive. Size shall be the largest standard inch square socket size inscribed and cut from the shaft diameter per standard Nema frame dimensions. Manual drive may be used with either a hand wheel, crank or portable drill. Coordinate with Town maintenance and operation staff. The existing equipment includes a similar arrangement and existing tool used for manual operation. The maximum torque of any manual tool shall not exceed 225% FLT of the motor. For wheels, cranks or similar this shall be taken as an applied 70lb force at the radius to the grip (wheel rim, crank handle etc.).
- (d) Gearmotor shall be similar to a Nuttall type G, unit G213T43D.
- (e) The motor is an electrical item. Refer to the electrical plans and specifications for further details.
- (f) Coordinate the gearmotor output shaft form with the required fit up to the C3 coupling. Gearmotor output shaft shall be 2.5" diameter.

(6) Brakes

- (a) Provide two new BR1 brake assemblies as shown on the plans. Brakes shall be equivalent to Mondel 12 inch MSTE-ED50 units.
- (b) Brakes shall be electro-hydraulically released, spring set, with adjustable torque setting and external spring, adjustable set time delay, rated for 720ft-lbs of maximum torque.
- (c) Brakes shall be set to 600 ft-lbs. Actual brake torque shall be validated via use of a calibrated torque wrench at assembly, and the spring scales modified to reflect the proven values as needed.
- (d) There is one left-hand and one right-hand unit required. Left/right hand refers to the location of the hand release levers, and form of the covers/enclosures. All else shall be the same between each unit. Coordinate as needed for final placement. See Plans.
- (e) Provide set time delays of 1-2 seconds at one unit, and 3-4 seconds at the other unit.
- (f) Brake wheels shall be mounted to the shafts as shown on the plans with an FN2 fit and key. Keys shall match the key size and requirements used at the adjacent C3 coupling, and bear across the full width of the brake wheels. Mount brake wheels in the shop.
- (g) The brake wheel shall have a runout of not more than 0.003" TIR, measured after mounting.
- (h) Perform bedding of the brake pad shoes such as achieves conformed contact between the pads and brake wheel. Take care not to overheat the pad material.
- (i) In general, installation and function shall be as per the manufacturer's instructions except as specifically required herein or on the plans.
- (j) Brakes are taken as electrical items. Refer to the electrical specifications for further

information.

MATERIAL REQUIREMENTS:

(1) Forgings

- (a) Carbon Steel and Alloy Steel Forgings shall meet the requirements of ASTM A668 or as shown on the Plans.
- (b) All forgings shall be reduced to size from a single bloom or ingot until the cross-sectional grain is homogeneous. The blooms or ingots shall have a cross-sectional area at least three times that required after finishing. No forging shall be done at less than a red heat.
- (c) Unless otherwise indicated, perform for each forging:
 - 1. Magnetic Particle exams in accordance with ASTM A275 and ASTM E709 performed by fabricator after finish machining.
 - 2. Ultrasonic exams in accordance with ASTM A388 performed by foundry.
 - 3. All other testing or criteria as established by the specified material specification of the forging.
- (d) Forgings acceptance based on non-destructive test free of indication of discontinuities unless otherwise noted or acceptance criteria of the forging material standard.
- (e) Forgings that are welded for fabrication of the completed machinery part shall have carbon content limited in accordance with Supplementary Requirement S4.
- (f) No tack welding on forged materials is permitted for lugs to aid with handling materials.
- (g) Submit certified factory and material test reports for forgings unless otherwise noted.

(2) Castings

- (a) Take all necessary precautions to fabricate the castings true to pattern in form and dimensions, free of pouring faults, cracks, cold shuts, blow holes and other defects.
- (b) Clean all castings of loose scale and sand, remove all fins, seams, gates, risers and other irregularities. All unfinished edges of castings shall be neatly cast with rounded corners and all inside angle shall have ample fillets.
- (c) Remove surface defects by rough machining prior to final heat treatment.
- (d) All castings shall be visually inspected in accordance with and otherwise meet the requirements of ASTM A802 and meeting Level II criteria.
- (e) Additional requirements may be required for critical components as specified for those components in the plans and specifications. Any requirements included in the specified material specification of any casting shall also be met. Unless otherwise specified, general references to the following test types shall meet:
 - a. Magnetic particle testing shall be done in accordance with ASTM A781. Note that this is a mandatory requirement of many of the casting material specifications such

as ASTM A27 and A148 and shall be performed where those materials are specified.

- b. Ultrasonic testing shall be done in accordance with ASTM A609 Method A. Castings undergoing this test shall be required to meet Quality Level 2.

(3) Fasteners

- (a) Machinery fit, high-strength turned bolts shall meet the requirements of ASTM F3125 Grade A325 or A449 high strength bolts with a finished full body diameter. The finished body or shank diameter shall have a tolerance that meets an ANSI LC6 fit with a field reamed hole. Bolt bodies shall have a straightness tolerance of 0.002 inch. Polish or machine the bolt diameter to achieve an overall body diameter deviation within the given shaft tolerance of an LC6 fit for the entire lot of finished body bolts. The finished body diameter shall be equal or greater than the thread major diameter after polishing or machining the bolt.
- (b) High strength bolts shall be connected using nuts meeting the requirements of ASTM A563.
- (c) Finished shanks of turned bolts shall be 1/16-inch larger in diameter than the diameter of the thread, unless otherwise noted. Where specified, order full body bolts with 1/64-inch oversized diameter, or for bolts greater than 1-3/8-inch diameter order 1/32-inch oversized diameter. The shanks of all turned bolts shall have Class LC6 fit in the finished holes in accordance with ANSI Standard B18.2. Turned bolts shall be fully detailed on shop drawings.
- (d) Hex socket flat countersunk head cap screws shall conform to ASTM F879 (Stainless Steel) for diameters less than 7/8" and ASTM F835 (Alloy Steel) for diameters equal or greater than 7/8".
- (e) 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.
- (f) 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 1/4 inch smaller in diameter than the bolt diameter and shall be reamed assembled for the proper fit at assembly or at erection with the steel work after the parts are correctly assembled and aligned.
- (g) All elements connected by bolts shall be drilled or reamed assembled to assure accurate alignment of the holes in each element and accurate clearance over the entire shank length of the bolt.
- (h) High-strength bolts shall be installed with a hardened plain washer meeting ASTM F436 at each end.
- (i) Fasteners less than 1/2-inch diameter to be stainless steel AISI type 304.
- (j) Anchor bolts connecting machinery parts to masonry shall conform to ASTM F1554 Grade 55, unless noted otherwise.

- (k) Except for turned bolts all bolts, screws, anchors, nuts, and washers shall be hot-dipped galvanized in accordance with ASTM A153 unless noted otherwise.
- (l) Split lock washers shall conform to the SAE regular dimensions. The material shall meet the SAE tests for temper and toughness.
- (m) All cotters shall conform to the SAE standard dimensions and shall be made of half-round stainless-steel wire, ASTM A276, Type 304.
- (n) All fasteners shall be of United States manufacture and shall be clearly marked with the manufacturer's designation.

(4) Shafts and Pins

- (a) 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.
- (b) All shafts and pins shall conform to tolerances in ASTM A29 unless otherwise indicated. Turned, ground and polished straightness tolerances shall be 0.001 inches per foot for shafts up to and including 1-1/2 inch in diameter and 0.002 inches per foot for shafts over 1-1/2 inches in diameter.
- (c) 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.
- (d) All pins shall be ASTM A668 class K forging unless otherwise shown on the Plans.
- (e) All hubs mounted on the ends of 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 shaft 1/16 inch larger than the nominal diameter specified and shall turn the ends to the required dimension for the hub.
- (f) Turned, ground, and polished shafts of the material and grade specified shall be used where shown on the drawings.
- (g) All journal-bearing areas on shafts and pins shall be accurately machined and polished, with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. Burnishing of the shaft journal areas and adjoining shoulder fillets will be acceptable in lieu of polishing provided that the burnishing is done with a Stellite roller or equal, finished to a mirror surface. The surface finish of shaft journals shall be as shown on the drawings. Journal diameters shall be finished to the limits of an ANSI Class RC6 running fit.
- (h) After field installation of shafts supported in bearing the circular run-out tolerance shall be measured and recorded. Run-out requirements:
 - 4. Shafts: 0.005-inch FIM (Full Indicator Movement)
 - 5. Pins: 0.002-inch FIM
 - 6. At any measuring position when the part is rotated 360 degrees about the datum axis with the indicator fixed in a position normal to the true geometric shape.

(5) Keys and Keyways

- (a) Keys and keyways or keyseats shall conform to the dimensions and tolerances for square and flat keys of ANSI Standard B17.1, Keys and Keyseats, unless otherwise specified. Fit of keys in their keyseats shall meet a Class 2 fit unless otherwise specified.
- (b) All keys shall be effectively held in place, preferably by setting them into closed-end keyways milled into the shaft. The ends of all such keys shall be rounded to a half circle equal to the width of the key. Keys in open end keyseats such as with couplings shall be held with a set screw against the top of the key.
- (c) If two or more keys are used in a hub, they shall be located 120 degrees apart. In those cases, the fit between keys and keyways shall conform to an ANSI B17.1 Class 1 fit.
- (d) Unless otherwise specified herein or in the drawings, keys shall be machined from carbon steel forgings, ASTM A668, Class K.

(6) Hubs and Collars

- (a) Hubs shall be finished and polished to 16 micro-inch rms where the hub face prevents axial movement. The hubs shall be bored concentric with the pitch-circle of gears or the hub's outside diameter. All hubs shall have an ANSI Class FN2 fit on the shafts, unless otherwise specified. Machine keyways into hubs as defined herein.
- (b) Collars for holding shafts axially shall be either shrink disc or clamp type.
 - 7. Clamp type collars are to be heavy-duty two-piece collars made from black oxide steel and clamped with high-strength forged alloy steel screws.
 - 8. Manufactured by Ruland, Marlborough, MA or approved equal.

(7) Open Gearing

- (a) Where required, provide fabricated and mounted spur gears in accordance with ANSI/AGMA 2015-1-A01, Accuracy Classifications System – Tangential Measurements for Cylindrical Gears, unless otherwise specified herein or shown on the Plans.
- (b) Open gearing shall meet or exceed either (AGMA Quality Q7 - ANSI/AGMA 2000-A88) or (AGMA Accuracy Grade 10 per ANSI/AGMA 2015-1-A01 and 2015-2-A06).
- (c) Test gear mesh and provide tip relief to avoid interference.
- (d) The teeth of all gears shall be cut from solid rims or blanks. The working surfaces of all gear teeth shall be smooth, and free from milling cutter ridges. Remove cutter burrs from all edges of the teeth, and round the top edges of all teeth to a 0.03-inch radius.
- (e) Finish the sides and peripheries of all gears and pinions and scribe the pitch circle on both sides not less than 0.020 inches deep with a V-pointed tool.
- (f) Backlash shall be provided in accordance with the AGMA recommended backlash range for coarse-pitch spur gears.
- (g) Final alignment of gearsets shall be accepted when the backlash is within the approved range, when there is no more than 0.010" per foot cross mesh, and when the tooth contact is at least 80% across the width of the contacting tooth surfaces at all teeth full around the gears. The contractor shall demonstrate acceptable tooth contact by using contact fluid on the contacting

surfaces during the field testing of the machinery. Final alignment shall be measured and approved by the Engineer. Note that where new gears are meshed to existing gears, the alignment criteria shall be per the Engineers discretion and otherwise based on achieving the best alignment possible given the existing/worn conditions.

(8) Gear reducers

- (a) Gear reducers shall be custom models from one manufacturer, with ratios, dimensions, and construction details shown on the Plans, and conform to AGMA standard 6013. Reducers shall have nameplates with the following information:
 - a. Size
 - b. Ratio
 - c. Service Power Rating
 - d. Shaft Speed
 - e. Service Factor
 - f. Lubrication Specification
 - g. AGMA Certification Symbol
- (b) Gear teeth shall be through-hardened and conform to the requirements of AGMA and AREMA. Case-hardened gear teeth shall not be permitted in the main drivetrain.
- (c) The AGMA yield strength rating shall be based on a torque equal to 300 percent of full load motor rated torque. The stress in any part of the gears and shafts shall not exceed 2/3 of the material yield strength at this load. This is a static stress state requirement.
- (d) Gearsets shall be designed for bending strength and pitting resistance as per AGMA standard 2001-D04.
- (e) Gears shall have helical or herringbone teeth. Gearing in enclosed factory assembled gear reducers shall meet or exceed either (AGMA Quality Q9 - ANSI/AGMA 2000-A88) or (AGMA Accuracy Grade 8 per ANSI/AGMA 2015-1-A01 and 2015-2-A06).
- (f) Pinions shall be proportioned so that the root diameter of the pinion is not smaller in diameter than the diameter of the journals for the pinion shaft. Suitable fillets and radii shall be provided at all corners and shaft transitions.
- (g) Bearings shall be anti-friction type in accordance with AFBMA and L-10 life of 40,000 hours. Reducer bearings which are grease lubricated shall be fitted with readily accessible grease fittings, as well as purge ports. Internal seals between the bearing housing and the gear oil shall prevent interaction between them (oriented for retention). On shaft output extensions, seals shall be spring loaded lip seals as recommended by the manufacturer of the bearings and be provided with grease fittings for greasing the seals. These shall be double lip seal arrangements or otherwise as approved on the shop drawings.
- (h) Housings shall be steel castings or welded steel plate, which shall be stress relieved. The inside of the housings shall be sandblast cleaned prior to assembly and be protected from rusting with special oil-resistant crankcase paint or approved equal. Reducer foundations shall extend past the body of the reducers to allow for mounting bolt hole reaming and bolts installation from above the mounting flanges.

- (i) Inspection covers shall be provided such that all gears, bearings and internal devices are readily visible when the covers are removed. Covers shall be located above the oil bath so that draining the speed reducer is not necessary to examine any interior components. Inspection covers shall be provided with seals or gaskets that do not require replacement when the covers are removed.
- (j) Lubrication of the gears and bearings shall be automatic when the unit is in operation. It is preferable that a bath lubrication system be utilized. In a bath lubrication system, all components in the reducer which require lubrication are partially submerged in the oil bath. When the configuration of gears and bearings prevent bath lubrication, a splash lubrication system should be used. Splash lubrication systems shall continuously lubricate all gears and bearings properly. Oil feed troughs may be used to supply oil to bearings and gears which are above the bath. Splash lubrication systems shall be designed such that equal lubrication is supplied to each internal component for both directions of operation. Gear reducers shall have provisions for oil expansion due to churning and temperature change.
- (k) Do not use pressurized lubrication systems for gear reducers unless specifically approved by the Engineer or specified in the Contract Documents. When a pressurized lubrication system is required for the reducer, provide a redundant lubrication system so that both systems operate concurrently. If a lubrication system malfunction can occur, provide a contact for remote alarm indication. Any forced lubrication system shall be interlocked with bridge operation in the electrical control system such that the equipment cannot be operated if the lubrication system is not functioning.
- (l) Reducers shall be furnished with a moisture trap and particle filter breather. The filter can be either reversible flow media or desiccant type. Particle filtration to be rated for 10 microns or less. Moisture trap must always maintain a lower dew point inside the reducer than ambient air dewpoint even when shut down overnight. Breathers shall be located above maximum oil levels in all positions of the reducer during operation, and its piping shall enter the unit at the highest point possible. Breathers shall not be mounted in bearing caps.
- (m) Provide an oil level indicator.
- (n) Oil drains shall be located at the lowest point possible. The drain shall have a bronze ball valve full port size with hand-operated lever that can be locked in the closed position. Valve is to have adjustable packing gland, blow-out proof stem design, PTFE seats and stuffing box ring, and hardened ball. Both ends to have NPT threads and include a threaded end plug. The drain valve shall overhang the machinery support and structure such that oil can be readily drained in the as-installed condition.
- (o) Oil fill and sampling plug ports shall be in accessible positions on the reducer. Plugs to have either hex or square head and with NPT thread and seal.
- (p) Shaft extensions shall be of the arrangement, lengths, and diameters shown on the drawings. Couplings shall be pressed on the shafts in the shop.
- (q) The manufacturer shall submit for approval a certified print of each gear reducer showing as a minimum the following:
 - 1. All external mounting dimensions including shaft sizes, bores, keyseats, and reducer

weight.

2. Internal drawings showing each gear box component with part numbers.
3. The ratings that will appear on the nameplate.
4. Location of all lubricant connections.
5. Lubrication recommendations and filled oil volume.

