



## DEPARTMENT OF PUBLIC WORKS

### CONSTRUCTION DEPARTMENT

#### Clarification No. 5

#### All Plan Holders

### Rehabilitation of Columbus Road Lift Bridge over the Cuyahoga River in the City of Cleveland Requisition No. 20792

Please note the following when referring to the Bid Package for the above mentioned project:

- Enclosed herewith are the revised Special Provisions for Mechanical Work, dated May 20, 2011 and revised September 15, 2011. This document replaces the Special Provisions for Mechanical Work included in the Bid Package. The revisions to the original have been highlighted and are located on page 20 of the document. The revisions clarify the requirements for the Electric Motor Driven Crane Bridge with Electric Chain Hoist that is included for payment with the Span Drive Machinery.
- Enclosed herewith is revised Sheet No. 163 of 301 of the project plans, which includes new Note No. 6. This sheet replaces Sheet No. 163 of 301 included in the Bid Package. Changes made from the original sheet have been bubbled for easy identification.
- Enclosed herewith are revised Sheet Nos. 117, 199 and 201 of 301 of the project plans. These sheets replace the original plan sheets included in the Bid Package. Changes made from the original sheets have been bubbled for easy identification.
- The lump sum price bid for Ref. No. 133, "Item Special – Misc.: General/Miscellaneous Electrical Installation", shall include an allowance of \$12,300.00 for the work to be performed by Cleveland Public Power (CPP) to remove existing power service from the bridge and an allowance of \$15,000.00 for the work to be performed by First Energy (CEI) to provide new power service to the bridge.

This clarification will not change the bid due date of September 21, 2011.

CUYAHOGA COUNTY  
CUY-COLUMBUS ROAD (C R. 356)  
PID No. 5383  
SPECIAL PROVISIONS FOR  
MECHANICAL WORK

May 20, 2011  
Revised September 15, 2011

**GENERAL**

**Work Description**

The mechanical work shall be as shown on sheets M1 through M46 of the Contract Plans and as specified in these Special Provisions. This work shall consist of providing new machinery on the new lift span and on the rehabilitated towers, and also rehabilitating a limited number of components on the existing towers and counterweights, as identified on the Contract Plans. This work shall also consist of providing a counterweight jacking system as identified on the Contract Plans to facilitate the rehabilitation work. Note that all removal and disposal of existing machinery is addressed under a common item with structural removals and is not covered under the mechanical work.

The Contractor shall be responsible for the coordination of the mechanical work with all other work items as necessary to produce completed systems which meet the requirements of the Contract Documents. This work shall include furnishing all labor, materials, tools, services and equipment required to perform the installation, adjustment and testing of the mechanical machinery shown on the Contract Plans and as indicated herein.

Any existing machinery items identified on the Contract Plans to be rehabilitated as part of this work shall be protected from damage. The Contractor shall repair any damage to existing machinery that may occur as a result of construction activities to the satisfaction of Cuyahoga County or their approved representative at no additional cost.

**Hierarchy of Plans, Specifications, and Industrial Standards**

All machinery shall conform to the requirements of the AASHTO Load and Resistance Factor Design (LRFD) Movable Highway Bridge Design Specifications 2007 with 2008 and 2010 Interim Revisions, unless otherwise noted (e.g. Wire Ropes and Sockets). If there is a discrepancy between the AASHTO Specifications, the Contract Plans, and/or these Special Provisions, the most stringent requirement as determined by the Engineer will apply.

**Standards**

Standards referred to in the Special Provisions and on the Contract Plans are published by the following organizations and are directly applicable to the material and workmanship required for this work:

- 1 American Society for Testing and Materials (ASTM)
- 2 American National Standards Institute (ANSI)
- 3 American Association of State Highway Transportation Officials (AASHTO)
- 4 American Iron and Steel Institute (AISI)
- 5 American Gear Manufacturers Association (AGMA)
- 6 Society of Automotive Engineers (SAE)
- 7 National Electrical Manufacturers Association (NEMA)
- 8 American Welding Society (AWS)
- 9 American Bearing Manufacturers Association (ABMA)
- 10 Society for Protective Coatings (SSPC)

**Substitutions**

Items specified by manufacturer name or part number within these Special Provisions may be replaced by an equivalent item by another manufacturer, subject to approval by the Engineer, with the understanding that all changes required by the substitution shall be made by the Contractor at no additional cost to the County. Item equivalency shall be determined at the sole discretion of the Engineer and may be based on one (1) or more of the following: quality, function, ease of maintenance, physical size, reliability, value, load capacity (static and dynamic), durability, standardized components, availability and other criteria as deemed appropriate by the Engineer.

**Qualifications**

Only individuals of high competence shall be utilized to perform the work required by this Contract. Competence shall be evaluated through the following criteria:

**Supervising Personnel**

The installation and adjustment of all mechanical work as defined in these Special Provisions shall be supervised and directed by foremen and supervising engineers who shall be on-site on a daily basis while work is on-going. Personnel proposed for this role shall have a minimum installation and design experience of two (2) movable bridge machinery projects. Evidence of experience shall be submitted in resume format to the Engineer for approval and shall include the following:

- 1 Description of movable bridge machinery projects to include the type of bridge and type and size of mechanical machinery drives associated with the project
- 2 Duration of each project including start and completion dates
- 3 Position held for each project
- 4 Location of each project
- 5 References, including names and current contact information for each project

**Workforce**

The installation and adjustment of all mechanical work defined in these Special Provisions shall be performed by millwrights experienced in this class of work. The millwrights must have a minimum of five (5) years experience in the wide range of skills typically associated with the millwright profession. The workers' experience shall include disassembly, installation, and precise alignment of bearings, shafts, gearing and other mechanical machinery of similar size to the machinery to be worked on or supplied under this Contract. In addition, the workers shall have demonstrated experience with all aspects of the tools and equipment typically associated with this type of work. Evidence of experience shall be submitted in resume format to the Engineer for approval and shall include the following:

- 1 Description of applicable projects over a five (5) year period, to include types and size of mechanical machinery associated with the project
- 2 Duration of each project including start and completion dates
- 3 Position held for each project
- 4 Location of each project
- 5 References, including names and current contact information for each project

Any evidence indicating that the relevant aspects of the work for one (1) or more of the projects submitted as experience was not performed by the candidate or that the work was not performed to the satisfaction of the owner/reference will be cause for rejection. The mechanical work shall be conducted only by personnel who have been approved by the Engineer.

**Submittals**

Shop Drawings, Final Record Drawings, Certified Drawings, Operation and Maintenance Manual, Machinery Installation Procedures and other required submittals specified within these Special

Provisions shall be submitted to the County for review. Submittals that do not meet the minimum requirements identified below will be considered non-responsive and will be returned without review. Submittals that have not been approved or require correction shall be resubmitted until such time as they are acceptable to the Engineer, and such procedure shall not be considered cause for delay. The Contractor shall bear all costs for damages which may result from ordering or fabrication of any materials prior to acceptance of Shop Drawings. The Contractor may request in writing from the Engineer approval to order raw materials of the correct type for later fabrication from approved Shop Drawings after they have been accepted. Such approval by the Engineer shall be in writing. No installation or assembly of mechanical components shall commence without approved installation and alignment procedures and supporting Assembly or Erection Drawings.