(r) Recommended Gear Reducer Manufacturers:

6. Nuttall Gear, Niagara Falls, NY
7. Overton Chicago Gear, Chicago, IL
8. Steward Machine. Birmingham, AL

(9) Bearings and Bushings

(a) Bushings

1. Sleeve bearing bushings material to be bronze ASTM B22 Alloy UNS C93700 unless otherwise shown on the Plans.
2. For split bushings, the outside diameter fit between bushing and housing shall be ANSI LC1 class fit. Double flanged bushings shall have the same fit between flanges and the end faces of the base and cap. Finish bores to achieve the fit with the shaft journal as specified in the Plans. Turn bushings with a predetermined gap between halves to suit the liner or shim thickness. The total thickness of liners in each bushing set shall include at least 1/8-inch laminated construction, permitting adjustment in increments of 0.003 inches. Liners shall be cut to fit shoulder fillets, shall be square with bushing flanges, and shall have bolt holes drilled through them.
3. All grease lubricated, and solid self-lubricating bronze bushings shall have grease grooves cut in a pattern as indicated in the Plans. All grease grooves shall be machine cut and smooth. The corners of all grooves shall be rounded to a minimum 1/8-inch radius, unless otherwise shown on the Plans. In cases of solid or split bushings required to support axial loads, provide flanges with grease grooves connected to the grooves in the bushing bore.
4. For solid bushings provide fits between the bushing outside diameter and housing and between the bore and the shaft as specified in the Plans.

(b) Pillow Blocks

1. Provide pillow blocks with turned bolts or turned studs for caps that meet or exceed the requirements of ASTM A449. Bearing housing material shall meet or exceed requirements of carbon steel ASTM A36 or cast steel ASTM A148 Grade 80-40.
2. Housings and cap bolts shall be capable of withstanding design radial and axial loads including uplift. Split bearing housings shall be keyed or doweled together to establish and maintain the bore for the bearing and to eliminate shear loads on the cap bolts. Provide bearing housings equipped with seals, end covers, bearing retainers, lube fittings, and vents.
3. Pillow block and flange-mounted roller bearings shall be adaptor mounting, self-aligning expansion and non-expansion types as called for on the Plans.

4. Undersized mounting holes shall be drilled from the solid in the shop to ensure perpendicularity and location. Seals shall retain the lubricant and exclude water and debris. Cap bolts on pillow blocks shall be high-strength steel. The cap and cap bolts shall be capable of resisting the rated bearing load as an uplift force.

(10) Couplings

(a) Grid Couplings

1. All grid couplings shall be provided as a complete assembly with new keys, bolts, seals, and gaskets.
 - h. Bore hubs for an ANSI FN2 fit with shafts in the shop.
 - i. Hub keyseats to connected shafting.
 - j. Provide new keys in all cases.
 - k. Spare parts: 1 spare seal kit, and 1 spare flexible steel grid for each size used.
2. Grid-type to be self-aligning, fully torsional flexible couplings.
3. The grid-type couplings shall have steel hubs, alloy steel grids and steel or aluminum covers with shrouded bolts.

(b) Gear Couplings

1. All gear couplings shall be provided as a complete assembly with new keys, bolts, seals, and gaskets.
 - a. Bore hubs for an ANSI FN2 fit with shafts in the shop.
 - b. Hub keyseats to match connected shafting.
 - c. Provide new keys in all cases.
 - d. Spare parts: 1 spare seal kit, and 2 spare coupling bolts for each size used.

(c) Instrument Drive Couplings

1. Provide zero backlash couplings for connecting span control equipment with high misalignment capability.
2. Coordinate coupling hub bore with electrical equipment. Match key seat and bore for an ANSI LC3 fit. Provide a stainless-steel set screw into the top of the key.
3. Instrument drive couplings may be mounted keyless where this meets the suggested option of the manufacturer of the coupling. A set screw or dowel or similar shall be provided at a minimum.

(d) Flexible couplings shall be as manufactured by one of the following companies, or approved equal:

4. Falk Corporation, Milwaukee, WI
5. Lovejoy, Inc., Downers Grove, IL
6. Kop-Flex / Regal, Florence, KY

(e) All couplings shall be final aligned to meet the manufacturer's provided alignment criteria.

(11) Lubrication Materials

- (a) Lubricants – Coordinate all lubricants to be used for the bridge machinery with Town maintenance forces, AASHTO, and the requirements and recommendations of component manufacturers. Submit lubricant information to the Engineer for review and approval as required by the “Submittals” header. Lubricant materials shall comply with all applicable environmental rules, regulations and ordinances as required herein.
- (b) Lubrication Piping & Fittings – All bearings and surfaces requiring lubrication, other than gear teeth, shall be fitted for a pressure system of lubrication using NPS 1/4-inch giant button head fittings, unless otherwise indicated on the Plans. The fittings for greasing bushed bearings shall be tapped into the housing or connected thereto by type 304 stainless steel seamless pipe, which shall be tapped into the housings so that grease will be discharged directly through the housing, shims, bushing, and into the grease grooves for distribution. All grease fittings shall be conveniently located for greasing, and if necessary, shall be connected to the points requiring lubrication from convenient lubrication stations by NPS 1/4 stainless steel seamless pipe - schedule 80 with stainless steel threaded pipe fittings – with an operating pressure of 10,000 psi. All stainless steel pipe and fittings shall meet ASTM A312 and ASTM A182, respectively. All pipe extensions shall be kept as short as practical, shall be securely supported at fittings and intermediate points, and located so that it shall be protected from injury. All lubricating equipment shall be installed in perfect condition.

Not more than two sizes of fittings shall be used. The large size shall be used wherever possible, and the smaller size shall be used for motor bearings and other small devices. Pressure fittings shall be rated at a minimum operating pressure of 10,000 psi. Fittings shall contain a steel check valve that will receive grease and close against back pressure.

Immediately after the completion of fabrication, all fitting locations shall be plugged until components are installed and regular lubrication is started. The plugs shall then be replaced with the proper grease fittings. During installation, the Contractor shall lubricate all rotating and sliding parts of the machinery and fill all gear reducers, bearing housings and flexible couplings with lubricants indicated on approved lubrication charts.

- (c) Lubrication Flexible Hose – For connections between components and elements which move with respect to one another, provide 1/4-inch nominal double walled, double braided, spirally wound, self-draining, corrugated stainless steel flexible hose, type 304. Minimum working and burst pressure shall be 5,800 psi and 23,000 psi respectively.

Lengths of lubrication hose installed shall be sufficient to remain slack throughout the full range of movement of the bascule span including any possible over-travel. The layout of the flexible hose shall not cause bending exceeding the manufacturer’s stated minimum bend radius throughout the full range of movement of the bascule span including any possible over-travel.

Hose shall be equipped with 1/4-inch NPT fittings at each end, one swivel end, male fitting for the bearing end, and one female fitting for the pipe end. The lengths of hoses installed shall not interfere with or rub against bridge elements during opening and closing operations.

- (d) Lubrication Manifolds – Manifold blocks used in the lubrication systems shall be solid blocks of stainless steel, meeting the requirements of ASTM A240 Grade S31600. Faces of

the blocks shall be machined smooth to a 125 micro-inch finish unless noted otherwise on the plans. Grease passages through the blocks shall be ¼-inch diameter. The faces of the blocks shall be tapped as appropriate to accept grease fittings, grease cleanout plugs, lubrication pipes, and lubrication hoses. Grease shall not leak or seep from the manifold blocks or its connections when the system is pressurized to the working pressures of the fittings, pipes, and hoses. The manifold blocks shall be bolted to carbon and alloy steel components and members using bolts complying with ASTM A193 Grade B8M and nuts complying with ASTM A194 Grade 8M. Provide flat plain washers complying with ASTM A240 Grade S31600 under the head and the nut. Torque lubrication manifold fasteners in proportion to their strength.

- (e) Lubrication Piping Supports – Pipes shall be supported at least every 6 feet on center and within one foot of both ends, of any pipe bend and of any hose connection. Type 316 stainless steel, vibration dampening U-bolts shall be used to secure each rigid pipe to the angle support. Each U-bolt shall be provided with a thermoplastic elastomer cushion to prevent chafing.

(12) Machinery Supports

- (a) Machinery supports shall be fabricated from minimum 3/8" thick structural steel ASTM A709 Grade 50 unless otherwise noted.
- (b) Unless otherwise noted or shown on the plans, support weldments shall be welded with continuous welds and all joining edges sealed by welding. Use full penetration groove welds on both sides of web plates at joints to top and bottom mounting plates or masonry plates. Use a 5/16-inch minimum fillet weld size all around stiffener plates.
- (c) The bottom of masonry plates to have milled grout grooves or welded steel grout lugs. Stress-relieve after welding. Mill mounting plate surfaces after stress relieving. All mounting plate surfaces are to be parallel over entire length to within 0.002 inch.
- (d) Provide air relief holes through masonry plates for complete grout pad penetration with no voids. Set all grout pads following final machinery alignment.

(13) Shims

- (a) Where shown on the drawings, all machinery shims required for leveling and alignment of equipment neatly trimmed to the dimensions of the assembled parts and drilled for all bolts that pass through the shims. Shims shall provide full bearing between machinery components and structural supports. In general, sufficient thicknesses shall be furnished to secure 1/64" variations of the shim allowance plus one shim equal to the full allowance. For motors thickness shall allow for 0.002" variations. Shims shall be Stainless Steel ASTM A240 Type 304. Shims shall be provided with bolt holes oversized not more than 1/8" greater than the fastener diameter.
- (b) 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. Shims length for motor feet to be across the motor perpendicular to its shaft.

- (c) The use of peel-able laminated shims with solder or resin bonding will be permitted. Plastic or other non-metallic shims will not be permitted. The laminations shall be peel-able, 0.002-inch thickness.

(14) Welding

- (a) Welding required for machinery shall be done in accordance with the Structural Welding Code AWS D1.5 and all interim revisions as of the bid opening date. All groove welds used to fabricate machinery shall be completely tested by ultrasonic inspection using the methods given by ASTM E164 and as per AWS D1.5, Section 6, Part C. Perform magnetic particle testing for all other welds used to fabricate machinery in accordance with ASTM E709 and as per AWS D1.5 Section 6.
- (b) Welding for stainless steel shall conform to AWS D1.6.
- (c) Weldments shall be stress relieved by heat after welding and prior to final machining.
- (d) Distortion during fabrication shall be kept to a minimum by the use of welding fixtures and proper welding procedures. Base metals that are forged or heat treated to increase hardness shall be preheated to prevent cracking prior to any welding.
- (e) Submit all weld procedures and welding qualifications prior to the start of the work.

(15) Coatings

- (a) The paint coating system shall be a 3-coat or 2-coat system consisting of one coat of aluminum epoxy mastic primer and one or two coats of aliphatic acrylic polyurethane.
 - 1. 3-coat system to be used on machinery and structural steel areas greater than 36 square inches which are cleaned to bare metal.
 - 2. Use 2-coat system over small areas of bare metal and existing paint.
 - 3. Use one of the paint manufacturers listed on the NEPCOAT Qualified Products List A or B and accepted by the Engineer.
 - 4. Machinery parts paint color shall be safety orange for parts that rotate.
 - 5. Stationary machinery, machinery fixed to structural steel, machinery supports, and structural steel parts to match paint color to existing structural steel color AMS-STD-595.
- (b) 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.
- (c) For general sealing against water intrusion use Permatex® No. 2 sealant for oily surfaces. For sealing pipe threads use Permatex® Seal + Lock Thread Compound during assembly. For sealing inspection covers use Permatex® Ultra Rubber Gasket Sealant and Dressing.
- (d) Unless otherwise shown on the plans, for screws in tapped holes use permanent assembly thread locker coating on threads. Approved products:
 - 1. Permatex® Threadlocker Blue
 - 2. Loctite® Threadlocker Blue 242

- (e) Rust inhibiting coatings shall be used for the temporary protection of machined surfaces. Rust inhibitor shall be wax-type petroleum based cosmoline meeting MIL-C-11796C Class C for use on machined metal surfaces.

CONSTRUCTION METHODS:

(1) Disassembly of Existing Machinery

- (a) Remove and dispose of the existing span drive machinery and associated supports as shown on the plans and as provided for in the “Removal of Machinery” specification.
- (b) The existing 4.5” diameter cross shaft shall be cut in the field as a part of the removals, for later fit up with the new cross shafts. Cut in the position roughly shown on the plans. The shaft must be temporarily supported in V-blocks or similar at this stage. Take care not to introduce binding, undue loading or damage to the existing intermediate gears and remaining outboard gear shaft bearing.
- (c) Document existing alignment conditions at the intermediate gearsets prior to disassembly. This shall include backlash at each of four corners of the tooth contact, and tip clearance at each end of the tooth. This may be done at only one tooth position per gearset – ensure that the same position is measured after installation of the new machinery by paint marking the measured teeth.
- (d) Temporary platforms, supports and all other means and methods necessary to perform this work shall be performed by the Contractor at no additional cost to the Town. Coordinate with any other structural work in the vicinity of this work.

(2) Installation of New Machinery Supports

- (a) Coordinate field installation of supports with the shop assembly of the new machinery. Field measure and verify the installation locations and layout and ensure compatibility with all mounting holes as verified in the shop assembly of the span drive machinery.
- (b) Temporary platforms, supports and all other means and methods necessary to perform this work shall be performed by the Contractor at no additional cost to the Town. Coordinate with any other structural work in the vicinity of this work.

(3) Gear Reducer R1

(a) Shop Test

1. Shop test the new R1 gear reducer by running it at the normal operating speed and mechanical design load (150% FLT of the motor) for at least one hour. Half of the run shall be one direction and the other half in the opposite direction. Immediately before the start of the test, and at 5-minute intervals thereafter, the following measurements shall be made and recorded and submitted in a test report for approval by the Engineer:
 - a. Temperature of ambient air.
 - b. Temperature of oil near bottom of crankcase.
 - c. Surface temperature of each shaft extension adjacent to shaft seal.

- d. Sound level at point above and 3 feet distant from center of unit.
2. Following the above load test operation, the reducer shall then be operated at 225% FLT of the motor for 3 minutes in each direction, 6 minutes total.
3. During testing each speed reducer shall be checked for unusual noise (thumping or any non-uniformity), lubrication leaks and any other unusual operating characteristics. The units shall operate smoothly, and without excessive vibration or temperature rise. All malfunctions shall be recorded and corrected, and the units retested if necessary, before release from the shop.
4. After successful completion of the test perform the following and submit as a part of the test report:
 - a. Measure input and output shaft run-out.
 - b. Measure shaft end play.
 - c. Remove the inspection cover, or otherwise provide access to (including draining the oil if necessary) the internal wearing components for inspection. Photos of the gear teeth shall be taken.
5. Do not run the test with the motor, couplings and keys that are to be provided as part of the Work. Do not ship the unit with the oil used during testing.
6. Ensure the units are filled to the proper levels with the proper oil type as shown on the shop drawings for the testing.
7. If internal inspection requires any level of disassembly beyond removal of inspection covers, after re-assembly the units shall be re-filled with the correct oil and re-inspected for leaks.
8. All gearbox shop testing shall be performed in the presence of the Engineer or their representative. Do not ship the gearbox for span drive shop assembly until acceptance of this testing by the Engineer.

(4) Couplings

(a) General

1. Ensure all fit tolerances and surface finish requirements are met.
2. Install new keys into shafts.
3. Install coupling hubs by use of heat to achieve the FN2 fits. Install covers/sleeves and flange bolts. Bolts shall be torqued per the manufacturer's values.
4. Couplings are to be packed with new grease prior to assembly.
5. Couplings shall be aligned to the manufacturer's alignment criteria.

(b) Shaft Locking Devices

1. The shaft locking device shall be a manufacturer's certified product and installed per the manufacturer's instructions.
2. Submit a procedure for the installation of this device with the C1 coupling hub for approval. Do not install the device prior to approval of the procedure. The installation

shall occur in the presence of the Engineer. This shall be included with the procedure for the installation of the span drive machinery and provide for the indexing requirements at each side.

(5) Bearings

- (a) Install new sleeve bearings onto the new machinery supports and install shafts to an RC6 fit and such that any taper in clearance across the bearing is no more than 0.001" per foot.
- (b) Demonstrate contact between the bushings and shaft journals in the shop. Assembled bearings shall be measured for total clearance (RC6 fit). Contact shall be a minimum of 70%. This shall be performed by or in the presence of and accepted by the Engineer as a part of the span drive shop assembly.

(6) Brakes

- (a) Install new brake linkages onto the pre-installed brake wheels. These may be shop assembled and protected for shipment, or field assembled. The brakes may be set in the shop or in the field. Ensure brakes are set correctly including torque, shoe pad contact and clearance, set time delay, hand release range of motion, thruster stroke, and any other requirements per the manufacturer's instructions.
- (b) The Engineer shall inspect the installed brakes and settings prior to the bridge being allowed to operate on the new equipment. This shall be done as a part of the initial operation procedure.

(7) Cross Shafting

- (a) Fabricate and install the new cross shafts as shown on the Plans. Coordinate shaft journals with couplings and bearings.
- (b) Inspect and/or measure the existing cross shaft conditions. Suggest remove paint and sand to a mirror finish along the required new journal length for installation with the C1 coupling assembly. Measure exact diameter to within 0.001". Measure runout and concentricity of the journal. Submit findings to the Engineer for review. If needed, field machine the journal to the necessary fit, runout, and finish. Remove as little material as possible to achieve results. Measure resulting conditions to within 0.001" and match with shaft locking device bore. Ensure any corners or transitions are blended smoothly.
- (c) After cutting and all field machining of the existing cross shaft has been completed, measure and adjust exact final new cross shaft length to suit. Ensure couplings gaps are accounted for properly to achieve coupling alignment per the manufacturer's requirements. Coordinate with approved gearbox and coupling shop drawings.

(8) Shop Assembly and Testing

- (a) Shop assemble and/or stage the new span drive machinery together in the shop. Measure and achieve all nominal dimensions, clearances, alignments, and document pertinent data for use in field assembly. Resolve any fit-up issues in the shop prior to shipment. Any issues found later during field assembly may require removing the equipment back to a shop environment to be resolved, re-shipped to the field, and re-installed at no additional cost to the Town.

- (b) Perform a no-load spin test of the equipment in the shop assembly. Rotate the equipment in each direction for at least 20 minutes and observe for general function. Ensure equipment is lubricated, at least lightly, for this operation.
- (c) Shop assembly shall be attended by the Engineer. The Engineer shall approve the condition and alignment of the equipment prior to shipment to the job site.

(9) Span Drive Field Assembly

- (a) Assemble the new span drive equipment on the bridge, on the newly installed machinery supports, as shown on the Plans. A procedure for the process of installation and alignment of this equipment shall be submitted and approved by the Engineer prior to beginning the work. This shall include all necessary alignment criteria. Alignment shall start at the low speed equipment and proceed to the high speed equipment, ending with the new span drive motor. If the Contractor determines that it is not possible to achieve the required alignment at any component for any reason, findings shall be submitted to the Engineer for direction.
- (b) Install all equipment using temporary undersized holes and fasteners. Do not drill and ream final bolts until acceptance of alignment by the Engineer.
- (c) The machinery alignment criteria are as follows:
 - 1. The existing intermediate gearset shall be restored to the same alignment as originally existed, via adjustment of the new B1 bearings. Document existing alignment conditions prior to disassembly. This shall include backlash at each of four corners of the tooth contact, and tip clearance at each end of the tooth. This may be done at only one tooth position – ensure that the same position is measured after installation of the new machinery by paint marking the measured teeth.
 - 2. Each B1 bearing shall be measured for clearances within an RC6 fit range, and to have no more than 0.001” per foot of taper across the bearing. Note that contact pattern between the journal and bushing will have been demonstrated during shop assembly and does not need to be repeated during field assembly. This will not require any disassembly of the bearings.
 - 3. Each flexible coupling shall be aligned in accordance with the manufacturer’s criteria for the supplied products. This generally shall include parallel offset and angular misalignment measurements and shall meet installation limits (not operating limits). Where not otherwise specified, installation limits shall be taken as 20% of maximum operating limits. This will require disassembly of the coupling hubs.
 - 4. The brakes shall be aligned such that there is even contact and clearance between the shoes and the brake wheels. Note that brakes should be bedded to achieve this. A procedure for bedding the brakes shall be included in the span drive assembly procedure. The brakes shall be shimmed such that the centerline of the brake shoes are within 1/32” of the centerline of the brakewheel and shaft elevation. The shoes shall not overhang the sides of the brake wheels.
- (d) Once the Contractor has achieved the correct alignment, they shall provide notice the Engineer to inspect the installation conditions and alignment on site. The Contractor shall be prepared to disassemble each coupling for measurement during this inspection. All alignment measurements for all components shall be taken by or under the supervision of

the Engineer. Once the Engineer accepts the alignment condition, final bolts can be installed. The final alignment measurements shall be submitted for documentation in a table format. This effort shall be performed as many times as is necessary until final alignment is achieved.

- (e) Inspection of the alignment of the machinery shall occur as a part of the initial operation procedure, or prior to it, and shall be approved by the Engineer prior to the new equipment being operated. Note that at this juncture, temporary alignment not meeting the final requirements may be acceptable at the discretion of the Engineer. Subsequent effort and repeat inspection of alignment shall then be performed to achieve final conditions as needed. After acceptance of final alignment, install final bolts.
- (f) Inspection of the general condition of all equipment as installed on site shall be performed as a part of the initial operating procedure, and then again during final acceptance testing. This shall include general inspection and validation of proper lubrication of all relevant components. Tightness of bolts shall be spot checked.
- (g) The C1 coupling assembly, the shaft locking devices, shall be installed such as to achieve proper indexing of gear contact at each side of the bridge. This shall be validated at the main rack and pinion teeth. This shall also be validated in review of strain gage test data. Firm contact on the same side of the teeth shall be achieved at each rack/pinion. Strain gage data shall show that the load sharing is no less than 60/40%, taken at approximately 100% FLT of the main motor. This may be demonstrated by driving the bridge down into the live load supports if required. Worse load sharing at lower operating loads is acceptable.
- (h) Demonstrate the installed capacity of the C1 couplings and shaft lock devices. The equipment shall be loaded by the new drive motor to 225% FLT of the motor. No slippage shall occur at this load. The drive shall be set with an over-torque trip/limit at this load value. This may be achieved via a temporary seating load setting, driving the bridge down into the live load supports.

(10) Bolting

- (a) Bolt holes involved in the field assembly for connecting machinery shall, in general, be drilled from the solid after alignment of the machinery. Sufficient erection holes, sub drilled undersize, for temporary bolts shall be used for erection and final alignment of the machinery. Suggest providing holes at 3/4 the final diameter subdrilled, installed with temporary bolts 1/2 the final nominal diameter, in all cases.
- (b) When the machinery is aligned in its final position, and has been accepted by the Engineer, with the equipment secured with temporary bolts, remove one bolt at a time and drill and ream and install final bolts. Ensure bolts are tightened properly, and as each final bolt is installed, to maintain alignment.
- (c) Turned bolts and other grades of bolts shall be installed with two nuts, and final tightened by the torque-tension method to develop a preload of 40% of their proof load at the first nut, and while holding the first nut stationary 70% of proof load at the second nut, unless otherwise noted, and shall be indicated on the erection drawings. If using jam nuts place the jam nut down first. Contractor shall provide a table of all bolt sizes used showing both of these torque values. Coat fasteners with anti-seize. Torque values shall be based on the

published friction factor for the anti-seize product used.

- (d) Bolts that connect secondary machinery baseplates or machinery supports, that are generally permanently installed and not used in the alignment, adjustment or typical maintenance or repair of equipment may be installed with a single nut and tightened by the turn-of-the-nut method per Table 8.2 of RCSC (research council for structural connections). Proposed locations shall be shown on the approved assembly drawings.
- (e) Fasteners that are a part of manufacturer's product assemblies, such as coupling flange bolts, shall be installed per the manufacturer's instructions unless otherwise noted or instructed by the Engineer.
- (f) Validate torque values using the Skidmore-Wilhelm apparatus for each bolt thread size and material variation. Perform the test with the recommended or approved equal thread lubricant to also be used for torquing bolts at installation.
- (g) Unless otherwise noted install nuts on bolts with a moly anti-seize lubricant, marine grade to reduce torque applied to bolt, hold the threaded connection, and prevent corrosion.

(11) Lubrication

- (a) Lubricate all equipment with provided lubrication ports, and/or otherwise in accordance with the manufacturer's instructions of any equipment, until fresh lubricant is purged out. Hand pack at initial assembly where appropriate.
- (b) A schedule of lubrication activities shall be submitted for approval, including clear visual schematics showing the locations of all activities, which shall be included in the O&M documentation.
- (c) Contractor shall be responsible for the proper upkeep and maintenance of all equipment for the duration of the contract, which includes periodic lubrication.

(12) Cleaning and Painting

- (a) New and refurbished machinery external surfaces shall be cleaned with final surface preparation, prior to painting, done by hand tools and power tool cleaning to meet the requirements of SSPC- SP 2 and 3 with the following exceptions:
 - 1. The following excepted machinery or equipment shall be cleaned with solvent to meet the requirements of SSPC-SP 1. Generally, these surfaces are not painted.
 - a. Gear and pinion teeth
 - b. Seals and gaskets
 - c. Brakes, motors, limit switches and other electro-mechanical components
 - d. Bronze, galvanized, and stainless-steel parts

After proper surface preparation, machinery surfaces shall be coated with a 3-coat system applied as per the coating manufacturer's temperature and humidity requirements for application. If environmental conditions are not suitable for painting in accordance with paint manufacturer's requirements, the contractor shall provide a temporary conditioned enclosure over the area to be painted in the field; maintain suitable temperature and humidity and protect the area from weather at no additional cost.

- (b) Surfaces for fit-up in fixed contact with other components to have one primer coat. This does not include machinery base on steel mounting surfaces.
- (c) Acceptable coatings are given under Material Requirements.
- (d) 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.

(13) Testing

- (a) Testing shall be performed as detailed in the acceptance testing specification section. This shall involve, as independent efforts, an initial operation test which shall qualify the span drive machinery to be placed into a during construction, temporarily operable condition, and, once all work is complete and all final bolts are installed, a final acceptance test for commissioning of the completed system. This shall be done as a joint effort in conjunction with all acceptance testing for all mechanical and electrical work on the bascule span.
- (b) Machinery alignment shall be approved by the Engineer prior to initial operation testing. A general inspection of all equipment shall be performed to ensure that it is properly lubricated and ready for operation. Note that there may be deviations that are acceptable for a temporarily operable condition that will require further resolution prior to final acceptance testing.

(14) Waste Disposal

Unless otherwise specified all refuse, materials and debris resulting from execution of this item shall become the responsibility of the Contractor and removed from the premises. Materials not scheduled for reuse shall be removed from the site and disposed of in accordance with all applicable Federal, State and Local requirements.

METHOD OF MEASUREMENT:

No direct measurement shall be made for the work, as it is paid on a lump sum basis.

BASIS OF PAYMENT:

- (a) The work will be paid for at the contract lump sum price for “Span Drive Machinery”, which shall include all materials, equipment, and labor necessary to complete the work as identified on the plans and as noted herein.
- (b) This work shall not be compensated until the Engineer determines that the work has been tested and functions to the satisfaction of the Engineer.
- (c) Final payment for span drive machinery will not be made until all the project closeout data

submittals have been completed. Once the completed package has been received in its entirety, the Town will make the final payment to the Contractor.

Pay Item

Span Drive Machinery

Unit

LS

107.12

SPAN LOCK MACHINERY

LUMP SUM

DESCRIPTION:

The work for Span Lock Machinery includes the installation, alignment and testing of a new span lock operator and guide assembly. Note that installation and alignment of electrical indication equipment is included herein. See electrical Plans and Specifications for further details of electrical work incidental to or adjacent to this work.

This work shall be coordinated and sequenced between all disciplines and with any road or marine traffic restrictions as needed.

This work shall be coordinated with the work under “Live Load Shoe Adjustment.” Final alignment of the lock equipment shall not be performed until the work on the live load shoe adjustment has been completed. Work may progress up to and excluding final alignment, generally up to the grouting of the receiver.

GENERAL REQUIREMENTS:

(1) Submittals

- (a) Bridge site field measurements report to document existing dimensions and locations of all interface points between existing surfaces. Show field verified dimensions on shop drawings. Attention is called specifically here to verifying the pier concrete elevation and any concrete form work in the vicinity of the span lock installation.
- (b) Manufacturer's data and/or shop drawings shall be submitted for all manufactured and purchased items of machinery.
 - 1. Shop drawings shall show all parts completely detailed and dimensioned. Reproduction of the Plans shall not be used as foundation sheets for assembly or erection drawings. Shop drawings shall include assembly drawings.
 - 2. The Contractor shall prepare and submit shop drawings to the Town for acceptance prior to fabricating the material.
 - 3. Shop drawings shall include, but not be limited to, field measurements, installation plans, material lists and material designations. The weight of the detailed elements shall be included on the shop drawings.
 - 4. Materials and material specifications shall be stated for each part. Where standard specifications are used, the applicable designation of such material specifications shall be given.
 - 5. Submit catalog cuts of new components.
- (c) Work Procedure: Submit a detailed list of the work procedure to be followed.

- (d) Task Schedule: Schedule of work that requires interruption to movable span operation and road way usage or channel navigation. Provide work activities for each day and the duration of the restriction.
- (e) Certified material test reports: Include all chemical and mechanical properties for each material that is part of the Work.
- (f) Test Reports: All measurements after field adjusting and testing.

(2) Delivery and Storage

- (a) Machinery parts shall be cleaned of dirt, chips, grit, and all other injurious materials prior to shipping. 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. This coating shall be removed from all surfaces prior to lubrication of machinery.
- (b) At any interface between stainless steel or aluminum and steel, the steel shall be coated with primer prior to assembly.
- (c) Machinery parts shall be completely protected from weather, dirt, and all other injurious conditions during manufacture, shipment, and storage.
- (d) 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.
- (e) Assembled units shall be mounted on skids or otherwise crated for protection during handling and shipment.
- (f) Spare parts as defined in the Plans shall be protected for shipment and prolonged storage by coating, wrapping, and boxing. All spare parts shall be durably tagged or marked with a clear identification showing the designation used on the approved shop drawing. Boxes for spare parts shall be clearly marked on the outside to show their contents.

(3) Guarantees and Warranties

- (a) Manufacturer's warranties or guarantees on equipment, materials or products purchased for use on the Contract which are consistent with those provided as customary trade practice, shall be obtained by the Contractor and, upon substantial completion of the contract, the Contractor shall assign to the Town, all manufacturer's warranties or guarantees on all such equipment, material or products furnished or installed.
- (b) The Contractor shall warrant the satisfactory in-service operation of the mechanical equipment, material, products, and related components. This warranty shall extend for a period of one year following the date of final acceptance of the Project.

(4) Quality Assurance

- (a) Products used in the work shall be produced by manufacturers regularly engaged in the manufacture of the specified products.
- (b) For the fabrication, installation, and testing of work required by the machinery items, 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 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 machinery.

- (c) The Contractor shall provide all reasonable facilities, necessary tools and instruments required for the proper performance of the personnel engaged in the execution of the specified work.

(5) Codes and Standards

- (a) Work shall comply with, but not be limited to, all applicable requirements of the following codes and standards and their abbreviations used in this Specification:

1. American Association of State Highway and Transportation Officials (AASHTO)
2. American Iron and Steel Institute (AISI)
3. American National Standards Institute (ANSI)
4. American Society of Mechanical Engineers (ASME)
5. American Society for Testing and Materials (ASTM)
6. American Welding Society (AWS)
7. National Lubricating Grease Institute (NLGI)
8. Society of Automotive Engineers (SAE)
9. Steel Structures Painting Council (SSPC)
10. United States Military Specifications (MIL)
11. Anti-Friction Bearing Manufacturers Association (AFBMA)
12. National Fluid Power Association (NFPA)
13. National Lubricating Grease Institute (NLGI)
14. Occupational Safety and Health Administration (OSHA)
15. Society of Automotive Engineers (SAE)
16. National Electric Code (NEC)
17. National Electrical Manufacturers Association (NEMA)
18. Underwriters Laboratory, Inc. (UL)

- (b) 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 attention to them; it is not intended to imply that any other codes and standards shall be assumed to be omitted if not mentioned.

(6) Measurements and Verification

Dimensions indicated on the Contract Drawings are nominal based on limited field verification and availability of existing "As-Built" drawings. Contractor is to field verify all indicated measurements herein and on the plans at the bridge site. Field verification may include partial or complete disassembly of existing components. The contractor is urged to

schedule any disassembly and reassembly prior to any other work as early as possible where field verification may be needed to finalize new parts and/or assembly details. Attention is called specifically to components replaced in-kind, and specifically to any existing mounting bolt holes in the existing structure to be re-used. New flanges, hubs or other fits, including turned bolt fits, shall be adjusted based on measuring the existing structure, including any cleanup needed to restore surface conditions. In all such cases, the sizes shown on the plans shall be the minimum sizes. Final sizes and/or custom fit tolerance ranges shall be submitted for approval on the shop drawings.