**Material Submittals**

The Contractor shall submit copies of producer or manufacturer data for raw materials or standard or proprietary products. These shall include specifications, tests, and installation instructions for the following items, but not excluding other items or materials not specifically mentioned.

- 1 Couplings
- 2 Brakes
3. Speed reducers
4. Mill reports and physical tests of all metals
5. Bolts, nuts, washers and other fasteners
- 6 Paint
- 7 Lubricants
- 8 Lubricators
9. Air filters
- 10 Valves, pipe, and tube
- 11 Pressure gages
- 12 Standard stocked items

**Dimensional Verification**

Dimensions indicated on the Contract Plans are nominal and intended for information. The Contractor shall coordinate the interface of the new mechanical systems with the new lift span and existing tower structure and counterweight and shall verify all dimensions in the preparation of the Shop, Assembly, and Erection Drawings. The dimensions indicated on the Contract Plans are based on limited site survey and a review of the available documents for the bridge.

The Contractor shall field survey and measure the existing structures as required to ensure that the replacement components and other system modifications as designed and detailed in the plans will fit as intended. All such survey and measurement shall be done before preparation of the shop plans or working drawings and before performing work at the bridge. The Contractor shall be responsible to ensure the field measuring accuracy is sufficient to properly fabricate and machine the components. The Contractor shall notify the Engineer of any dimensional deviations found during the field verification.

**Certified Drawings**

The dimensions indicated on the Contract Plans for standard manufactured products have been obtained from information provided by various machinery manufacturers. The dimensions have not been obtained from certified drawings (certified drawings are drawings certified by the manufacturer to be dimensionally accurate and which contain sufficient details to determine if the requirements of the contract documents have been satisfied). The Contractor shall obtain certified drawings for all manufactured products and utilize the certified dimensions in the preparation of the Shop and Erection Drawings. The certified drawings shall be submitted in support of the Shop Drawings. The Contractor shall notify the Engineer of any dimensional deviations from the Contract Plans.

### **Drawing Submittals**

Working drawings shall be prepared to depict all work to be performed as part of this Contract. Shop and Assembly Drawings shall be submitted for all components that are custom built for this project. Any deviations from the work depicted on the Contract Plans or alterations proposed by the Contractor which affect the integrity or capacity of the machinery shall be signed and sealed by a Professional Engineer licensed in the state of Ohio.

Under no circumstance shall machinery be fabricated, assembled, or erected from the Contract Plans. Working drawings which are reproductions of the Contract Drawings, either in part or in their entirety, shall be considered non-responsive or shall be returned without review.

The Contractor shall submit six (6) copies of all working drawings, unless otherwise directed, that include Shop, Assembly, and Erection Drawings. All working drawings shall conform to the following:

- 1 All drawings shall be drawn to scale. All details of a given part shall be clearly visible at the scale selected for that part with the exception that enlarged views of small details within a part may be used to improve clarity and prevent excessively large drawings.
- 2 Separate details shall be provided for all opposite hand components.
- 3 Drawings shall be prepared using the English system of units. This shall apply to all dimensions, surface finishes and fits between mating components. The Contractor may include metric units parenthetically if so desired.
- 4 All field-verified dimensions shall be clearly identified and distinguished from other dimensions on the Shop Drawings.
- 5 The surface finish of machined surfaces.
- 6 Tolerances shall be provided for all drawing dimensions, either directly or via a standard tolerance block.
- 7 Parts shall be dimensioned with appropriate tolerances to ensure that components of a common purpose that are fabricated from the same detail are interchangeable.
- 8 Materials for each item shall be given using reference to standard specifications by the organizations listed under General Materials.
- 9 All appropriate weld symbols along with stress relieving process for weldments.
- 10 Instructions for painting the machinery.
- 11 The type of tightening, type of wrench, the required tension, and other pertinent information of all connection bolts for all items and machinery.
- 12 Proprietary parts shall be shown in outline on the drawings with sufficient dimensions and data to determine the clearances required for installation and operation.
- 13 Certified dimension prints from equipment manufacturers shall state pertinent ratings of the equipment, and shall indicate, when applicable, provisions for adding, draining, and checking the lubricant, method of lubrication, amount and type of lubricant required and type of fittings, the location of inspection openings and the location and type of venting devices.
- 14 The Contractor shall identify conflicts between manufacturers' instructions and Contract Documents and submit resolution for review and approval.
- 15 The Contractor shall identify variations between Contract Documents and product or system limitations that may be detrimental to the successful performance of the completed work.
- 16 Complete shop Bill of Materials shall be included for all machinery parts. The computed shipping and operating weights of each piece of machinery shall be stated on the Shop Drawing upon which it is detailed.
- 17 Complete Assembly and Erection drawings shall be furnished. These drawings shall clearly indicate how the work is to be performed.
- 18 Assembly and Erection Drawings shall be given identifying marks and essential dimensions for locating each part or assembled unit with respect to the bridge or equipment foundation. Each part shall be cross-referenced to the Shop Drawing on which it is detailed.

- 19 Final "As-Built" Shop, Assembly and Erection Drawings shall be submitted at the completion of the project. Any deviations from the approved Shop Drawings shall be clearly indicated. Reproducible drawings shall be made on the County's standard title block. These drawings shall be stamped "As Built", immediately above the title block.
- 20 The Contractor shall sequentially number all transmittal forms. Resubmittals shall be numbered with original submittal number and an alphabetic suffix.

#### **Procedure Submittals**

The Contractor shall submit procedures providing a step-by-step breakdown of all construction activities for each major work item identified on sheet M1 of the Contract Plans. The procedures should clearly indicate the order in which each item is to be performed and should accurately reflect the flow of construction in the field. The procedures should constitute a suitable working document for construction supervision in the field.

The procedures shall address machinery installation means and methods, alignment methods and tolerances, bolt tightening methods, and torque values. The procedures shall contain sufficient detail to demonstrate to the Engineer that the Contractor has full knowledge of machinery connections, alignment procedures, and all other work to be performed as part of this Contract.

Installation procedures for components of standard manufacture shall contain the manufacturer's recommended alignment tolerances for a new installation, which will be the basis for acceptance of such parts. Installation procedures for custom-manufactured components shall contain alignment tolerances as specified in the Contract Documents.

Submittal quantities and acceptance guidelines shall be per the Drawing Submittals requirements.

#### **Schedule Submittals**

The Contractor shall submit a detailed work schedule identifying the progression of work to be performed under this Contract. The schedule shall include, as a minimum, all major work items identified on sheet M1 of the Contract Plans. When work is to be performed during a marine outage, the schedule shall provide a daily or hourly task breakdown clearly identifying those tasks on the critical path to return the bridge to service within the allotted outage. All tasks shall be referenced to the main work items in the approved work procedures.

Reference the Contract Documents for required notification for marine or roadway outages associated with the Mechanical Work.

Submittal quantities and acceptance guidelines shall be per the Drawing Submittals requirements.

#### **Operating, Maintenance, and Lubrication Manuals**

The Contractor shall provide an Operation, Maintenance, and Lubrication Manual for all new components provided.