In general, the machinery removals shall be performed prior to this work, as well as cleaning of all rust, grease and dirt from the areas and materials to be reused.

Notice shall be given to allow the Engineer to witness and review field verification efforts on site.

(7) Substitutions

- (a) The terms "approved equal", "of equal quality" and "or equal" which may appear on the Contract Drawings and in these Specifications are intended to allow the Contractor to submit for review other manufacturers and model numbers of products of equal quality and rating for those specified.
- (b) Prior to the Contractor's ordering of any substitute product, the Engineer's acceptance 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.
- (c) Acceptance 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.
- (d) Where a 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 made by another manufacturer may be submitted for review for the specified product subject to the acceptance of the Engineer; however, all necessary changes required by the substitution in related machinery, structural, architectural and electrical parts, and scheduling shall be made by the Contractor at no additional cost to the Town.

(8) Inspection

- (a) The Contractor shall give no less than ten (10) working days' notice to the Town of the beginning of work at foundries, forge, and machine shops so that inspection may be provided. No materials shall be cast, forged, or machined before the Town has been notified where the orders have been placed.
- (b) 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 Town 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.

- (c) The Inspector will have the authority to reject materials or workmanship which does not fulfill the requirements of these Specifications.
- (d) Inspection at the foundries, forge, and machine shops is intended as a means of facilitating the work and avoiding errors. It is expressly understood that inspection will not relieve the Contractor from any responsibility regarding material or workmanship and the necessity for replacing defective materials or workmanship which are delivered to the job site.
- (e) The Contractor shall furnish the Town with a copy of all orders covering work performed by subcontractors or suppliers.

(9) Defective Materials and Workmanship

- (a) The acceptance of any material or finished parts by the Town shall not prohibit their subsequent rejection if found defective. Rejected material and workmanship shall be replaced or made acceptable by the Contractor at no additional cost to the Town.
- (b) All machinery rejected during inspection and testing shall be removed from the work site and replaced at no additional cost to the Town.
- (c) Delays resulting from the rejection of material, equipment or work shall not be the basis of any claim.
- (d) All defects found during the warrantee/guarantee period resulting from faulty material, components, workmanship, or installation shall be corrected by the Contractor at no additional cost to the Town. The Town reserves the right to make necessary corrections with its own forces and charge the resulting costs to the Contractor.

(10) Work Procedures

- (a) All labor, materials, tools, equipment, services, testing, insurance, and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these Specifications shall be provided by the Contractor. The Contractor shall be prepared to work all shifts and weekends throughout the course of this project.
- (b) Prior to beginning work, the Contractor shall review conditions at the site for verifying measurements, assessing existing conditions, and safety reasons. In addition, the Contractor shall instruct all workers in all aspects of personal protection, work procedures, movable bridge operation, emergency evacuation procedures and use of equipment including procedures unique to this project.
- (c) Shut down and lockout/tagout operating machinery electrical power while working on equipment.
- (d) Whenever the contractor is not at the bridge site the span is to be operational unless work is done during an approved navigation or roadway outage.
- (e) Provide temporary supports, rigging, or access as needed to facilitate all work.
- (f) Submit a schedule of all work that requires interruption to movable span operation and restrictions to either road traffic or channel navigation for review and acceptance. Provide work activities for each day and the duration of the restriction.

MATERIALS:

(1) Span Lock Operator

- (a) The span lock operator shall be Steward Machine's Earle EG-2B unit or an approved equivalent system. Note that alternatives, in particular typical linear actuator options such as Raco electric actuators, will require additional external adjustments and components to meet requirements, notably an additional guide assembly and flexible connection to isolate loading from the lockbar to the actuator rod. Hydraulic actuators will not be considered.
- (b) The span lock operator shall include a 240V, 3PH motor with integral marine duty brake. The lockbar shall operate at 1.5 inches per second with a mechanically limited 9" stroke. The assembly shall be weatherproof. There shall be a shaft extension for manual operation of the lockbar, with a removable cover and safety interlock that shall be wired to prevent the operator from energizing the motor when the hand drive is attached.
- (c) The span lock operator shall be ordered specifying the mounting arrangement as show on the Plans, with the motor oriented to reduce vertical envelope of the assembly.

(2) Span Lock Guides

- (a) Provide new span lock guides as shown on the Plans. Two similar guide assemblies are provided and referred to as the front guide and receiver. The front guide is mounted to the bascule span along with the lock bar operator, and the receiver is anchored to the pier concrete.
- (b) Provide spare shim sets, to be stored on site for future use, matching the form as shown in the Plans equivalent to the full nominal thickness. Both the spares and the installed shim sets shall include a minimum of one each of the following thicknesses: 1/4", 1/8", 1/16", 1/32", 0.010", 0.003".

(3) External Limit Switches

- (a) The lock bar operator may include internal limit switches available for use as suits the requirements of this project, however external limit switches have been added intentionally to improve maintenance access and robustness, and independence of the electrical control system from the internal assembly of the lock bar operator. Ensure external switches are provided for each of the fully driven and fully released lock bar positions as shown on the Plans. Refer to the electrical plan and specifications for further requirements of electrical equipment.

MATERIAL REQUIREMENTS:

(1) Forgings

- (a) Carbon Steel and Alloy Steel Forgings shall meet the requirements of ASTM A668 or as shown on the Plans.
- (b) All forgings shall be reduced to size from a single bloom or ingot until the cross-sectional grain is homogeneous. The blooms or ingots shall have a cross-sectional area at least three times that required after finishing. No forging shall be done at less than a red heat.

- (c) Unless otherwise indicated, perform for each forging:
 - 1. Magnetic Particle exams in accordance with ASTM A275 and ASTM E709 performed by fabricator after finish machining.
 - 2. Ultrasonic exams in accordance with ASTM A388 performed by foundry.
 - 3. All other testing or criteria as established by the specified material specification of the forging.
- (d) Forgings acceptance based on non-destructive test free of indication of discontinuities unless otherwise noted or acceptance criteria of the forging material standard.
- (e) Forgings that are welded for fabrication of the completed machinery part shall have carbon content limited in accordance with Supplementary Requirement S4.
- (f) No tack welding on forged materials is permitted for lugs to aid with handling materials.
- (g) Submit certified factory and material test reports for forgings unless otherwise noted.

(2) Castings

- (a) Take all necessary precautions to fabricate the castings true to pattern in form and dimensions, free of pouring faults, cracks, cold shuts, blow holes and other defects.
- (b) Clean all castings of loose scale and sand, remove all fins, seams, gates, risers and other irregularities. All unfinished edges of castings shall be neatly cast with rounded corners and all inside angle shall have ample fillets.
- (c) Remove surface defects by rough machining prior to final heat treatment.
- (d) All castings shall be visually inspected in accordance with and otherwise meet the requirements of ASTM A802 and meeting Level II criteria.
- (e) Additional requirements may be required for critical components as specified for those components in the plans and specifications. Any requirements included in the specified material specification of any casting shall also be met. Unless otherwise specified, general references to the following test types shall meet:
 - 1. Magnetic particle testing shall be done in accordance with ASTM A781. Note that this is a mandatory requirement of many of the casting material specifications such as ASTM A27 and A148 and shall be performed where those materials are specified.
 - 2. Ultrasonic testing shall be done in accordance with ASTM A609 Method A. Castings undergoing this test shall be required to meet Quality Level 2.

(3) Fasteners

- (a) Machinery fit, high-strength turned bolts shall meet the requirements of ASTM F3125 Grade A325 or A449 high strength bolts with a finished full body diameter. The finished body or shank diameter shall have a tolerance that meets an ANSI LC6 fit with a field reamed hole. Bolt bodies shall have a straightness tolerance of 0.002 inch. Polish or machine the bolt diameter to achieve an overall body diameter deviation within the given shaft tolerance of an LC6 fit for the entire lot of finished body bolts. The finished body diameter shall be equal or greater than the thread major diameter after polishing or machining the bolt.

- (b) High strength bolts shall be connected using nuts meeting the requirements of ASTM A563.
- (c) Finished shanks of turned bolts shall be 1/16-inch larger in diameter than the diameter of the thread, unless otherwise noted. Where specified, order full body bolts with 1/64-inch oversized diameter, or for bolts greater than 1-3/8-inch diameter order 1/32-inch oversized diameter. The shanks of all turned bolts shall have Class LC6 fit in the finished holes in accordance with ANSI Standard B18.2. Turned bolts shall be fully detailed on shop drawings.
- (d) Hex socket flat countersunk head cap screws shall conform to ASTM F879 (Stainless Steel) for diameters less than 7/8" and ASTM F835 (Alloy Steel) for diameters equal or greater than 7/8".
- (e) 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.
- (f) 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 1/4 inch smaller in diameter than the bolt diameter and shall be reamed assembled for the proper fit at assembly or at erection with the steel work after the parts are correctly assembled and aligned.
- (g) All elements connected by bolts shall be drilled or reamed assembled to assure accurate alignment of the holes in each element and accurate clearance over the entire shank length of the bolt.
- (h) High-strength bolts shall be installed with a hardened plain washer meeting ASTM F436 at each end.
- (i) Fasteners less than 1/2-inch diameter to be stainless steel AISI type 304.
- (j) Anchor bolts connecting machinery parts to masonry shall conform to ASTM F1554 Grade 55, unless noted otherwise.
- (k) Except for turned bolts all bolts, screws, anchors, nuts, and washers shall be hot-dipped galvanized in accordance with ASTM A153 unless noted otherwise.
- (l) Split lock washers shall conform to the SAE regular dimensions. The material shall meet the SAE tests for temper and toughness.
- (m) All cotter pins shall conform to the SAE standard dimensions and shall be made of half-round stainless-steel wire, ASTM A276, Type 304.
- (n) All fasteners shall be of United States manufacture and shall be clearly marked with the manufacturer's designation.

(4) Shafts and Pins

- (a) 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.

- (b) All shafts and pins shall conform to tolerances in ASTM A29 unless otherwise indicated. Turned, ground and polished straightness tolerances shall be 0.001 inches per foot for shafts up to and including 1-1/2 inch in diameter and 0.002 inches per foot for shafts over 1-1/2 inches in diameter.
- (c) 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.
- (d) All shafts and pins shall be ASTM A668 class K forgings unless otherwise shown on the Plans.
- (e) All hubs mounted on the ends of 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 shaft 1/16 inch larger than the nominal diameter specified and shall turn the ends to the required dimension for the hub.
- (f) Turned, ground, and polished shafts of the material and grade specified shall be used where shown on the drawings.
- (g) All journal-bearing areas on shafts and pins shall be accurately machined and polished, with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. Burnishing of the shaft journal areas and adjoining shoulder fillets will be acceptable in lieu of polishing provided that the burnishing is done with a Stellite roller or equal, finished to a mirror surface. The surface finish of shaft journals shall be as shown on the drawings. Journal diameters shall be finished to the limits of an ANSI Class RC6 running fit.
- (h) After field installation of shafts supported in bearing the circular run-out tolerance shall be measured and recorded. Run-out requirements:
 - 1. Shafts: 0.005-inch FIM (Full Indicator Movement)
 - 2. Pins: 0.002-inch FIM
 - 3. At any measuring position when the part is rotated 360 degrees about the datum axis with the indicator fixed in a position normal to the true geometric shape.

(5) Clevises, Turnbuckles and Connection Rods

- (a) Clevises and turnbuckles shall meet the dimensional and load ratings in accordance to the American Institute of Steel Construction (AISC) Manual of Steel Construction. Carbon and alloy steel clevises are forged per ASTM A668 Class A.
- (b) Length adjustment for clevis and rod assembly shall be achieved by RH/LH thread pairing or by the use of turnbuckle assemblies in combination with threaded rods and clevis assemblies.
- (c) Threads shall be U.N.C. Class 2B, right or left hand
- (d) All connection rods shall be ASTM A449 unless otherwise indicated on the plans.

(6) Keys and Keyways

- (a) Keys and keyways or keyseats shall conform to the dimensions and tolerances for square and flat keys of ANSI Standard B17.1, Keys and Keyseats, unless otherwise specified. Fit of keys in their keyseats shall meet a Class 2 fit unless otherwise specified.

- (b) All keys shall be effectively held in place, preferably by setting them into closed-end keyways milled into the shaft. The ends of all such keys shall be rounded to a half circle equal to the width of the key. Keys in open end keyseats such as with couplings shall be held with a set screw against the top of the key.
- (c) If two or more keys are used in a hub, they shall be located 120 degrees apart. In those cases, the fit between keys and keyways shall conform to an ANSI B17.1 Class 1 fit.
- (d) Unless otherwise specified herein or in the drawings, keys shall be machined from carbon steel forgings, ASTM A668, Class K.

(7) Hubs and Collars

- (a) Hubs shall be finished and polished to 16 micro-inch rms where the hub face prevents axial movement. The hubs shall be bored concentric with the pitch-circle of gears or the hub's outside diameter. All hubs shall have an ANSI Class FN2 fit on the shafts, unless otherwise specified. Machine keyways into hubs as defined herein.
- (b) Collars for holding shafts axially shall be either shrink disc or clamp type.
 - 4. Clamp type collars are to be heavy-duty two-piece collars made from black oxide steel and clamped with high-strength forged alloy steel screws.
 - 5. Manufactured by Ruland, Marlborough, MA or approved equal.

(8) Open Gearing

- (a) Where required, provide fabricated and mounted spur gears in accordance with ANSI/AGMA 2015-1-A01, Accuracy Classifications System – Tangential Measurements for Cylindrical Gears, unless otherwise specified herein or shown on the Plans.
- (b) Open gearing shall meet or exceed either (AGMA Quality Q7 - ANSI/AGMA 2000-A88) or (AGMA Accuracy Grade 10 per ANSI/AGMA 2015-1-A01 and 2015-2-A06).
- (c) Test gear mesh and provide tip relief to avoid interference.
- (d) The teeth of all gears shall be cut from solid rims or blanks. The working surfaces of all gear teeth shall be smooth, and free from milling cutter ridges. Remove cutter burrs from all edges of the teeth, and round the top edges of all teeth to a 0.03-inch radius.
- (e) Finish the sides and peripheries of all gears and pinions and scribe the pitch circle on both sides not less than 0.020 inches deep with a V-pointed tool.
- (f) Backlash shall be provided in accordance with the AGMA recommended backlash range for coarse-pitch spur gears.
- (g) Final alignment of gearsets shall be accepted when the backlash is within the approved range, when there is no more than 0.010" per foot cross mesh, and when the tooth contact is at least 80% across the width of the contacting tooth surfaces at all teeth full around the gears. The contractor shall demonstrate acceptable tooth contact by using contact fluid on the contacting surfaces during the field testing of the machinery. Final alignment shall be measured and approved by the Engineer. Note that where new gears are meshed to existing gears, the alignment criteria shall be per the Engineers discretion and otherwise based on achieving the best alignment possible given the existing/worn conditions.

(9) Gear reducers

- (a) Shall be custom models from one manufacturer, with ratios, dimensions, and construction details shown on the Plans, and conform to AGMA standard 6013. Reducers shall have nameplates with the following information:
 - a. Size
 - b. Ratio
 - c. Service Power Rating
 - d. Shaft Speed
 - e. Service Factor
 - f. Lubrication Specification
 - g. AGMA Certification Symbol
- (b) Gear teeth shall be through-hardened and conform to the requirements of AGMA and AREMA. Case-hardened gear teeth shall not be permitted in the main drivetrain.
- (c) The AGMA yield strength rating shall be based on a torque equal to 300 percent of full load motor rated torque. The stress in any part of the gears and shafts shall not exceed 2/3 of the material yield strength at this load. This is a static stress state requirement.
- (d) Gearsets shall be designed for bending strength and pitting resistance as per AGMA standard 2001-D04.
- (e) Gears shall have helical or herringbone teeth. Gearing in enclosed factory assembled gear reducers shall meet or exceed either (AGMA Quality Q9 - ANSI/AGMA 2000-A88) or (AGMA Accuracy Grade 8 per ANSI/AGMA 2015-1-A01 and 2015-2-A06).
- (f) Pinions shall be proportioned so that the root diameter of the pinion is not smaller in diameter than the diameter of the journals for the pinion shaft.
- (g) Bearings shall be anti-friction type in accordance with AFBMA and L-10 life of 40,000 hours. Reducer bearings which are grease lubricated shall be fitted with readily accessible grease fittings, as well as purge ports. Internal seals between the bearing housing and the gear oil shall prevent interaction between them (oriented for retention). On shaft output extensions, seals shall be spring loaded lip seals as recommended by the manufacturer of the bearings and be provided with grease fittings for greasing the seals. These shall be double lip seal arrangements or otherwise as approved on the shop drawings.
- (h) Housings shall be steel castings or welded steel plate, which shall be stress relieved. The inside of the housings shall be sandblast cleaned prior to assembly and be protected from rusting special oil-resistant crankcase paint or approved equal. Reducer foundations shall extend past the body of the reducers to allow for mounting bolt hole reaming and bolts installation from above the unit.
- (i) Inspection covers shall be provided such that all gears, bearings and internal devices are readily visible when the covers are removed. Covers shall be located above the oil bath so that draining the speed reducer is not necessary to examine any interior components. Inspection covers shall be provided with seals or gaskets that do not require replacement when the covers are removed.