Six (6) preliminary copies of the Manual shall be submitted prior to shipment of machinery to the site. The preliminary manual shall be complete in all respects with regard to material content, organization and legibility for review by the Engineer. Preliminary copies need not comply with presentation requirements including page size, paper weight, paper reinforcement and protection including oil, moisture and wear resistant covers, and copy method.

Preliminary copies will be reviewed and the changes made will be incorporated into the final manual. Six (6) final hard copies of the Manual and one (1) electronic copy (PDF or alternative format selected by the Contractor and approved by the Engineer) shall be submitted after the machinery is

in operation. The final manual shall incorporate all of the Engineer's comments on the preliminary manual and all field changes made during construction and installation. Final copies shall also comply with all presentation requirements to ensure permanence of the manuals

**Contents of Manual:**

The Operating, Maintenance, and Lubrication Manual shall include the following items:

- 1 Table of contents, in numerical order.
- 2 Index, in alphabetical order
- 3 Manufacturer's literature describing each piece of equipment, giving manufacturer's model number and drawing number for standard manufactured units
- 4 Manufacturer's operating and maintenance manuals giving complete instructions relative to assembly, installation, operation, adjustment, lubrication, maintenance, and carrying complete parts lists. Manuals may be manufacturer's standard publications for standard manufactured units provided that they comply with specified requirements relative to quantity and quality of information and data
- 5 Copies of all warranties on equipment supplied to the project
- 6 Copies of all approved machinery installation procedures.
- 7 Copies of all assembly and shop drawings. These drawings to be included "as built" in the final version of the manual
- 8 Complete details and procedures for adjusting all items that have adjustments to compensate for wear.
- 9 Steps for cursory inspection that should be carried out annually
- 10 Steps for semi-in-depth inspection that should be carried out every three (3) years
- 11 Steps for in-depth inspection that should be carried out every six (6) years
- 12 List of nearest local suppliers of all equipment parts.
- 13 List of parts and supplies that are to be furnished as part of the Contract
- 14 Name, address, and telephone number of the local manufacturer's representative and of the service company for each piece of equipment so that prices or spare parts can easily be obtained

The covers and title page shall be neatly imprinted with a descriptive title and shall contain the name of the bridge, owner, and location. The title page shall also contain the names of the Engineer, the Contractor, and the date of issue. Divider pages with tabs shall separate the various sections which comprise the Manual. All parts information shall be correct for the equipment provided under this Contract. If standard parts drawings are used, they shall be modified to be suitable and irrelevant material shall be blocked out. All general information used as text shall be modified where necessary to show pertinence to the equipment furnished under this Contract, and irrelevant material shall be removed. The arrangement of the manual, method of binding, including material and text shall be submitted to the Engineer for approval.

Illustrations shall be clear. Printed matter, including dimensions and lettering on drawings, shall be easily legible. If reduced drawings are incorporated into the manuals, the original lines and letters shall be darkened if necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to page size. Diagrams and prints used in the manual shall be reproduced to a size not to exceed 11 in. by 17 in. and shall be complete and legible in all respects. Diagrams shall be made on white paper and vacuum sealed in transparent plastic material impervious to moisture and oil, and resistant to abrasion. Other formats which are equal in clarity, sharpness, durability and permanence will be considered.

Manuals shall be prepared from the following materials:

- 1 Tear, water, and grease resistant paper
- 2 Page size, 8 1/2 inches by 11 inches
- 3 Fold out diagrams and illustrations

4. Reproducible by dry copy xerography method
5. Oil, moisture and wear resistant plastic covers

#### **Lubrication Charts**

The Contractor shall furnish a lubrication plan for all machinery including electrical machinery to the Engineer for approval. The plan shall be developed from recommendations made by the machinery manufacturers. The Contractor shall coordinate the lubrication plans for the various machinery elements and minimize the number of different lubricants required. The Contractor shall furnish the Engineer with copies of letters from the machinery manufacturers endorsing the lubricant which have been selected. Lubricants shall be selected for year round exposure at the bridge.

The Contractor shall furnish a lubrication chart for each of the following machinery systems:

1. Span drive machinery
2. Span lock machinery
3. Tower machinery, including main counterweight ropes
4. Span and counterweight guides
5. Operating rope system
6. Auxiliary counterweight system
7. Air buffers

The lubrication charts shall show all points requiring lubrication with type of lubricant to be used at each point and the frequency and the method lubrication. Those electrical components related to the mechanical machinery that requires lubrication shall be included on the charts. The charts shall be submitted to the Engineer for approval and the approved charts shall be mounted with a suitable and approved frame and transparent weatherproof cover in the locations selected by the Engineer.

#### **General Quality Assurance**

The County reserves the right to inspect all machinery at the point of manufacture prior to shipping. No items shall be fabricated, machined, welded, cast or forged without sufficient advance notification to the Engineer to permit scheduling of inspection by the Engineer or his/her designated representative (the Inspector). The Contractor shall furnish all facilities and provide for free access at the plant or shop for the inspection of material and workmanship, and to witness shop tests.

The Engineer or the Inspector shall base all inspections on the requirements of the Contract Plans, the Special Provisions, any referenced codes or standards and the Contractor's approved submittal documents. The Inspector shall have the authority to recommend to the Engineer rejection of material or workmanship that does not satisfy Contract requirements. The final decision for rejection shall be made by the Engineer. The Contractor shall replace or repair to the satisfaction of the Engineer any such rejected item. All such replacements or repairs shall be made at no cost to the County.

The Engineer or the Inspector will make inspections of equipment and machinery throughout the construction period. Any defects, deficiencies, or deviations from the Contract Plans or Special Provisions discovered during such inspections shall be corrected at no cost to the County. Shop approval of machinery does not relieve the Contractor from making such repairs to parts which are found to be deficient at a later time (regardless of prior inspection or approval) as directed by the Engineer.

The Contractor shall furnish without charge test specimens required and all labor, testing machines, tools, and equipment necessary for physical tests and chemical analyses. Copies of test reports for all tests shall be submitted to the Engineer.

## MATERIALS

### General Materials

All materials shall be new and shall meet the minimum requirements of the standards indicated on the Contract Plans and as specified herein unless otherwise noted. All materials shall be supplied by manufacturers who have supplied similar materials for similar applications for a period of not less than ten (10) years.

### Anchor Bolts

The replacement of the centering guide, live load supports, and counterweight guide components utilize existing anchor bolts. Where existing anchor bolts are damaged or where the existing anchor bolt has more than 20% section loss, as determined by the Contractor and confirmed by the Engineer, the anchor bolts shall be replaced in-kind. New anchor bolt preload shall be 50% of the anchor bolt material yield strength. Full anchor bolt replacement details shall be provided on the Shop Drawings for review along with the method of tightening and verifying the tension as determined by the Contractor.

### Bronze Bearing Bushings

Material for bronze bushings shall be as indicated on the Contract Plans and shall meet the requirements for Castings. Bronze bushings shall be provided with grease grooves as indicated on the Contract Plans. The grease grooves shall have smooth edges that blend smoothly in the bearing surface. The entry hole from the grease fitting must intersect and lie completely within the grooves. All grease grooves shall be machine cut. Hand cutting of grease grooves is not acceptable.