- (j) Lubrication of the gears and bearings shall be automatic when the unit is in operation. It is preferable that a bath lubrication system be utilized. In a bath lubrication system, all components in the reducer which require lubrication are partially submerged in the oil bath. When the configuration of gears and bearings prevent bath lubrication, a splash lubrication system should be used. Splash lubrication systems shall continuously lubricate all gears and bearings properly. Oil feed troughs may be used to supply oil to bearings and gears which are above the bath. Splash lubrication systems shall be designed such that equal lubrication is supplied to each internal component for both directions of operation. Gear reducers shall have provisions for oil expansion due to churning and temperature change.
- (k) Do not use pressurized lubrication systems for gear reducers unless specifically approved by the Engineer or specified in the Contract Documents. When a pressurized lubrication system is required for the reducer, provide a redundant lubrication system so that both systems operate concurrently. If a lubrication system malfunction can occur, provide a contact for remote alarm indication. Any forced lubrication system shall be interlocked with bridge operation in the electrical control system such that the equipment cannot be operated if the lubrication system is not functioning.
- (l) Reducers shall be furnished with a moisture trap and particle filter breather. The filter can be either reversible flow media or desiccant type. Particle filtration to be rated for 10 microns. Moisture trap must always maintain a lower dew point inside the reducer than ambient air dewpoint even when shut down overnight. Breathers shall be located above maximum oil levels in all positions of the reducer during operation, and its piping shall enter the unit at the highest point possible. Breathers shall not be mounted in bearing caps.
- (m) Provide an oil level indicator.
- (n) Oil drains shall be located at the lowest point possible. The drain shall have a bronze ball valve full port size with hand-operated lever that can be locked in the closed position. Valve is to have adjustable packing gland, blow-out proof stem design, PTFE seats and stuffing box ring, and hardened ball. Both ends to have NPT threads and include a threaded end plug.
- (o) Oil fill and sampling plug ports shall be in accessible positions on the reducer. Plugs to have either hex or square head and with NPT thread and seal.
- (p) Shaft extensions shall be of the arrangement, lengths, and diameters shown on the drawings. Couplings shall be pressed on the shafts in the shop.
- (q) The manufacturer shall submit for approval a certified print of each gear reducer showing as a minimum the following:
 - 2. All external mounting dimensions including shaft sizes, bores, keyseats, and reducer weight.
 - 3. Internal drawings showing each gear box component with part numbers.
 - 4. The ratings that will appear on the nameplate.
 - 5. Location of all lubricant connections.
 - 6. Lubrication recommendations and filled oil volume.
- (r) Recommended Gear Reducer Manufacturers:
 - 7. Nuttall Gear, Niagara Falls, NY

8. Overton Chicago Gear, Chicago, IL
9. Steward Machine. Birmingham, AL

(10) Bearings and Bushings

(a) Bushings

6. Sleeve bearing bushings material to be bronze ASTM B22 Alloy UNS C93700 unless otherwise shown on the Plans.
7. For split bushings, the outside diameter fit between bushing and housing shall be ANSI LC1 class fit. Double flanged bushings shall have the same fit between flanges and the end faces of the base and cap. Finish bores to achieve the fit with the shaft journal as specified in the Plans. Turn bushings with a predetermined gap between halves to suit the liner or shim thickness. The total thickness of liners in each bushing set shall include at least 1/8-inch laminated construction, permitting adjustment in increments of 0.003 inches. Liners shall be cut to fit shoulder fillets, shall be square with bushing flanges, and shall have bolt holes drilled through them.
8. All grease lubricated, and solid self-lubricating bronze bushings shall have grease grooves cut in a pattern as indicated in the Plans. All grease grooves shall be machine cut and smooth. The corners of all grooves shall be rounded to a minimum 1/8-inch radius, unless otherwise shown on the Plans. In cases of solid or split bushings required to support axial loads, provide flanges with grease grooves connected to the grooves in the bushing bore.
9. For solid bushings provide fits between the bushing outside diameter and housing and between the bore and the shaft as specified in the Plans.

(b) Pillow Blocks

10. Provide pillow blocks with turned bolts or turned studs for caps that meet or exceed the requirements of ASTM A449. Bearing housing material shall meet or exceed requirements of carbon steel ASTM A36 or cast steel ASTM A148 Grade 80-40.
11. Housings and cap bolts shall be capable of withstanding design radial and axial loads including uplift. Split bearing housings shall be keyed or doweled together to establish and maintain the bore for the bearing and to eliminate shear loads on the cap bolts. Provide bearing housings equipped with seals, end covers, bearing retainers, lube fittings, and vents.
12. Pillow block and flange-mounted roller bearings shall be adaptor mounting, self-aligning expansion and non-expansion types as called for on the Plans.
13. Undersized mounting holes shall be drilled from the solid in the shop to ensure perpendicularity and location. Seals shall retain the lubricant and exclude water and debris. Cap bolts on pillow blocks shall be high-strength steel. The cap and cap bolts shall be capable of resisting the rated bearing load as an uplift force.

(11) Couplings

(a) Grid Couplings

1. All grid couplings shall be provided as a complete assembly with new keys, bolts, seals, and gaskets.

- a. Bore hubs for an ANSI FN2 fit with shafts in the shop.
 - b. Hub keyseats to connected shafting.
 - c. Provide new keys in all cases.
 - d. Spare parts: 1 spare seal kit, and 1 spare flexible steel grid for each size used.
 2. Grid-type to be self-aligning, fully torsional flexible couplings.
 3. The grid-type couplings shall have steel hubs, alloy steel grids and steel or aluminum covers with shrouded bolts.
- (b) Gear Couplings
1. All gear couplings shall be provided as a complete assembly with new keys, bolts, seals, and gaskets.
 - a. Bore hubs for an ANSI FN2 fit with shafts in the shop.
 - b. Hub keyseats to match connected shafting.
 - c. Provide new keys in all cases.
 - d. Spare parts: 1 spare seal kit, and 2 spare coupling bolts for each size used.
- (c) Instrument Drive Couplings
1. Provide zero backlash couplings for connecting span control equipment with high misalignment capability.
 2. Coordinate coupling hub bore with electrical equipment. Match key seat and bore for an ANSI LC3 fit. Provide a stainless-steel set screw into the top of the key.
 3. Instrument drive couplings may be mounted keyless where this meets the suggested option of the manufacturer of the coupling. A set screw or dowel or similar shall be provided at a minimum.
- (d) Flexible couplings shall be as manufactured by one of the following companies, or approved equal:
4. Falk Corporation, Milwaukee, WI
 5. Lovejoy, Inc., Downers Grove, IL
 6. Kop-Flex / Regal, Florence, KY
- (e) All couplings shall be final aligned to meet the manufacturer's provided alignment criteria.

(12) Lubrication Materials

- (a) Lubricants – Coordinate all lubricants to be used for the bridge machinery with Town maintenance forces, AASHTO, and the requirements and recommendations of component manufacturers. Submit lubricant information to the Engineer for review and approval as required by the “Submittals” header. Lubricant materials shall comply with all applicable environmental rules, regulations and ordinances as required herein.
- (b) Lubrication Piping & Fittings – All bearings and surfaces requiring lubrication, other than gear teeth, shall be fitted for a pressure system of lubrication using NPS 1/4-inch giant button head fittings, unless otherwise indicated on the Plans. The fittings for greasing bushed

bearings shall be tapped into the housing or connected thereto by type 304 stainless steel seamless pipe, which shall be tapped into the housings so that grease will be discharged directly through the housing, shims, bushing, and into the grease grooves for distribution. All grease fittings shall be conveniently located for greasing, and if necessary, shall be connected to the points requiring lubrication from convenient lubrication stations by NPS ¼ stainless steel seamless pipe - schedule 80 with stainless steel threaded pipe fittings – with an operating pressure of 10,000 psi. All stainless steel pipe and fittings shall meet ASTM A312 and ASTM A182, respectively. All pipe extensions shall be kept as short as practical, shall be securely supported at fittings and intermediate points, and located so that it shall be protected from injury. All lubricating equipment shall be installed in perfect condition.

Not more than two sizes of fittings shall be used. The large size shall be used wherever possible, and the smaller size shall be used for motor bearings and other small devices. Pressure fittings shall be rated at a minimum operating pressure of 10,000 psi. Fittings shall contain a steel check valve that will receive grease and close against back pressure.

Immediately after the completion of fabrication, all fitting locations shall be plugged until components are installed and regular lubrication is started. The plugs shall then be replaced with the proper grease fittings. During installation, the Contractor shall lubricate all rotating and sliding parts of the machinery and fill all gear reducers, bearing housings and flexible couplings with lubricants indicated on approved lubrication charts.

- (c) Lubrication Flexible Hose – For connections between components and elements which move with respect to one another, provide ¼-inch nominal double walled, double braided, spirally wound, self-draining, corrugated stainless steel flexible hose, type 304. Minimum working and burst pressure shall be 5,800 psi and 23,000 psi respectively.

Lengths of lubrication hose installed shall be sufficient to remain slack throughout the full range of movement of the bascule span including any possible over-travel. The layout of the flexible hose shall not cause bending exceeding the manufacturer's stated minimum bend radius throughout the full range of movement of the bascule span including any possible over-travel.

Hose shall be equipped with 1/4-inch NPT fittings at each end, one swivel end, male fitting for the bearing end, and one female fitting for the pipe end. The lengths of hoses installed shall not interfere with or rub against bridge elements during opening and closing operations.

- (d) Lubrication Manifolds – Manifold blocks used in the lubrication systems shall be solid blocks of stainless steel, meeting the requirements of ASTM A240 Grade S31600. Faces of the blocks shall be machined smooth to a 125 micro-inch finish unless noted otherwise on the plans. Grease passages through the blocks shall be ¼-inch diameter. The faces of the blocks shall be tapped as appropriate to accept grease fittings, grease cleanout plugs, lubrication pipes, and lubrication hoses. Grease shall not leak or seep from the manifold blocks or its connections when the system is pressurized to the working pressures of the fittings, pipes, and hoses. The manifold blocks shall be bolted to carbon and alloy steel components and members using bolts complying with ASTM A193 Grade B8M and nuts complying with ASTM A194 Grade 8M. Provide flat plain washers complying with ASTM A240 Grade S31600 under the head and the nut. Torque lubrication manifold fasteners in proportion to their strength.

- (e) Lubrication Piping Supports – Pipes shall be supported at least every 6 feet on center and within one foot of both ends, of any pipe bend and of any hose connection. Type 316 stainless steel, vibration dampening U-bolts shall be used to secure each rigid pipe to the angle support. Each U-bolt shall be provided with a thermoplastic elastomer cushion to prevent chafing.

(13) Machinery Supports

- (a) Machinery supports shall be fabricated from minimum 3/8" thick structural steel ASTM A709 Grade 50 unless otherwise noted.
- (b) Unless otherwise noted or shown on the plans, support weldments shall be welded with continuous welds and all joining edges sealed by welding. Use full penetration groove welds on both sides of web plates at joints to top and bottom mounting plates or masonry plates. Use a 5/16-inch minimum fillet weld size all around stiffener plates.
- (c) The bottom of masonry plates to have milled grout grooves or welded steel grout lugs. Stress-relieve after welding. Mill mounting plate surfaces after stress relieving. All mounting plate surfaces are to be parallel over entire length to within 0.002 inch.
- (d) Provide air relief holes through masonry plates for complete grout pad penetration with no voids. Set all grout pads following final machinery alignment.

(14) Shims

- (a) Where shown on the drawings, all machinery shims required for leveling and alignment of equipment neatly trimmed to the dimensions of the assembled parts and drilled for all bolts that pass through the shims. Shims shall provide full bearing between machinery components and structural supports. In general, sufficient thicknesses shall be furnished to secure 1/64" variations of the shim allowance plus one shim equal to the full allowance. For motors thickness shall allow for 0.002" variations. Shims shall be Stainless Steel ASTM A240 Type 304. Shims shall be provided with bolt holes oversized not more than 1/8" greater than the fastener diameter.
- (b) 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. Shims length for motor feet to be across the motor perpendicular to its shaft.
- (c) The use of peel-able laminated shims with solder or resin bonding will be permitted. Plastic or other non-metallic shims will not be permitted. The laminations shall be peel-able, 0.002-inch thickness.

(15) Welding

- (a) Welding required for machinery shall be done in accordance with the Structural Welding Code AWS D1.5 and all interim revisions as of the bid opening date. All groove welds used to fabricate machinery shall be completely tested by ultrasonic inspection using the methods given by ASTM E164 and as per AWS D1.5, Section 6, Part C. Perform magnetic particle testing for all other welds used to fabricate machinery in accordance with ASTM E709 and as per AWS D1.5 Section 6.

- (b) Welding for stainless steel shall conform to AWS D1.6.
- (c) Weldments shall be stress relieved by heat after welding and prior to final machining.
- (d) Distortion during fabrication shall be kept to a minimum by the use of welding fixtures and proper welding procedures. Base metals that are forged or heat treated to increase hardness shall be preheated to prevent cracking prior to any welding.
- (e) Submit all weld procedures and welding qualifications prior to the start of the work.

(16) Coatings

- (a) The paint coating system shall be a 3-coat or 2-coat system consisting of one coat of aluminum epoxy mastic primer and one or two coats of aliphatic acrylic polyurethane.
 - 1. 3-coat system to be used on machinery and structural steel areas greater than 36 square inches which are cleaned to bare metal.
 - 2. Use 2-coat system over small areas of bare metal and existing paint.
 - 3. Use one of the paint manufacturers listed on the NEPCOAT Qualified Products List A or B and accepted by the Engineer.
 - 4. Machinery parts paint color shall be safety orange for parts that rotate.
 - 5. Stationary machinery, machinery fixed to structural steel, machinery supports, and structural steel parts to match paint color to existing structural steel color AMS-STD-595.
- (b) 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.
- (c) For general sealing against water intrusion use Permatex® No. 2 sealant for oily surfaces. For sealing pipe threads use Permatex® Seal + Lock Thread Compound during assembly. For sealing inspection covers use Permatex® Ultra Rubber Gasket Sealant and Dressing.
- (d) Unless otherwise shown on the plans, for screws in tapped holes use permanent assembly thread locker coating on threads. Approved products:
 - 1. Permatex® Threadlocker Blue
 - 2. Loctite® Threadlocker Blue 242
- (e) Rust inhibiting coatings shall be used for the temporary protection of machined surfaces. Rust inhibitor shall be wax-type petroleum based cosmoline meeting MIL-C-11796C Class C for use on machined metal surfaces.

CONSTRUCTION METHODS:

(1) Install Span Lock Machinery

- (a) Remove existing span lock machinery under “Removal of Machinery”.
- (b) Field verify conditions as otherwise indicated herein and on the plans. Identify any necessary concrete modification or form work that will be required to achieve the new arrangement as shown on the plans from the existing site conditions. This nominally will include

modification of the existing concrete block under the existing receiver, for mounting of the new receiver.

- (c) Do not perform any concrete work or lay out and drill new concrete anchors for mounting of the receiver until all new equipment shop drawings have been approved.
- (d) Install new span lock machinery. Ensure coordination with other work. Ensure all relevant structural work is complete, and the live load shoe adjustment work has been completed, prior to final alignment of the span lock. Work may progress up to and excluding final alignment prior to this. Suggest achieving final alignment through leveling and grouting of the new receiver after installing the operator and front guide.
- (e) Install new limit switch equipment and associated mounting hardware as shown on the Plans.

(2) Shop Assembly and Testing

- (a) Shop assemble and/or stage the span lock operator with the new guides. Measure and achieve nominal alignment and guide clearances as required in the shop. Verify critical dimensions and mounting hole spacing and coordinate with field installation plan.
- (b) Test cycle the lock bar operator in the above assembly with the new guides. Ensure smooth operation and no binding. This can be done using the hand wheel and does not require electrical hook up.
- (c) In accordance with the general requirements for all work ensure notification of this work is provided to the Town so that an inspector may witness the shop assembly if desired.