### Rolling Element Bearings

Rolling element bearings shall meet ABMA standards. The fit and surface finish of the shaft at the bearing locations shall be in accordance with the bearing manufacturer's recommendations. The Contractor shall submit certification of the recommended fits and surface finishes at the bearing locations. Bearing data shall be provided on a nameplate mounted on the housing.

### Castings

Castings shall be free of defects such as sand and slag inclusions, cracks, cold shuts, shrink holes, blow holes, porosity, free of loose scale and sand, fins, seams, gates, risers and irregularities. Unfinished edges shall be neatly cast with rounded corners and inside angles shall have ample fillets.

Unless otherwise indicated in the Contract Plans, perform visual surface examinations of steel castings per ASTM A802, liquid-penetrant exams in accordance with ASTM E165, or magnetic particle exams in accordance with ASTM E709 in the manufacturer's shop, for each casting.

Unless otherwise indicated in the Contract Plans, perform visual surface examinations of bronze castings per MIL-STD-271F, or liquid-penetrant exams in accordance with ASTM E165 in the manufacturer's shop, for each casting.

Identify and remove unacceptable surface discontinuities in accordance with ASTM A802. Obtain approval from the Engineer before making any necessary major (as defined in ASTM A781 S16 Weld Repair Charts) weld repairs. Perform radiographic examination of welds per ASTM E94. Any aberrant indications must be brought to the Engineer's attention for review and may result in rejection of the weld repair.

### Fasteners

All bolts 1 1/2 in. or smaller shall be high strength heavy hex bolts made from material equal to ASTM A325 unless otherwise specified on the Contract Plans. All bolts greater than 1 1/2 in. shall be made from material equal to ASTM A449. All bolts shall conform to the Unified Thread Standards, coarse thread series, for threads on bolts, nuts, and cap screws with a Class 2A.

tolerance for bolts and Class 2B tolerance for nuts, in accordance with ANSI B1.1, unless otherwise specified. Bolt head and nut bearing surfaces must be flat and square with the axis of the bolt holes; spot face nut bearing surfaces as necessary to produce firm bearing around the entire perimeter of the contact surface.

Hole size for all bolts not identified as turned bolts are to be 1/32" larger than the body diameter for bolts up to 1" diameter and 1/16" larger than the body diameter for bolts over 1" diameter.

Turned bolts are called out by nominal thread diameter on the Contract Plans. The bodies of turned bolts shall be 63 microinch finish or finer, unless noted otherwise on the Contract Plans. Turned bolt body diameters shall be 1/16 inch to 1/8 inch larger than the thread diameter. Turned bolt heads shall be standard hex for bolts of the next nominal size larger than the thread diameter or heavy hex for nominal thread diameter. Unless otherwise noted, bolt holes in machinery parts required for connecting to supporting steel may be sub-drilled (in the shop) smaller than the turned bolt diameter and shall be reamed together with supporting structural steel either during assembly or at erection to provide an ANSI LC6 fit, after the parts are correctly assembled and aligned.

Positive type lock nuts and hardened washers shall be furnished for all bolts and for all flat countersunk head cap screws used as bolts. Double heavy hex nuts conforming to ASTM A563 are required unless indicated otherwise on the Contract Plans. Alternate locking methods must be submitted to the Engineer for approval. All hardened steel washers shall be in accordance with ASTM F436.

All items called out as hex head cap screws shall be in accordance with ASTM Specification A449. All hexagon socket head cap screws shall be ASTM A574.

All hexagon socket flat countersunk head cap screws shall conform to ANSI B18.3.5. Where utilized as turned bolts, hex socket flat countersunk head cap screws shall be manufactured from ASTM F835 with turned body dimensions meeting the requirements for turned bolts dimensions provided above. Where called out as bronze hex socket flat countersunk cap screws shall meet ASTM F468 Alloy Cu651.

All fasteners shall be tightened to provide a tension of 50 percent of the bolt's ultimate tensile strength unless noted otherwise on the Contract Plans or in these Special Provisions. The method of tightening and verifying the tension in all bolts shall be determined by the Contractor and shall be provided on the Shop Drawings for approval by the Engineer.

### **Forgings**

Forged shafts and bars shall be reduced to size from a single bloom or ingot until perfect homogeneity is obtained. Blooms and ingots shall have a cross section area equal to at least three times the required size. Forging shall be done at no less than red heat. Rounds for shafts shall be true, straight and free from all injurious flaws such as piping, laps, seams or cracks. Finished ends of shafts shall have a 60 degree lathe center with clearance hole at the exact center of the shaft. Shafts with bored holes shall have the ends prepared for a device equivalent to the lathe centering device furnished as part of the work unless detailed otherwise on the Contract Plans. Stepped shafts shall have fillets finished smoothly to adjacent surfaces without tool marks or scratches. Surface finish for fillets shall have a maximum roughness of 63 microinch according to ANSI Standard B46.1 unless a finer finish is required. Forgings shall be subjected to ultrasonic examination in accordance with ASTM A388. Any indications using the straight beam method that cannot be readily explained by the geometry of the piece shall be cause for rejection. Any forgings that are rejected shall be replaced at no cost to the County.

Where ASTM A668 forgings are used in weldments with plate steel, the Contractor shall ensure that the forgings meet ASTM A668 supplemental requirement S4 for low carbon content.

### General Speed Reducer Requirements

All speed reducers shall be designed to current AGMA standards unless otherwise specified in these Special Provision or on the Contract Plans. Reducer gearing shall have ANSI/AGMA 2015-1-A01 quality of A8 or better. Allowable gear loads shall be based on AGMA 2001 Grade 1 materials. Reducers shall have an AGMA durability rating equal to or greater than the full load-rated horsepower of the driving motor at full load motor torque and speed with a service factor of 1.5. The AGMA strength rating shall provide for an overload of 300 percent of the motor full load torque. All speed reducer bearings shall be anti-friction type and provide an L10 life of 40,000 hours at motor full load speed and torque. All reducer shaft extensions shall have a minimum of two (2) seals. The two (2) seals shall be separated by a grease cavity which shall be equipped with a lube fitting and a pressure relief fitting. The seals used at the shaft extensions shall be easily replaced without removal of the components mounted on the shaft extensions. Double lip type seals are acceptable. The speed reducer manufacturer shall submit a proposed seal arrangement for review by the Engineer. All reducers shall support any overhung load they are subjected to. All reducers are to have steel housings. All reducer housings shall provide at least one (1) inspection cover. The cover shall be located above the oil line and shall allow inspection of the internal gearing without requiring the oil to be drained. The holes for the inspection cover fasteners shall be boxed out to prevent corrosion or debris from infiltrating the box during fastener removal. Reducer manufacturers shall submit the model, size and manufacture of all bearings and seals to facilitate future repairs.

All reducers shall have brass or stainless steel nameplates permanently fastened to the housing stating the following:

- 1 AGMA symbol
- 2 Manufacturer's name and address
- 3 Type of reducer
- 4 Date of manufacture
- 5 Model and size
- 6 Service horsepower
- 7 High speed shaft rpm
- 8 Service factor
- 9 Gear reduction ratio
- 10 Lubrication specifications, including AGMA lubricant number and viscosity in SSU at 100° F. The lubricant shall be suitable for year-round exposure at the bridge site.