(3) Bolting

- (a) Bolt holes involved in the field assembly for connecting machinery shall, in general, be drilled from the solid after final alignment of the machinery. Sufficient erection holes, sub drilled undersize, for temporary bolts shall be used for erection and alignment of the machinery. Suggest providing holes at 1/2 the final diameter subdrilled, installed with temporary bolts 3/4 the final nominal diameter, in all cases.
- (b) When the machinery is aligned in its final position, and has been accepted by the Engineer, with the equipment secured with temporary bolts, remove one bolt at a time and drill and ream and install final bolt. Ensure bolts are tightened properly, and as each final bolt is installed, to maintain alignment.
- (c) Turned bolts and other grades of bolts shall be installed with two nuts, and final tightened by the torque-tension method to develop a preload of 40% of their proof load at the first nut, and while holding the first nut stationary 70% of proof load at the second nut, unless otherwise noted, and shall be indicated on the erection drawings. If using jam nuts place the jam nut down first. Contractor shall provide a table of all bolt sizes used showing both of these torque values. Coat fasteners with anti-seize. Torque values shall be based on the published friction factor for the anti-seize product used.
- (d) Bolts that connect secondary machinery baseplates or machinery supports, that are generally permanently installed and not used in the alignment, adjustment or typical maintenance or repair of equipment may be installed with a single nut and tightened by the turn-of-the-nut method per Table 8.2 of RCSC (research council for structural connections).

- (e) Fasteners that are a part of manufacturer's product assemblies, such as coupling flange bolts, shall be installed per the manufacturer's instructions unless otherwise noted or instructed by the Engineer.
- (f) Validate torque values using the Skidmore-Wilhelm apparatus for each bolt thread size and material variation. Perform the test with the recommended or approved equal thread lubricant to also be used for torquing bolts at installation.
- (g) Unless otherwise noted install nuts on bolts with a moly anti-seize lubricant, marine grade to reduce torque applied to bolt, hold the threaded connection, and prevent corrosion.

(4) Lubrication

- (a) Lubricate guides and any other required lubrication in accordance with the manufacturer's instructions of any equipment until fresh lubricant is purged out.
- (b) Contractor shall be responsible for the proper upkeep and maintenance of all equipment for the duration of the contract, which includes periodic lubrication.

(5) Cleaning and Painting

- (a) New and refurbished machinery external surfaces shall be cleaned with final surface preparation, prior to painting, done by solvent hand tools, or power tool cleaning to meet the requirements of SSPC- SP 1, 2, or 3 with the following exceptions:

The following excepted surfaces and equipment shall be cleaned with solvent to meet the requirements of SSPC-SP 1. Generally, these surfaces are not painted, however remove excess grease for painting non-wearing surfaces of these components.

Seals and gaskets

Brakes, motors, limit switches and other electro-mechanical components

Bronze, galvanized, and stainless-steel parts

- (b) After proper surface preparation, machinery surfaces shall be coated with a 3-coat system applied as per the manufacture's temperature and humidity requirements for application.
- (c) Surfaces for fit-up in fixed contact with other components to have one primer coat. This does not include machinery base on steel mounting surfaces.
- (d) Acceptable coatings are given under Supplemental Materials.
- (e) The Contractor shall take special care to avoid painting of machinery surfaces which are in normal sliding contact. All nameplates, legend plates, and escutcheons mounted on machinery shall be masked for protection from paint. Lubrication fittings shall be kept clog-free.

(6) Testing

- (a) Testing is to be done without any live load on the span. Test cycle the span lock assembly three (3) times while recording the motor current after completion of the work. The motor current draw shall not exceed 75% of the full motor's rated full load amperes. Test results shall be submitted to the engineer for approval. Operate the lockbar manually at least once.
- (b) Testing shall be done joint with the final acceptance testing as required by that specification and in coordination with all mechanical and electrical work on the bascule span. Testing shall demonstrate all functionality and prove all required alignment and other requirements.

- (c) Initial testing shall be performed joint with the initial span operation procedure and approved prior to putting the new equipment into service.

(7) Waste Disposal

- (a) Unless otherwise specified all refuse, materials and debris resulting from execution of this item shall become the responsibility of the Contractor and removed from the premises. Materials not scheduled for reuse shall be removed from the site and disposed of in accordance with all applicable Federal, State and Local requirements.

METHOD OF MEASUREMENT:

No direct measurement shall be made for the work, as it is paid on a lump sum basis.

BASIS OF PAYMENT:

- (a) The work will be paid for at the contract lump sum price for “Span Lock Machinery”, which shall include all materials, equipment, and labor necessary to complete the work as identified on the plans and as noted herein.
- (b) This work shall not be compensated until the Town determines that the work has been tested and functions to the satisfaction of the Town.
- (c) Final payment will not be made until all the project closeout data submittals have been completed. Once the completed package has been received in its entirety, the Town will make the final payment to the Contractor.

Pay Item
Lock Machinery

Unit
LS

107.13

BASCULE SPAN BALANCE

LUMP SUM

DESCRIPTION:

This work shall include balancing and balance testing the bascule leaves to ensure compliance with the design criteria listed on the Plans and elsewhere herein. Under this item the work includes:

- (a) Balance testing performed using the dynamic strain gage procedure described in this provision.
 - 1. The Contractor shall employ the services of an established testing company experienced in dynamic strain gage measurement of movable bridge imbalance, subject to acceptance of the Town. Such experience shall be demonstrated by identifying a minimum of six movable bridges including at least three trunnion bascule bridges for which the company has provided complete and satisfactory dynamic strain gage measurements and reporting. The measurements shall be made under the immediate direction of a Professional Engineer registered in the State of Massachusetts who has had hands-on experience measuring movable span imbalance by the dynamic strain gage procedure.
 - 2. Acceptable testing companies include but are not limited to:
 - (a) Gresham Consulting LLC, Chalfont, PA
 - (b) Wiss Janney Engineering (Stafford Bandlow Engineering), Doylestown, PA
 - (c) Modjeski & Masters, Mechanicsburg, PA
- (b) Preparation of balance summary tables (balance calculations) prior to and during construction.
- (c) The development and documentation of the balance procedure and methods.
- (d) All other work required to complete the balancing, including placing and adjusting ballast required for balancing the bascule leaves. This includes placement and removal of temporary balance weight as required during various phases of construction. This also includes repeated readjustment of balance ballast as necessary until the leaves are balanced as specified on the plans. Documentation is required for all balancing work, including temporary balancing during construction.

BALANCE CRITERIA:

- (a) The final balance target is a 1-kip (± 250 -lbs) dead load reaction (toe reaction) as taken at the live load supports, as measured and presented as a torque at the bridge shafts. Based on a distance of 50 feet from the center of span rotation to the live load supports, the target span heavy positive imbalance is 50-kip-feet (± 12.5 -kip-feet).
- (b) The maximum permissible imbalance moment at any point over the range of operation shall not exceed 100-kip-feet.
- (c) The balance shall be targeted such that the span maintains a toe heavy imbalance moment (not counterweight heavy) at all times to the extent feasible. If initial testing demonstrates significant limitations, adjusted targets will be provided.

- (d) During construction, while the span is NOT operational, and with the span properly supported, the span shall be span (toe) heavy at all times. Other criteria may be waived for these conditions.
- (e) During construction, with the span operational, the maximum imbalance targets may be doubled from the above final targets.

MATERIALS:

(1) Balance Blocks

- (a) Steel blocks made from ASTM A36 steel or cast-iron ASTM A48. All blocks to have the same dimensions and weigh 100 pounds +/- 2.5 pounds.
- (b) Include hole or handle for lifting.
- (c) Coordinate with structural work. Quantity, if any, of required ballast is based primarily on weight changes incurred in the structural work.

(2) Coatings

- (a) The paint coating system shall be in accordance with that used elsewhere on the project.
- (b) Encapsulant Coating: epoxy-based paint for encapsulation of lead that is waterproof and weatherproof shall be used where appropriate.

CONSTRUCTION METHODS:

(1) Submittals

- (a) Qualifications of the strain gage testing company to perform the imbalance measurements shall be submitted to the Town for acceptance. Required qualifications are specified herein.
- (b) Strain gage test procedure: Submit a detailed list of the test procedure to be followed.
 - (1) Description of experimental procedure including type and method of installation of strain gage rosettes, method of transmission of low-level signals, and data acquisition equipment.
 - (2) Layout of leaf drive machinery showing proposed location of strain gages, amplifiers, cable or radio links, data acquisition equipment and all associated cabling.
 - (3) Elementary wiring diagrams of interconnection of strain gages, amplifiers, and data acquisition equipment.
 - (4) Sample computations of shaft torque from measured strains, leaf imbalance, curve fitting and basis for friction correction.
 - (5) Catalog sheets of all strain gage equipment.
- (c) Submit balance summary tables (balance calculations). Include figures and tables to exhibit method of approach and summarize results. Balance calculations shall be submitted by a

licensed professional engineer in the state of Massachusetts.

- (d) Submit strain gage test reports providing for an initial and final balance condition, performed prior to any field work, and at the end of all work that may affect balance.
- (e) Strain gage test reports shall include the following:
 - (1) Introductory section giving the name of the bridge, the date of the measurements, weather conditions during measurements and any other information requested by the Town.
 - (2) Description of experimental procedure and equipment used.
 - (3) Leaf drive diagram showing location at which strain gages were attached and all applicable gear ratios.
 - (4) Description of relationships and sample calculations for obtaining shaft torque from strains, leaf imbalance from shaft torque, curve fitting and basis for friction correction.
 - (5) Plots of the following parameters versus degree of opening during each opening/closing run and fitted imbalance curves corrected for friction.
 - (6) Total imbalance (kip-feet) for each leaf.
 - (7) Frictional moment (kip-feet) for each leaf.
 - (8) Tabulation of imbalance moment at seated position for each leaf/run including the average value for each leaf.
 - (9) The location of the leaf center of gravity in polar coordinate system with respect to the center of roll as the origin and the angle defined from the horizontal towards the toe end of the leaf.
- (f) Initial operation procedure to be performed at the time of first operation on the new machinery. This shall include/require:
 - (1) A means for physically verifying the seated toe reaction.
 - (2) Incremental span openings stopping every 10 degrees and performing a static drift test to validate span behavior.
 - (3) Strain gage load monitoring during the initial operations. This shall include validation of the load sharing achieved by indexing of the machinery cross shafts.
 - (4) This activity shall be performed in the presence of the Engineer. The span shall not be allowed to be operated in any capacity prior to approval of this procedure and performing the work.
 - (5) Inspection of all equipment performed by the Engineer on site to their satisfaction.

MEASUREMENTS AND VERIFICATION:

Dimensions and weights indicated on the Contract Drawings are nominal and are intended for guidance only. Field verify any ballast, quantities, and locations.

BALANCE CALCULATIONS & BALANCING DURING CONSTRUCTION:

- (a) During the work the contractor shall maintain the balance of each leaf to within the permitted acceptance criteria.
- (b) Balance calculations and summary tables shall be coordinated with structural shop drawings and any other miscellaneous or incidental work to be incorporated on each bascule leaf.
- (c) Document the exact locations of component weights in three dimensional cartesian coordinate system with the center of roll as the origin and the toe as the positive “x” direction and up as the positive “y” direction.
- (d) The quantity and location of required temporary weight based on weight added or removed from the leaf and the specified balance requirements shall be computed.
- (e) For all balance summary table submittals, a narrative shall be included with the outline of the proposed balance phasing, the duration of the imbalance condition, and all other aspects of the work in accordance with the approved construction schedule. This information shall be coordinated with the Contractor’s scheduling requirements. The balance summary tables shall be updated by the Contractor throughout construction and shall be submitted to the Town daily as required to meet the requirements in these Specifications and in the Plans.

CLEANING AND PAINTING:

New or refurbished, and existing steel surfaces associated with the balancing work shall be cleaned and painted in accordance with the general coating requirements otherwise specified in this Contract.

METHOD OF MEASUREMENT:

No direct measurement will be made for the work, as it is paid on a lump sum basis.

BASIS OF PAYMENT:

- (a) The work will be paid for at the contract lump sum price for “Bascule Span Balance”, which shall include all materials, equipment, and labor necessary to complete the work as identified on the plans and as noted herein.
- (b) The strain gage testing shall be paid on a lump sum basis for each test as incurred.
- (c) This work will not be compensated until the Town determines that the work has been tested and functions to the satisfaction of the Engineer.
- (d) Final payment will not be made until all the project closeout data submittals have been completed. Once the completed package has been received in its entirety, the Town will make the final payment to the Contractor.

<u>Pay Items</u>	<u>Pay Unit</u>
Bascule Span Balance	LS
Strain Gage Installation and Test (each as incurred)	LS
Strain Gage Repeat Tests (no installation) (each as incurred)	LS

107.14

REMOVAL OF MACHINERY

LUMP SUM

DESCRIPTION:

Work consists of removing bascule span operating machinery assembly, span lock assembly, and all associated electrical equipment as indicated in the Plans. Machinery noted as “Existing” to remain and shall be protected and refurbished in accordance with the Contract. This work includes structural supports and/or machinery supports where clearly shown and noted in the mechanical drawings.

Ensure all work is coordinated between structural, electrical and mechanical disciplines.

GENERAL REQUIREMENTS:

(1) Submittals

- (a) Work Procedure: Submit a detail list of the work procedure to be followed, method of removal and disposal of equipment.
- (b) Submit assembly drawings showing all equipment to be removed. Indicate equipment to be reused. Indicate any temporarily removed equipment to facilitate the work. Drawings shall show means of temporary supports/blocking as needed.
- (c) Submit a schedule of all work that requires interruption to movable span operation and/or restrictions to road traffic. Coordinate with other planned work to occur during interruptions.

(2) Work Procedures

- (a) All labor, materials, tools, equipment, services, testing, insurance, and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these Specifications shall be provided by the Contractor. The Contractor shall be prepared to work extended shifts, nighttime work and weekends.
- (b) Prior to beginning work, the Contractor shall review conditions at the site for verifying measurements, assessing existing conditions, and safety reasons. In addition, the Contractor shall instruct all workers in all aspects of personal protection, work procedures, movable bridge operation, emergency evacuation procedures and use of equipment including procedures unique to this project.
- (c) Shut down and lockout/tagout operating machinery electrical power while working on equipment.

MATERIALS:

(1) Protective Materials

(a) Tarpaulin

1. Woven plastic or heavy-duty fire-retardant canvas, tear and puncture resistant for use with abrasive blasting media used on steel.

(b) Tape

1. Heavy duty tape, leak proof, abrasive and petroleum product resistant.

(c) Lumber and Dunnage

1. Marine grade plywood water and weather resistant, and free of surface and core defects. Shall meet BS1088 marine standard. Provide minimum thickness of 3/8 inch.
2. Soft Pine #1 grade

(2) Coatings

(a) EP-2 (extreme pressure) rated grease.

(b) Lubricating oil SAE rated.

(c) Rust inhibitor and penetrating solvent.

CONSTRUCTION METHODS:

(1) Waste Disposal

Unless otherwise specified all refuse, materials and debris resulting from execution of this item shall become the responsibility of the Contractor and removed from the premises. Materials not scheduled for reuse shall be removed from the site and disposed of in accordance with all applicable Federal, State and Local requirements.

METHOD OF MEASUREMENT:

No direct measurement shall be made for the work, as it is paid on a lump sum basis.

BASIS OF PAYMENT:

- (a) The work will be paid for at the contract lump sum price for “Removal of Machinery”, which shall include all materials, equipment, and labor necessary to complete the work as identified on the plans and as noted herein.
- (b) Final payment will not be made until all the project closeout data submittals have been completed. Once the completed package has been received in its entirety, the Town will make the final payment to the Contractor.

Pay Item

Removal of Machinery

Unit

LS

107.15

LIVE LOAD SHOE ADJUSTMENT

LUMP SUM

DESCRIPTION:

The work for Live Load Shoes includes measurement and adjustment of shims at the load shoes. This work also includes installation of the new fully seated span limit switch (electrical item).

After all structural and road deck work has been completed, the live load supports shall be adjusted to achieve correct road joint alignment and seated span elevation, and such that there is equal, firm contact at each of the two supports.

Work on the live load supports shall also be coordinated with work on the span lock equipment, setting of electrical indication equipment and the control sequence of the bridge. The work under this item shall be completed prior to final alignment of the lock machinery.

Ensure all work is coordinated between structural, electrical and mechanical disciplines.

GENERAL REQUIREMENTS:

(1) Submittals

- (a) Bridge site field measurements report and drawings to document existing and final road joint alignment and live load support elevations/conditions, and any other dimensions and locations of all interface points between existing surfaces incidental to this work.
- (b) Manufacturer's data and/or shop drawings shall be submitted for all manufactured and purchased items of machinery/components.
 - 1. Shop drawings shall show all parts completely detailed and dimensioned. Reproduction of the Plans shall not be used as foundation sheets for assembly or erection drawings. Shop drawings shall include assembly drawings.
 - 2. The Contractor shall prepare and submit shop drawings to the Town for acceptance prior to fabricating the material.
 - 3. Shop drawings shall include, but not be limited to, field measurements, installation plans, material lists and material designations. The weight of the detailed elements shall be included on the shop drawings.
 - 4. Materials and material specifications shall be stated for each part. Where standard specifications are used, the applicable designation of such material specifications shall be given.
 - 5. Submit catalog cuts of new components.
- (c) Work Procedure: Submit a detailed list of the work procedure to be followed.

- (d) Task Schedule: Schedule of work that requires interruption to movable span operation and roadway usage or channel navigation.
- (e) Certified material test reports: Include all chemical and mechanical properties for each material that is part of the Work.
- (f) Test Reports: All measurements after field adjusting and testing.

(2) Delivery and Storage

- (a) Machinery parts shall be cleaned of dirt, chips, grit, and all other injurious materials prior to shipping. 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. This coating shall be removed from all surfaces prior to lubrication of machinery.
- (b) At any interface between stainless steel or aluminum and steel, the steel shall be coated with primer prior to assembly.
- (c) Machinery parts shall be completely protected from weather, dirt, and all other injurious conditions during manufacture, shipment, and storage.
- (d) 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.
- (e) Assembled units shall be mounted on skids or otherwise crated for protection during handling and shipment.
- (f) Spare parts as defined in the Plans shall be protected for shipment and prolonged storage by coating, wrapping, and boxing. All spare parts shall be durably tagged or marked with a clear identification showing the designation used on the approved shop drawing. Boxes for spare parts shall be clearly marked on the outside to show their contents.

(3) Guarantees and Warranties

- (a) Manufacturer's warranties or guarantees on equipment, materials or products purchased for use on the Contract which are consistent with those provided as customary trade practice, shall be obtained by the Contractor and, upon substantial completion of the contract, the Contractor shall assign to the Town, all manufacturer's warranties or guarantees on all such equipment, material or products furnished or installed.
- (b) The Contractor shall warrant the satisfactory in-service operation of the mechanical equipment, material, products, and related components. This warranty shall extend for a period of one year following the date of final acceptance of the Project.

(4) Quality Assurance

- (a) Products used in the work shall be produced by manufacturers regularly engaged in the manufacture of the specified products.
- (b) For the fabrication, installation, and testing of work required by the machinery items, 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 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 machinery.

- (c) The Contractor shall provide all reasonable facilities, necessary tools and instruments required for the proper performance of the personnel engaged in the execution of the specified work.

(5) Codes and Standards

- (a) Work shall comply with, but not be limited to, all applicable requirements of the following codes and standards and their abbreviations used in this Specification:

1. American Association of State Highway and Transportation Officials (AASHTO)
2. American Iron and Steel Institute (AISI)
3. American National Standards Institute (ANSI)
4. American Society of Mechanical Engineers (ASME)
5. American Society for Testing and Materials (ASTM)
6. American Welding Society (AWS)
7. National Lubricating Grease Institute (NLGI)
8. Society of Automotive Engineers (SAE)
9. Steel Structures Painting Council (SSPC)
10. United States Military Specifications (MIL)
11. Anti-Friction Bearing Manufacturers Association (AFBMA)
12. National Fluid Power Association (NFPA)
13. National Lubricating Grease Institute (NLGI)
14. Occupational Safety and Health Administration (OSHA)
15. Society of Automotive Engineers (SAE)
16. National Electric Code (NEC)
17. National Electrical Manufacturers Association (NEMA)
18. Underwriters Laboratory, Inc. (UL)

- (b) 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 attention to them; it is not intended to imply that any other codes and standards shall be assumed to be omitted if not mentioned.

(6) Measurements and Verification

Dimensions indicated on the Contract Drawings are nominal based on limited field verification and availability of existing “As-Built” drawings. Contractor is to field verify all indicated measurements herein and on the plans at the bridge site. Field verification may include partial or complete disassembly of existing components. The contractor is urged to schedule any disassembly and reassembly prior to any other work as early as possible where field verification may be needed to finalize new parts and/or assembly details. Attention is

called specifically to components replaced in-kind, and specifically to any existing mounting bolt holes in the existing structure to be re-used. New flanges, hubs or other fits, including turned bolt fits, shall be adjusted based on measuring the existing structure, including any cleanup needed to restore surface conditions. In all such cases, the sizes shown on the plans shall be the minimum sizes. Final sizes and/or custom fit tolerance ranges shall be submitted for approval on the shop drawings.

In general, the machinery removals shall be performed prior to this work, as well as cleaning of all rust, grease and dirt from the areas and materials to be reused.

Notice shall be given to allow the Engineer to witness and review field verification efforts on site.

(7) Substitutions

- (a) The terms "approved equal", "of equal quality" and "or equal" which may appear on the Contract Drawings and in these Specifications are intended to allow the Contractor to submit for review other manufacturers and model numbers of products of equal quality and rating for those specified.
- (b) Prior to the Contractor's ordering of any substitute product, the Engineer's acceptance 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.
- (c) Acceptance 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.
- (d) Where a 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 made by another manufacturer may be submitted for review for the specified product subject to the acceptance of the Engineer; however, all necessary changes required by the substitution in related machinery, structural, architectural and electrical parts, and scheduling shall be made by the Contractor at no additional cost to the Town.

(8) Inspection

- (a) The Contractor shall give no less than ten (10) working days' notice to the Town of the beginning of work at foundries, forge, and machine shops so that inspection may be provided. No materials shall be cast, forged, or machined before the Town has been notified where the orders have been placed.
- (b) 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 Town 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.

- (c) The Inspector will have the authority to reject materials or workmanship which does not fulfill the requirements of these Specifications.
- (d) Inspection at the foundries, forge, and machine shops is intended as a means of facilitating the work and avoiding errors. It is expressly understood that inspection will not relieve the Contractor from any responsibility regarding material or workmanship and the necessity for replacing defective materials or workmanship which are delivered to the job site.
- (e) The Contractor shall furnish the Town with a copy of all orders covering work performed by subcontractors or suppliers.

(9) Defective Materials and Workmanship

- (a) The acceptance of any material or finished parts by the Town shall not prohibit their subsequent rejection if found defective. Rejected material and workmanship shall be replaced or made acceptable by the Contractor at no additional cost to the Town.
- (b) All machinery rejected during inspection and testing shall be removed from the work site and replaced at no additional cost to the Town.
- (c) Delays resulting from the rejection of material, equipment or work shall not be the basis of any claim.
- (d) All defects found during the warrantee/guarantee period resulting from faulty material, components, workmanship, or installation shall be corrected by the Contractor at no additional cost to the Town. The Town reserves the right to make necessary corrections with its own forces and charge the resulting costs to the Contractor.

(10) Work Procedures

- (a) All labor, materials, tools, equipment, services, testing, insurance, and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these Specifications shall be provided by the Contractor. The Contractor shall be prepared to work all shifts and weekends throughout the course of this project.
- (b) Prior to beginning work, the Contractor shall review conditions at the site for verifying measurements, assessing existing conditions, and safety reasons. In addition, the Contractor shall instruct all workers in all aspects of personal protection, work procedures, movable bridge operation, emergency evacuation procedures and use of equipment including procedures unique to this project.
- (c) Shut down and lockout/tagout operating machinery electrical power while working on equipment.
- (d) Whenever the contractor is not at the bridge site the span is to be operational unless work is done during an approved navigation or road outage.
- (e) Provide temporary supports, rigging, or access as needed to facilitate all work.
- (f) Submit a schedule of all work that requires interruption to movable span operation and restrictions to either road outage or channel navigation for review and acceptance. Provide work activities for each day and the duration of the restriction.

MATERIALS:

(1) Live Load Shoe Shims

- (a) Provide live load shoe shims as needed based on the field measurements to achieve the proper elevation and alignment of the span, and equal firm contact at each support.

(2) Fully Seated Limit Switch

- (a) Install the new fully seated limit switch as shown on the Plans. Note the switch is an electrical item and shall be provided and installed as per the electrical requirements.

(3) Fasteners

- (a) Provide new fasteners as shown on the Plans or otherwise as required/included in manufacturer's products. Replace any other fasteners exhibiting section loss or otherwise damaged as directly associated with performing the work herein.

MATERIAL REQUIREMENTS:

(1) Fasteners

- (a) Machinery fit, high-strength turned bolts shall meet the requirements of ASTM F3125 Grade A325 or A449 high strength bolts with a finished full body diameter. The finished body or shank diameter shall have a tolerance that meets an ANSI LC6 fit with a field reamed hole. Bolt bodies shall have a straightness tolerance of 0.002 inch. Polish or machine the bolt diameter to achieve an overall body diameter deviation within the given shaft tolerance of an LC6 fit for the entire lot of finished body bolts. The finished body diameter shall be equal or greater than the thread major diameter after polishing or machining the bolt.
- (b) High strength bolts shall be connected using nuts meeting the requirements of ASTM A563.
- (c) Finished shanks of turned bolts shall be 1/16-inch larger in diameter than the diameter of the thread, unless otherwise noted. Where specified, order full body bolts with 1/64-inch oversized diameter, or for bolts greater than 1-3/8-inch diameter order 1/32-inch oversized diameter. The shanks of all turned bolts shall have Class LC6 fit in the finished holes in accordance with ANSI Standard B18.2. Turned bolts shall be fully detailed on shop drawings.
- (d) Hex socket flat countersunk head cap screws shall conform to ASTM F879 (Stainless Steel) for diameters less than 7/8" and ASTM F835 (Alloy Steel) for diameters equal or greater than 7/8".
- (e) 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.
- (f) 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 $\frac{1}{4}$ inch smaller in diameter than the bolt diameter and shall be reamed assembled for the proper fit at assembly or at erection with the steel work after the parts are correctly assembled and aligned.
 - (g) All elements connected by bolts shall be drilled or reamed assembled to assure accurate alignment of the holes in each element and accurate clearance over the entire shank length of the bolt.
 - (h) High-strength bolts shall be installed with a hardened plain washer meeting ASTM F436 at each end.
 - (i) Fasteners less than 1/2-inch diameter to be stainless steel AISI type 304.
 - (j) Anchor bolts connecting machinery parts to masonry shall conform to ASTM F1554 Grade 55, unless noted otherwise.
 - (k) Except for turned bolts all bolts, screws, anchors, nuts, and washers shall be hot-dipped galvanized in accordance with ASTM A153 unless noted otherwise.
 - (l) Split lock washers shall conform to the SAE regular dimensions. The material shall meet the SAE tests for temper and toughness.
 - (m) All cotter pins shall conform to the SAE standard dimensions and shall be made of half-round stainless-steel wire, ASTM A276, Type 304.
 - (n) All fasteners shall be of United States manufacture and shall be clearly marked with the manufacturer's designation.

(2) Shims

- (a) Where shown on the drawings, all machinery shims required for leveling and alignment of equipment neatly trimmed to the dimensions of the assembled parts and drilled for all bolts that pass through the shims. Shims shall provide full bearing between machinery components and structural supports. In general, sufficient thicknesses shall be furnished to secure $\frac{1}{64}$ " variations of the shim allowance plus one shim equal to the full allowance. For motors thickness shall allow for 0.002" variations. Shims shall be Stainless Steel ASTM A240 Type 304. Shims shall be provided with bolt holes oversized not more than $\frac{1}{8}$ " greater than the fastener diameter.
- (b) 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. Shims length for motor feet to be across the motor perpendicular to its shaft.
- (c) The use of peel-able laminated shims with solder or resin bonding will be permitted. Plastic or other non-metallic shims will not be permitted. The laminations shall be peel-able, 0.002-inch thickness.

(3) Welding

- (a) Welding required for machinery shall be done in accordance with the Structural Welding Code AWS D1.5 and all interim revisions as of the bid opening date. All groove welds used to fabricate machinery shall be completely tested by ultrasonic inspection using the methods given by ASTM E164 and as per AWS D1.5, Section 6, Part C. Perform magnetic particle testing for all other welds used to fabricate machinery in accordance with ASTM E709 and as per AWS D1.5 Section 6.
- (b) Welding for stainless steel shall conform to AWS D1.6.
- (c) Weldments shall be stress relieved by heat after welding and prior to final machining.
- (d) Distortion during fabrication shall be kept to a minimum by the use of welding fixtures and proper welding procedures. Base metals that are forged or heat treated to increase hardness shall be preheated to prevent cracking prior to any welding.
- (e) Submit all weld procedures and welding qualifications prior to the start of the work.

(4) Coatings

- (a) The paint coating system shall be a 3-coat or 2-coat system consisting of one coat of aluminum epoxy mastic primer and one or two coats of aliphatic acrylic polyurethane.
 - 1. 3-coat system to be used on machinery and structural steel areas greater than 36 square inches which are cleaned to bare metal.
 - 2. Use 2-coat system over small areas of bare metal and existing paint.
 - 3. Use one of the paint manufacturers listed on the NEPCOAT Qualified Products List A or B and accepted by the Engineer.
 - 4. Machinery parts paint color shall be safety orange for parts that rotate.
 - 5. Stationary machinery, machinery fixed to structural steel, machinery supports, and structural steel parts to match paint color to existing structural steel color AMS-STD-595.
- (b) 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.
- (c) For general sealing against water intrusion use Permatex® No. 2 sealant for oily surfaces. For sealing pipe threads use Permatex® Seal + Lock Thread Compound during assembly. For sealing inspection covers use Permatex® Ultra Rubber Gasket Sealant and Dressing.
- (d) Unless otherwise shown on the plans, for screws in tapped holes use permanent assembly thread locker coating on threads. Approved products:
 - 1. Permatex® Threadlocker Blue
 - 2. Loctite® Threadlocker Blue 242
- (e) Rust inhibiting coatings shall be used for the temporary protection of machined surfaces. Rust inhibitor shall be wax-type petroleum based cosmoline meeting MIL-C-11796C Class C for use on machined metal surfaces.

CONSTRUCTION METHODS:

(1) Measure and adjust live load support elevations

- (a) Document existing conditions at the beginning of the contract, including clearance from rest pier to bascule end floorbeam, road joint alignment, and live load shoe contact (clearances).
- (b) After all structural work has been completed, clean up the live load support assemblies, and perform adjustments as necessary to achieve road joint alignment within 1/16" and even firm contact at each support. Replace fasteners in-kind as needed to facilitate potential shimming and where existing fasteners are found to exhibit significant section loss.
- (c) Submit results for review and approval of work. Note results will be verified as a part of final acceptance testing.
- (d) Paint the assemblies.

(2) Install new fully seated limit switches (electrical items)

- (a) Remove existing limit switches under "Removal of Bridge Machinery".
- (b) Field verify placement based on approved shop drawings and/or catalog cuts of new equipment.
- (c) Install new seated plunger switches. Adjust and incorporate into the control system. Ensure coordination with all other critical elevations and sequencing of work. See electrical plans and specifications.

(3) Cleaning and Painting

- (a) Refurbished external surfaces shall be cleaned with final surface preparation, prior to painting, done by solvent hand tools, or power tool cleaning to meet the requirements of SSPC- SP 1, 2, or 3 with the following exceptions:

The following excepted surfaces and equipment shall be cleaned with solvent to meet the requirements of SSPC-SP 1. Generally, these surfaces are not painted, however remove excess grease for painting non-wearing surfaces of these components.

Seals and gaskets

Brakes, motors, limit switches and other electro-mechanical components

Bronze, galvanized, and stainless-steel parts

- (b) After proper surface preparation, machinery surfaces shall be coated with a 3-coat epoxy paint system applied as per the manufacture's temperature and humidity requirements for application. Coordinate products with other bridge work and submit all paint products to the Town for approval.
- (c) Surfaces for fit-up in fixed contact with other components to have one primer coat. This does not include machinery base on steel mounting surfaces.
- (d) Acceptable coatings meeting the general requirements are given under Supplemental Materials. Contract shall submit actual products for review and approval.
- (e) The Contractor shall take special care to avoid painting of machinery surfaces which are in

normal sliding contact. All nameplates, legend plates, and escutcheons mounted on machinery shall be masked for protection from paint. Lubrication fittings shall be kept clog-free.

(4) Testing

- (a) Testing shall include operating the span and validating the live load support contact (clearances), span/road alignment, and incidentally the lock equipment alignment. This shall be performed as a part of joint acceptance testing as described in that specification section.