Oil drains shall be provided for each reducer with bronze or stainless steel drain cocks to permit easy replacement of oil. The proper oil level shall be marked on the side of all housings in a readily visible location. A stand pipe with a threaded pipe cap shall be provided adjacent to the oil level indicator to permit checking the oil level. All speed reducers shall be provided with a hygroscopic breather.

The reducer manufacturer shall subject all speed reducers provided under this Contract to the following shop tests:

- 1 After the reducers are completely assembled, they shall be filled completely with SAE 10W oil in the manufacturer's plant to test for leaks. No leakage shall occur around seals, covers, welds, etc., with the reducer filled with oil for a minimum of 1 hour. The leak test shall also apply to the collar reservoir at each secondary reducer output shaft.
- 2 The reducers shall be subjected to a no-load test run at rated speed by the manufacturer for a minimum of 1 hour in each direction. During the test, the reducer shall be checked for unusual heat buildup and unusual noise. Noise level shall not exceed 90 db at a 3 foot offset around the perimeter of the reducer housing as measured with a microphone.
- 3 At the completion of the no-load testing, each reducer shall be subjected to 150-percent full load motor torque at rated speed for 1 hour in each direction, and then 200-percent

full load motor torque at rated speed for 5 minutes in each direction. During the testing, the reducers shall be checked for unusual heat buildup, and unusual noise. Noise level of the reducer shall not exceed 90 db with the microphone held 3 feet from the reducer housing

4. At the completion of the load testing, the reducers shall be drained and the top half of the reducer housing shall be removed for examination of all gears and bearings. All gear sets shall exhibit a minimum of 85 percent of full face contact and there shall be no visible damage to any part of the reducers including the gear teeth. The manufacturer shall blue the gear teeth prior to testing to aid in this portion of the inspection. Bearings shall be checked for axial play. No bearing shall exhibit any change in axial play greater than 5 percent from the measurements taken prior to the testing.
5. After successful completion of the internal inspection, the reducers shall be reassembled and subjected to a no-load spin test for 30 minutes in each direction. There shall be no significant variation in the performance of the gear box.
6. As a final step, the leak test outlined in Step 1 shall be repeated. No further load testing is required if leakage is present. The leakage shall be corrected and this step repeated until satisfactory results are attained.
7. The coupling manufacturer's written approval is required to ensure that the coupling warranty has not been voided, if the couplings used in the 200 percent load test are to be re-used as part of the new machinery installation. If such approval is granted, the couplings shall be disassembled following the test for inspection of the internal wearing components. Any deficiencies shall be repaired to the satisfaction of the Engineer at no cost to the County. If approval is not granted, new couplings shall be furnished and installed at no additional cost for the new machinery installation.

All testing shall be performed by the manufacturer and witnessed by the Engineer or the Inspector. Failure to successfully complete any portion of this testing shall be cause for repair, realignment, and replacement as necessary. All load and no-load testing shall then be re-performed. Testing and inspection will continue in this manner for each reducer until it successfully completes the testing.

Speed reducers shall be manufactured by the Cleveland Gear, Chicago Gear, The Gear Works (Seattle, WA), Steward Machine Company, or approved equal.

#### **General Coupling and Coupling Guard Requirements**

Couplings shall be gear-type couplings with shrouded bolts unless specified otherwise. All couplings shall be oil tight under all operating conditions. Coupling halves shall be bored and keywayed by the coupling manufacturer and mounted by the manufacturer of the equipment on which it is to be mounted, or mounted in the field by the Contractor if the erection procedure so dictates. All couplings shall have a minimum service factor of 2.0 on the torque produced at the respective coupling location from motor full load torque while the motor is rotating at full speed. Coupling hubs shall be mounted to shafts with fit and finishes that comply with AASHTO 6.7.8. Coupling arrangement relative to the mating machinery shall be such that inspection of the internal wearing components is possible without removal of the coupling hub from the shaft on which it is mounted.

The span drive motor couplings and span lock motor couplings shall be provided with safety guards. Guards are to be fabricated from expanded metal and structural shapes necessary to construct a rigid cover that will withstand a load of 300 pounds applied vertically at the motor shaft couplings, without any permanent deformations in the covers. The covers are to be bolted to the machinery supports or adjacent structural steel as necessary. The coupling guards are not shown on the Contract Plans. The Contractor shall provide details of all coupling guards and any required supports on the Shop Drawings.

### **Hardness Requirements**

Brinell or Rockwell hardness tests shall be made and results included on inspection reports for all materials for which hardness values are required on the Contract Plans, in the material specifications, or specified herein.

### **Keys and Keyways**

Keys and keyways shall conform to dimensions and tolerances in accordance with ANSI B17.1 including keyseat radii and key chamfers and shall meet ANSI Class 2 fit requirements unless otherwise indicated in the Contract Plans. Keys shall be effectively held in place by closed end keyways milled into the shafts. Ends of keyways shall be rounded to half circle with a diameter equal to the width of the key. Keys shall be machined from ASTM A668 Class K forgings unless noted otherwise on the Contract Plans. Where more than one (1) key is required, keys shall be located 120° apart.

### **Lubrication Fittings and Piping**

Size of grease lubricating fittings shall be standardized and shall be of the giant button head type unless indicated otherwise on the Contract Plans or unless the location of the fitting requires the use of a fitting that is smaller than the giant button head fitting. The Contractor shall provide a battery powered grease gun with adequate pressure to lubricate all necessary items. The gun shall have a minimum two foot hose. Fittings shall be located in a protected and conveniently accessible position for use and shall be connected to the points requiring lubrication by pipe extensions where necessary. All fittings and pipe material shall be stainless steel meeting ASTM A312 Type 304 or 316. All piping necessary to provide access for lubrication shall be clearly indicated on the Shop Drawings and all pipe components listed in the Bill of Materials.

Pipe nipples shall meet the requirements of ASTM B 687

Pipe fittings shall meet the requirements of ASTM B 584

Pipe shall meet the requirements of ASTM B 43.

### **Lubrication**

During installation, the Contractor shall lubricate all rotating and sliding parts with lubricant as indicated on the approved charts. The surfaces of components which will rotate or slide relative to one another once assembled shall be lubricated prior to assembly. All clearance fits involving mating steel components shall be installed with a marine duty anti seize compound prior to assembly.

Contact the Engineer to obtain a list of lubricants currently in use on other movable bridges in the City of Cleveland. The Contractor shall verify that the existing lubricants used by the City are acceptable with the new component manufacturers for year round use at the bridge. If no such lubricant exists, the Contractor shall choose a lubricant that is compatible with the lubricants currently used by the City of Cleveland and matches the requirements listed below. The Contractor shall submit written documentation to the Engineer documenting this selection.