(5) Waste Disposal

- (a) Unless otherwise specified all refuse, materials and debris resulting from execution of this item shall become the responsibility of the Contractor and removed from the premises. Materials not scheduled for reuse shall be removed from the site and disposed of in accordance with all applicable Federal, State and Local requirements.

METHOD OF MEASUREMENT:

No direct measurement shall be made for the work, as it is paid on a lump sum basis.

BASIS OF PAYMENT:

- (a) The work will be paid for at the contract lump sum price for “Live Load Shoe Adjustment”, which shall include all materials, equipment, and labor necessary to complete the work as identified on the plans and as noted herein.
- (b) This work shall not be compensated until the Town determines that the work has been tested and functions to the satisfaction of the Town.
- (c) Final payment will not be made until all the project closeout data submittals have been completed. Once the completed package has been received in its entirety, the Town will make the final payment to the Contractor.

Pay Item

Live Load Shoe Adjustment

Unit

LS

107.16

ACCEPTANCE TESTING

LUMP SUM

DESCRIPTION:

Under this item, the Contractor shall perform final acceptance testing of the completed mechanical and electrical systems. This also includes producing Operating and Maintenance Manuals. This work will include acquiring, coordinating, assembling, organizing and editing all information required for inclusion in the manuals. As part of this item, the Contractor shall also provide training for bridge maintenance and operational personnel.

This work also includes an initial operating procedure and site test that shall be performed and approved prior to any operation of the span on the new equipment. No equipment shall be placed into service until approval of such initial operational checks. This is in addition to the final acceptance testing effort.

The Contractor shall coordinate this work with all field inspection and electrical testing.

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.

The work under this item shall be coordinated with structural, mechanical and electrical work and shall provide for all requirements identified elsewhere in the plans and specifications.

GENERAL REQUIREMENTS:

(1) Submittals

(a) Test Procedures and Schedules.

1. The Contractor shall prepare and submit testing procedures for span operating machinery and lock machinery to the Engineer for acceptance at least one month prior to the scheduled tests.
2. The testing procedure shall be coordinated with any other tests required for the electrical equipment and shall include measurements of power and current drawn by the motors when operating under load as required hereinafter.
3. Submit catalog cuts of testing equipment and calibration certificates.

(b) Submit a report of all measurements and checks after field adjusting and testing.

1. Provide accurate graphs of each span drive motor current readings during three (3) test trails of span operation from closed to full open and based to closed.
2. Provide accurate graphs of each lock motor current for three (3) test trails of engaging and disengaging the locks.

3. Any other measurements or criteria as set forth in the approved procedure.

(c) Operation and Maintenance (O&M) Manuals.

(2) Testing Requirements

- (a) 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 and electricians for a minimum of four working days 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 systems shall be considered ready for testing at such time that all work has been completed and all equipment and systems are final installed to the requirements in the plans and specifications. The testing shall demonstrate that all equipment and systems meet the final requirements to the satisfaction of the Engineer.
- (b) When the machinery is ready for field testing, all machinery systems shall be driven by the permanent electrical system through at least ten complete cycles. All components, drives, power supplies and modes shall be included at least once, including manual operation where applicable. If any adjustments or corrections are required, the testing shall be repeated in full. No further adjustments or corrections shall be made after approval of the testing report. If such work is performed for any reason, the testing shall be repeated once all work has been completed.
- (c) Power and current drawn by all motors shall be automatically data logged and graphed. The recordings shall be made for complete cycles of operation.
- (d) The testing shall demonstrate the complete functionality of the control system including all interlocks by physically simulating the functionalities.
- (e) The testing shall be coordinated with and meet any equipment, system and testing requirements as otherwise provided for in the Plans and Specifications.
- (f) During the test runs, all machinery systems in their entirety shall be inspected to determine whether everything is in proper working order and fully meets the requirements of the Contract Drawings and Specifications. 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.

(3) O&M Manual Requirements

- (a) The document shall include a clear title, name of the bridge/project, location, date, and Town.
- (b) A list of all relevant contact information including but not limited to:
 - 1. All manufacturers of all equipment used on the project.
 - 2. The Contractor.
 - 3. The Engineer.
 - 4. Others as requested by the Town.
- (c) A table of contents with clearly identifiable descriptions including volumes and page

numbers.

(d) The manual shall be broken into the following volumes:

1. Operation, including:

- Site safety considerations, including but not limited to all lock-out tag-out procedures.
- A general description of the bridge, the systems installed, and how it functions. This shall include a description of the control system and any interlock functionalities.
- Detailed step-by-step operating procedures for all operational modes and functions, and any other typical activities expected.
- Procedures for troubleshooting operational issues, drive faults etc., including but not limited to all electrical indication equipment.
- A list of all spare parts to be kept on site and names and contacts of local suppliers for ordering new parts, including but not limited to all electrical indication equipment.

2. Maintenance, including for each component and/or system on the bridge:

- Detailed descriptions of how each system and component functions including all electrical and mechanical items.
- Recommended inspection practices, including both for maintenance personnel to perform as a part of regular walkthroughs or scheduled inspections, as well as for biennial inspection to be performed by engineering inspectors.
- All required maintenance activities with clear instructions and references to further product documentation or other sections of the manual where appropriate.
- Individual component troubleshooting and likely points of repair. This shall include information (settings, suggested procedures) for adjustment of all adjustable or wearing features.
- Lubrication schematics showing the products, type, method, and frequency of all lubrication activities required. This shall include clear pictorial representation of the location of all equipment.

3. Drawings and Literature, including:

- Any O&M documentation such as installation instructions or manuals provided by manufacturers of all equipment on the bridge.
- Catalog cuts of all parts or components associated with all equipment identifying the make, model, technical specifications, and safety documentation. This shall also include all products necessary for maintenance, such as greases, oils, paints etc.
- A full set of “As-Built” plans. These shall accurately incorporate all final shop drawings, any RFI’s, and/or field adjustments or changes

throughout the project.

- Copies of all warranties for equipment supplied to the project.
- (e) All above information shall be updated based on any changes or findings found through testing, training etc.

(4) Training Requirements

- (a) The Contractor shall provide training for the bridge maintenance and operational personnel.
- (b) Training shall include all operating procedures, troubleshooting, and maintenance activities included in the approved O&M manual. All activities shall be performed on site with the bridge personnel.
- (c) Training shall be done to the satisfaction of the Town and such that bridge personnel are sufficiently capable of performing all operation and maintenance activities, as demonstrated by directly performing these activities on site.
- (d) The Contractor shall be available by call for (90) days after turning over the bridge to the Town to assist with any issues that arise in the performance of the operating and maintenance activities by bridge personnel.
- (e) Any other requirements identified elsewhere in the plans and specifications.

METHOD OF MEASUREMENT:

No direct measurement shall be made for the work, as it is paid on a lump sum basis.

BASIS OF PAYMENT:

- (a) The work will be paid for at the contract lump sum price for “Acceptance Testing”, which shall include all materials, equipment, and labor necessary to complete the work as identified on the plans and as noted herein.
- (b) This work shall not be compensated until the Engineer determines that the work has been tested and functions to the satisfaction of the Engineer.
- (c) Final payment will not be made until all the project closeout data submittals have been completed. Once the completed package has been received in its entirety, the Town will make the final payment to the Contractor.

Pay Item

Acceptance Testing

Unit

LS



<u>ITEM 901.01</u>	<u>CONCRETE REPAIRS – DECK UNDERSIDE</u>	<u>SQUARE FOOT (SF)</u>
<u>ITEM 901.02</u>	<u>CONCRETE REPAIRS – CURBS</u>	<u>SQUARE FOOT (SF)</u>
<u>ITEM 901.03</u>	<u>CONCRETE REPAIRS – SIDEWALK</u>	<u>SQUARE FOOT (SF)</u>
<u>ITEM 901.04</u>	<u>CONCRETE REPAIRS – COUNTERWEIGHT</u>	<u>SQUARE FOOT (SF)</u>
<u>ITEM 901.05</u>	<u>CONCRETE REPAIRS – BEARING SUPPORTS</u>	<u>SQUARE FOOT (SF)</u>

DESCRIPTION

The work under these items include concretes repairs to the deck underside (901.01), curbs (901.02), sidewalk (901.03), counterweight (901.04), and bearing supports (901.05) to the limits designated on the Contract Drawings. This includes installation of a bonding compound between new and previously hardened concrete and new rebar spliced with existing rebar as required.

The work to be done under these Items shall conform to the relevant provisions of Subsection 901 “Cement Concrete” of the current Massachusetts Highway Department Standard Specifications for Highway and Bridges, with supplements, as modified by the following.

MATERIALS

Materials shall be as noted on the Contract Drawings and conform to the Standard Specifications.

Cementitious Product for Concrete Repairs

Concrete repairs shall be made using an approved product from the MassDOT Qualified Construction materials List (QCML) for Rapid Hardening Cementitious Products for Concrete Repairs (M4.04.2). Products must be qualified for the intended application.

Reinforcing Steel

Reinforcement for the concrete deck shall be Steel Reinforcement for Structures – Epoxy Coated, in accordance with Subsection 901. “Cement Concrete”.

Epoxy Bonding Compound

Epoxy bonding compound to be used between new and previously hardened concrete shall be an approved product from the MassDOT QCML.

CONSTRUCTION METHODS

Disposal

Concrete shall be sawcut around the perimeter of the repair, and the area shall be chipped back to sound concrete. All concrete that is chipped out shall be disposed of in accordance with state and federal environmental regulations.

Debris tarps shall be installed to prevent any construction materials or debris from falling into the waterway beneath the construction area. The tarps shall be checked daily for tears or openings. If any debris enters the waterway, Contractor shall immediately retrieve the debris and remove it from the waterway.

Splicing to existing rebar



Where sound concrete is behind existing rebar, clean existing reinforcement to remove corrosion. Where the bar section loss is greater than 25%, splice in a section of new rebar. All existing rebar to remain and be spliced to new rebar shall be cut to provide the length for lap splices shown on the Contract Drawings. Contractor shall exercise caution during demolition to preserve the lengths required.

COMPENSATION

Basis of Payment

The work will be paid for at the contract square footage price under the respective item number for all work and materials necessary to repair concrete elements, as set forth in the Contract Drawings, which price shall include full compensation for all the work prescribed herein. Additional rebar and bonding compounds shall be considered incidental to this item.

END OF SECTION

ITEM 950.1

TEMPORARY SUPPORT

LUMP SUM

DESCRIPTION

The work under this item includes the temporary support of the stringer at the end bay of Span 3 for removal and replacement of the Span 3 truss as designated on the Contract Drawings. It includes installing temporary shoring posts on the bascule pier and supporting the machinery platform.

The work to be done under this Item shall conform to the relevant provisions of Subsection 112 "Demolition of Buildings, Structures and Bridges" and Subsection 960 "Structural Steel and Miscellaneous Metal Products" of the current Massachusetts Highway Department Standard Specifications for Highway and Bridges, with supplements, as modified by the following.

CONSTRUCTION METHODS

Temporary Supports

The existing Span 3 stringers in Bay 5 shall be supported prior to demolition as shown on the Contract Drawings. The existing machinery platform shall also be supported prior to demolition. The Contractor shall submit calculations and plans for the supports, stamped by a registered Professional Engineer. The machinery platform shall be reattached to the new steel members. The Contractor shall temporarily support and protect in place any various conduits and elements that are attached to the truss to be replaced. Upon replacement of the stringers, these elements shall be reattached with new clamps or fasteners.

COMPENSATION

Basis of Payment

The work will be paid for at the contract lump sum price under the respective item number for all work and materials necessary to temporarily support the elements required to execute work as set forth in the Contract Drawings, which price shall include full compensation for all the work prescribed herein.

END OF SECTION

<u>ITEM 960.01</u>	<u>TRUNNION COLUMN REPAIR</u>	<u>LUMP SUM</u>
<u>ITEM 960.02</u>	<u>STEEL REPAIRS – DETERIORATED STRINGERS</u>	<u>LUMP SUM</u>
<u>ITEM 960.03</u>	<u>STEEL REPLACEMENT – SPAN 3 TRUSS FLOORBEAM</u>	<u>LUMP SUM</u>
<u>ITEM 960.04</u>	<u>STEEL REPAIRS - LINK ARM</u>	<u>LUMP SUM</u>
<u>ITEM 960.05</u>	<u>STEEL RETROFIT – SPANS 1&3 FLOORBEAMS</u>	<u>LUMP SUM</u>
<u>ITEM 960.06</u>	<u>STEEL RETROFIT– SPANS 1&3 GIRDERS – POST-TENSION REPAIR</u>	<u>LUMP SUM</u>
<u>ITEM 960.071</u>	<u>STEEL RETROFIT – SPAN 2 END FLOORBEAMS</u>	<u>LUMP SUM</u>
<u>ITEM 960.072</u>	<u>STEEL RETROFIT – SPAN 2 INTERIOR FLOORBEAMS</u>	<u>LUMP SUM</u>
<u>ITEM 960.08</u>	<u>STEEL RETROFIT – SPANS 1&3 STRINGERS</u>	<u>LUMP SUM</u>
<u>ITEM 960.09</u>	<u>SIDEWALK JOINT REPLACEMENT</u>	<u>LUMP SUM</u>
<u>ITEM 960.10</u>	<u>STEEL REPLACEMENT – MACHINERY SUPPORT PLATFORM</u>	<u>LUMP SUM</u>

DESCRIPTION

The work under this item includes the repair and strengthening of steel elements as designated on the Contract Drawings and as follows: repair of the trunnion column webs (960.01); web and flange repairs on deteriorated stringers in Spans 1 and 2 (960.02); removal and replacement of the existing truss floorbeam at the end bay of Span 3 (960.03); repair of the webs of the counterweight link arms (960.04); flange and web retrofit on the bascule girders in Span 2 (960.042); strengthening of the floorbeams in Spans 1 and 3 with flange and web repairs (960.05); strengthening of the girders in Spans 1 and 3 with the addition of a post-tensioning system (960.06); strengthening of the floorbeams in Span 2 with the addition of flange repairs to the end floorbeam (960.071) and interior floorbeams (960.072); strengthening of the undeteriorated stringers in Spans 1 and 3 with the addition of a flange plate (960.08); the replacement-in-kind of a bent sidewalk joint plate (960.09); and the replacement of the machinery support platform and hangers.

The work described above shall be performed from below the bridge where applicable, allowing traffic to remain open across the bridge with temporary supports in place as necessary.

The work to be done under these Items shall conform to the relevant provisions of and Subsection 960 “Structural Steel and Miscellaneous Metal Products” of the current Massachusetts Highway Department Standard Specifications for Highway and Bridges, with supplements, as modified by the following.

MATERIALS

Materials shall be as noted on the Contract Drawings and conform to the Standard Specifications.

Weld Metal

All welding and the preparation and assembly of material for welding shall conform to the Standard Specifications for Highways and Bridges, the AASHTO LRFD Bridge Design Specifications, and AASHTO/AWS Bridge Welding Code D1.5 (2025) (ANSI/AASHTO/AWS) and all interim revisions by AAHTO as of the bid opening date. Welds shall be E70XX minimum.

Structural Steel Coatings

Paint system shall be a three-coat system approved by Northeast Protective Coating Committee (NEPCOAT) and shall meet requirements of Subsection M7.02.0. Structural steel replacement members and repairs shall be coated to match the color of existing structural steel elements.

Concrete

Any concrete used in conjunction with steel repairs shall be incidental to the Item and shall be an approved product from the MassDOT Qualified Construction Materials List (QCML). Products must be qualified for the intended application.

Post-Tensioning System

The entire post-tensioning system, including ducts and anchors, must comply with relevant specifications from the Post-Tensioning Institute (PTI).

CONSTRUCTION METHODS

Temporary Support

Items that require the removal of existing steel during installation of the repair or replacement member shall include temporary support of the existing members. Replacement of the Span 3 floorbeam truss shall include temporary support of the Span 3 stringers as described in Item 950.1 of these Specifications. Contractor is responsible for stability of the existing members during construction.

Disposal

All materials which consist of hazardous substances such as lead paint, asbestos, petroleum products, etcetera, shall be disposed of in accordance with state and federal environmental regulations. Structural steel has the potential to contain coatings with lead. Contractor shall test and dispose in accordance with all regulations.

Debris tarps shall be installed to prevent any construction materials or debris from falling into the waterway beneath the construction area. The tarps shall be checked daily for tears or openings. If any debris enters the waterway, Contractor shall immediately retrieve the debris and remove it from the waterway.

COMPENSATION

Basis of Payment

The work will be paid for at the contract lump sum price under the respective item numbers for all work and materials necessary to install the steel elements described above as set forth in the Contract Drawings, which price shall include full compensation for all the work prescribed herein.

END OF SECTION