- 1 Enclosed Gear Reducers: Enclosed gear reducer lubrication shall meet the requirements of the American Gear Manufacturers Association (AGMA) Standard 250.04 "Lubrication of Industrial Gear Drives". The lubricant shall be manufactured by a reputable and knowledgeable supplier of lubrication and shall be as recommended by the reducer manufacturer. The lubricant should contain oxidation inhibitors, rust inhibitors, anti-foaming agents, and anti-wear additives. The maintenance of the lubricant, method of application, and re-lubrication intervals shall be as recommended by both the reducer manufacturer and the lubricant manufacturer.
- 2 Roller Bearings: The roller bearing lubricant, the maintenance of the lubricant, method of application, and re-lubrication intervals shall be recommended or approved by the roller bearing manufacturer unless specified otherwise in the plans.

- 3 Sleeve Bearings: The lubricant chosen shall be approved for use in sleeve bearings by the lubricant manufacturer Recommended Lubricant: NLGI No 2 grease with rust and oxidation inhibiting additives, 280 Worked Penetration at 77° F [25° C], 340°F [171°C] (or higher) ASTM Drop Point, SUS 900 @ 100°F, water resistant, anti-wear/extreme pressure.
- 4 Couplings: Coupling lubricant and its maintenance shall be specified by the coupling manufacturer
- 5 Wire Rope Lubricant: Provide lubricants approved by the manufacturer.
- 6 Proprietary units will use lubricants approved by the manufacturer

The Contractor shall furnish the Engineer with copies of letters from the machinery manufacturers endorsing the lubricants that have been selected Lubricants shall be selected for year round exposure at the bridge. All lubricants shall be selected to be compatible with lubricants currently in use by the City of Cleveland. The Contractor shall submit written documentation indicating compatibility for any lubricant which is not in current use by the City of Cleveland

The Contractor shall furnish an additional supply for future maintenance use to include 25 lb of each type of grease, a quantity of brake thruster oil sufficient to replace the oil in each thruster one (1) time, 100 lbs of rope lubrication, 16 auto lubricators for the air buffers, and 200 gallons of gear oil for the speed reducers All lubricant shall be provided in the original manufacturer's sealed container to prevent contamination Contractor shall protect all lubricants used during construction from contamination

### **Painting**

Paint for machinery and touch-up of field damaged paint shall be in conformance with CMS 514 requirements and this Special Provision

All new and rehabilitated machinery, including supports and fasteners, shall be painted in its entirety except for machined contact surfaces (e.g. brakewheel friction surfaces, etc) Paint on existing machinery that is damaged as part of the rehabilitation shall be touched up in the field

All painting shall be in accordance with this Special Provision and with the paint manufacturer's most stringent specification for surface preparation. If there is a conflict between them, the most stringent specification will govern. Caution shall be exercised during cleaning and painting operations to prevent cleaning and painting materials from entering machinery components and coming into contact with sliding surfaces on components such as bearings, seals, gears, couplings, and other components which would be damaged by such intrusion Nameplates shall be clean and kept free of paint. Detailed instructions for painting, including paint manufacture information and surface preparation of the machinery, shall be provided on the Shop Drawings for review by the Engineer

Shop painting shall be three (3) coat painting with an inorganic zinc rich paint for corrosive environments in accordance with the paint manufacturer's specifications A modified aluminum epoxy mastic primer shall be used for all machined surfaces that require paint (e.g., couplings, shafts, and all other machined surfaces that cannot be blast cleaned). One (1) prime coat and one (1) intermediate coat shall be applied in the shop All three coats of paint shall be applied in the shop All damaged paint surfaces shall be cleaned and receive a touch-up coat of primer and first coat and final coat in the field after the machinery has been installed and successfully tested

The third (top) coat of paint shall color code the machinery to identify fixed and moving parts in accordance with OSHA requirements Color for the final coat shall be safety orange (Federal Id No 12300 or 12246) for all moving parts including shafts, couplings, brakewheel hubs, and any other moving part. Color for the final coat shall be safety green (Federal Id No 14120 or 14260) for all stationary parts including machinery supports and any other stationary part

### **Shafts and Pins**

Shafts shall be finished accurately, round, smooth, and straight. Straightness tolerances shall be 0.003 inches per foot. Forged shafts and pins shall meet the requirements for forgings.

### **Shims**

Shims required for leveling and alignment of machinery and equipment shall be brass or ASTM A666 Type 304 or 316 stainless steel. All shims shall be neatly trimmed to the dimensions of the assembled part, and drilled for all bolts that pass through the shims. Sufficient shims shall be furnished to provide for a total thickness of not less than two times the dimensions given as "nominal shims" on the Contract Plans, with one (1) shim equal to the nominal thickness. Shims shall be provided to allow adjustments of 0.003 inch for machinery parts.

The Contractor shall make every effort to use full size shims and achieve full contact between the shims and the mating components to achieve the specified alignment requirements. In some cases, full contact between the shims and the mating components and achieving the alignment requirements may be mutually exclusive. In these cases, the use of partial or custom machined tapered shims may be required to achieve the alignment requirements. Partial shims shall only be used when the gaps produced between mating parts by the use of partial shims is less than 1/64". At least one (1) bolt shall pass through any partial shim that is used. In cases where partial shims would produce a gap greater than or equal to 1/64", a custom machined tapered shim shall be used. The cost of any partial or custom shims including materials, manufacturing, engineering, shipping, field measurements, etc. is considered incidental to the work and no additional compensation will be made for providing partial or custom shims. Any gaps that exist between shims and mating surfaces shall be sealed with silicone caulk to prevent moisture infiltration.

Shims not installed after final alignment shall be neatly assembled and tagged with the part number from the approved shop drawings, then delivered to the City of Cleveland for future use.

### **Spare Parts**

The Contractor shall supply the following spare parts for the mechanical machinery:

1. One (1) set total of brake shoes for the motor brakes.
2. One (1) set total of brake shoes for the machinery brakes.
3. One (1) grid total for the motor couplings.

### **Tools**

The Contractor shall supply the City of Cleveland with two (2) complete sets of wrenches to facilitate the maintenance, adjustment, installation, and removal of all machinery items installed as part of this Contract. Each set of wrenches shall be provided in a suitable high quality tool box complete with lock. Each tool box shall be of sufficient size to store all wrenches in a given set. All tools shall be new and shall be of standard manufacture.

The Contractor shall submit a list of all bolt, screw, and nut sizes to the Engineer along with the name, size, type, and manufacturer of the wrenches to be provided for approval by the Engineer. A wrench shall be provided in each set for each size and type of bolt, screw, or nut, including any special hardware which may be required as part of the Contract. Adjustable wrenches which fit more than one size bolt, screw, nut, or other item of hardware are not acceptable.

### **Welding and Weldments**

Welding required for the work shall be done in accordance with the requirements of the Bridge Welding Code as stated in AWS D1.1. Treat all machinery and weldments that support machinery as main members, all welds as joining primary components, unless otherwise specified in the Contract Documents. All welds are subject to reversing tension and compression loading. Do not perform field welding unless specified in the Contract Documents.

Under no circumstances shall open ended welds be acceptable. Dimensions shown on welded parts in the Contract Plans are final dimensions. All welded machinery parts or supports shall be stress relieved by heat prior to machining. The Contractor shall include welding and stress relieving procedures with the Shop Drawings for parts that require welding.

The Contractor shall ensure that all weld procedures are appropriate for the materials identified in the Contract Plans. All information required for manufacturing the parts, including supplemental requirements, shall be included on the shop drawings.

Where fillet welds are used for main support webs or as stiffeners, the components shall be milled to bear to ensure that loading is transferred through the steel, not the fillet. Complete weld and milling details shall be provided in the Shop Drawings for review.

#### **Wire Ropes and Sockets**

Ropes and sockets shall meet the requirements of section 3.2 of the 1988 AASHTO Movable Highway Bridge Design Specifications except as modified herein.

Rope size and minimum ultimate strength shall be as defined in the subsequent sections of this Special Provision for each rope type. Nominal rope lengths are provided in the Contract Plans. The Contractor shall provide detailed rope length calculations prepared and signed by a Professional Engineer licensed in Ohio. The calculations shall be submitted with the shop drawings for review.

Each specified rope size shall be destructively tested to verify the minimum ultimate strength requirements in accordance with Sec 3.2.8 of the 1988 AASHTO Standard Specifications for Movable Highway Bridges. Rope and socket quantities provided in the Contract Plans do not include quantities to fulfill the test requirements. The sockets used for destructive testing shall not be reused for the permanent rope assemblies.

All ropes (main counterweight, auxiliary counterweight, and operating rope) shall be prestretched in accordance with section 3.2.10 of the 1988 AASHTO Standard Specifications for Movable Highway Bridges.

The length of the main and auxiliary counterweight ropes shall be measured in accordance with section 3.2.13 of the 1988 AASHTO Standard Specifications for Movable Highway Bridges and shall conform to the variation on length tolerance provided under the same section. Each auxiliary and main counterweight ropes shall have a stripe painted along its entire length at the time of length measurement to facilitate its correct alignment upon installation in the bridge. The stripe width shall be not less than one quarter (25%) of the rope diameter and shall be so applied that it does not rub off during normal handling operations. At installation, the main and auxiliary counterweight ropes shall be installed so that the stripe is straight without revolving around the axis of the rope.

Sockets shall meet the requirements of section 3.2.11 of the 1988 AASHTO Movable Highway Bridge Design Specifications. Particular attention is directed to the requirements regarding allowable slippage under load, which must be coordinated with and performed during the destructive load test so that rope slippage can be measured at 80% of the specified ultimate strength. Attention is also directed to the pin and socket fits required on the Contract Plans at each rope assembly detail.

All ropes shall be shipped on reels not less than 26 times the nominal diameter of the wire rope. The windings must be securely fastened and the reels shall be protected to avoid damage or contamination during shipment, storage, and handling. Bends, kinks, or other significant damage to the rope will be cause for rejection at the discretion of the Engineer.

Wire ropes shall be manufactured by Bridon American, Wire Rope Co., or approved equal.

## MACHINERY SYSTEM REQUIREMENTS

### COUNTERWEIGHT JACKING SCHEME

#### General

The counterweight jacking scheme is predicated on the use of strands jacks to lower the counterweights approximately 80 feet from tower level to pier level where they will be supported on cribbing as detailed on the structural drawings. Note that the jacks will initially need to raise the counterweights in order to unload and remove the existing counterweight ropes prior to lowering the counterweights to the pier. The jacking work must be coordinated with a channel closure and the minimum project completion milestones provided in the structural plans.

#### Strand Jack

Provide four (4) strand jack assemblies. Each assembly shall comprise the strand jack, strand length required for work, strand anchorage and any associated frame necessary to handle the strand and maintain a minimum bend radius in accordance with the manufacturer's guidelines.

Each jack shall have a minimum 330 ton working capacity and be shop tested to 125% of the working capacity. The jack pressure and applied load shall be documented via calibrated instrumentation throughout the shop test and submitted to the Engineer in report format prior to the field work. The calibrated pressure monitoring system shall be utilized in the field to determine the weight of the main counterweights.

Jack strands shall have a minimum breaking load of 250% of the working capacity.

Jacks shall have the following features:

1. Strand patterns to allow ease of access to service the grips. All grips shall be fully serviceable in the middle of a lift with the jack fully stranded.
2. Double acting mini-jacks used for opening and closing grips in the top and bottom anchors which can be fully replaced in the middle of a lift if necessary without dismantling the strand anchors or cutting the strand.
3. Load holding valve for safe holding of the load in the event of a hose burst.
4. Pressure compensated bleed valve fitted to the extension port block for very slow final lowering for precise alignment of the load and smooth transfer of load to supports.
5. Telescopic strand guide tubes through the full height of the strand jack to prevent buckling and 'birds nesting' of the strands inside of the jack.

Acceptable providers include Dormon Long Technology and VSL.

### SPAN DRIVE MACHINERY

#### General

The Contractor shall provide span drive operating machinery as shown on the Contract Plans. The machinery design conforms to section 5 of the AASTHO LRFD Movable Highway Bridge Design. The machinery shall raise the lift span 79'-8 1/4" in approximately 120 seconds for normal operation, assuming a uniform 10-second acceleration period upon starting to open and a uniform 10-second deceleration period prior to reaching the fully raised position. The machinery shall be capable of providing an additional 5 feet of lift from the normal open position for emergency circumstances to provide a maximum lift of 84'-8 1/4".

All span drive machinery components shall be new, unless explicitly specified otherwise in these Special Provisions or on the Contract Plans. Span drive machinery components subject to

stipulations not detailed on the Contract Plans or addressed under the General Materials section are as follows:

**Motors**

Motor procurement, installation, and payment falls under the Electrical work. The key and keyway requirements provided in this mechanical Special Provision shall also apply to the motors. The driving shaft extension shall be custom and shall suit the dimensions shown on the Contract Plans. The back end of each motor shaft shall be extended three (3) inches beyond the motor housing/encoder and shall be machined to a hex (1-5/8 inch across flats) to facilitate the checking of brake torques. The Contractor shall provide a custom sheet metal cover to guard the shaft extension and encoder. The cover shall be limit switch protected to de-energize the motor when removed.

**Primary Reducer**

One (1) required. Foot mount parallel shaft reducer rated 125hp at 1200 RPM input speed with 10 1:1 reduction ratio. Select gearing to provide special extended center distance between input and output as well as general envelope dimensions as shown on the Contract Plans.

The reducer shall have double extended input and output shafts. Mounted on each reducer input shaft extension shall be a motor brake wheel and a coupling hub. Mounted on each output shaft shall be a brakewheel coupling hub. All coupling hubs and brake wheels shall be mounted in the shop with an FN2 fit and key by the speed reducer manufacturer. The output shafts shall be long enough to permit opening the coupling half mounted on this extension to inspect the internal wearing components (gear teeth) of the coupling.

The primary reducers shall be lubricated via a splash oil system designed to provide ample oil to all bearings and gear meshes.

**Secondary Reducers**

Two (2) required. Triple reduction foot mount spiral bevel reducer rated 62.5 hp at 118 RPM input speed with 38.44:1 reduction ratio. Provide general envelope dimensions as shown on the Contract Plans.

Provide single input and double extended output shafts. Mounted on the input shaft extension shall be a brakewheel coupling hub. Mounted on each output shaft shall be a coupling hub. All coupling hubs shall be mounted in the shop with an FN2 fit and key by the speed reducer manufacturer. The output shafts shall be long enough to permit opening the coupling half mounted on this extension to inspect the internal wearing components (gear teeth) of the coupling.

The reducers shall be lubricated via a splash oil system designed to provide ample oil to all bearings and gear meshes.

One (1) of the two (2) secondary reducers shall include an intermediate shaft extension to mate with a rotary cam limit switch. Provide an integral support off of the reducer to support the rotary cam limit switch.

**Brakes**

Four (4) required. All brakes shall be thruster-operated shoe-type brakes that are thruster released and spring set. The thruster motors on the brakes shall be 240/480V, 3-phase, 60 Hz. The motors shall be integral with the thruster units. Motor Brakes shall be Bubenzer EBN 250-30/5, Mondel or approved equal. Machinery Brakes shall be Bubenzer EBN 400-80/6, Mondel or approved equal. All brakes must fit within the constraints of the system as shown in the Contract Plans.

The brakes' size and torque settings shall be as indicated on the Contract Plans. The *motor* brake torque settings shall not be less than 60% or more than 80% of their continuous rated capacity for normal operation. The *machinery* brake torque settings shall not be less than 80% or more than 100% of their continuous rated capacity for normal operation. The torque provided by the motor brakes and the machinery brakes shall be set in the shop, verified by a torque wrench (or comparable method approved by the Engineer) and adjusted to within 10% of the required setting as indicated on the Contract Plans. The brake torque shall be rechecked at installation in the field per the approved method and adjusted as required. Brake time delays for brake setting shall be as indicated in the Contract Plans, unless otherwise directed by the Engineer pending analysis of peak loading recorded during the strain gage testing required as part of the balance and load testing requirements provided under this Contract.

All brakes shall have the following features:

- 1 External and infinitely adjustable mechanical time delays for setting the brake with a minimum range from 0.6 to 6 seconds
- 2 External torque springs with brake torque scales in English units
- 3 Shoes to be provided with special high torque molded linings
- 4 Latching hand releases. The applied force at the hand release required to release the brake shall not exceed 50 pounds
- 5 Limit switches as described below
- 6 Stainless steel pins and related hardware
- 7 All items to be coated with the 3-coat paint system specified for the machinery under Materials. The manufacturer may submit an alternate coating system that is suitable for a corrosive, high-humidity environment with supporting information documenting demonstrated performance on at least three (3) comparable installations. If such alternate system is not approved by the Engineer, the specified 3-coat paint system shall be used.

The following specific requirements shall also apply:

- 1 Motor brakewheels shall be mounted to the primary reducer input shafts with an FN2 fit and a key.
- 2 Machinery brakewheels shall be provided with a piloted bore that fits the mating coupling with an LC1 fit. When assembled on the coupling hub, the surface of the brakewheel shall be concentric to the coupling hub bore.

Stainless steel or brass nameplates permanently affixed to each brake shall be stamped with, but not limited to, the following:

1. Manufacturer
2. Model number
3. Specified Brake Torque (per Contract Plans)
4. Maximum Brake Torque
5. Reserve stroke of the actuator
6. Brake lining material

Stainless steel or brass nameplates shall also be permanently affixed to each brake actuating device stamped with, but not limited to, the following:

1. Manufacturer
2. Model number
3. Push capacity of the actuator
4. Recommended reserve stroke of the actuator
5. Maximum stroke of the actuator
6. Volts, phase, Hz, Watts
7. Type of fluid required in the reservoir

All brakes shall be equipped with three (3) limit switches: one (1) switch to indicate when the brake is fully set, one (1) to indicate when the brake is fully released, and one (1) to indicate when the brake is hand released

Any electrical requirements for the brakes are provided in the electrical section of the Special Provisions

**Motor Couplings**

Two (2) required The motor couplings shall be double-engagement, grid-type couplings with horizontally split covers, and sized as indicated on the Contract Plans The motor coupling hubs shall be secured to shafts with an FN2 fit and one (1) key Motor couplings shall be Falk Type T10 Size 1100T, Amerigear, or approved equal.

**Machinery Brakewheel Couplings**

Two (2) required The machinery brakewheel couplings shall be double-engagement, gear type couplings sized as indicated on the Contract Plans The brakewheel coupling hubs shall be secured to shafts with an FN2 fit and one (1) key Brakewheel couplings shall be Falk Type G62 Size 1035G, Amerigear, or approved equal.

**Floating Shaft Coupling Hubs**

Eight (8) required The floating shaft coupling hubs shall be double-engagement gear type couplings One (1) hub from each coupling shall be mounted on the operating drum shaft and the mating hub shall be mounted on the secondary reducer output shafts These hubs shall mate with custom end plugs on the floating shafts. All hubs shall be secured to their respective shafts with an FN2 fit and two (2) keys as noted in the Contract Plans Operating drum shaft couplings shall be Falk Type G20 Size 1070G, Amerigear, or approved equal

**Operating Drums**

Four (4) required Two (2) left hand (LH) and two (2) right hand (RH) drums are required. In addition to the details provided on the Contract Plans, the following requirements shall apply to the drums:

The machining procedure for the operating drum and shaft shall be such that the pitch circles of the completed rope grooves be concentric with the operating drum shaft The tolerance for drum groove pitch diameter and drum groove radius shall conform to the Contract Plans. For each completed drum assembly, the fabrication shop shall make a record of groove radius and concentricity for each drum groove relative to the shaft and submit this record to the Engineer for review and approval

**Operating Drum Support Frame**

Four (4) required. The operating drum support frames shall be of welded construction. Mounting surfaces shall be machined to a 125 microinch finish after the weldment has been stress relieved. The supports shall be shipped to the field separate from the operating drum and bearing assemblies. The supports shall be aligned and secured to the support beams prior to the installation of the operating drum assemblies

**Secondary Reducer Support Frame**

Two (2) required The secondary reducer support frames shall be of welded construction. Mounting surfaces shall be machined to a 125 microinch finish after the weldment has been stress relieved The supports shall be shipped to the field separate from the reducers The supports shall be aligned and secured to the support beams prior to the installation of the secondary reducers.

### **Primary Reducer Support Frame**

One (1) required. The primary reducer support frame supports the motors, motor brakes, machinery brakes, and primary reducer as detailed in the Contract Plans. The supports shall be of welded construction. The Contractor should note that all details for the supports have not been provided. Mounting pads shall be provided on top of the supports as necessary to facilitate installation of the motors and brakes. Mounting surfaces shall be machined to a 125 microinch finish after the weldment has been stress relieved.

The motors, brakes, and primary reducer shall be mounted to the primary reducer support frame in the shop. The components shall first be properly aligned and then secured using turned bolts. The machinery and the support shall be shipped to the field as a complete assembly. The Contractor shall take care in picking the assembled frame so as not to cause permanent deflection or distortion of the frame. The Contractor will be required to demonstrate that the alignment between mating components has not been disturbed after installation of the support frame in the field. Any deviations from the initial alignment will be cause for realignment which may involve installation of oversized turned bolts.

### **Electric Motor Driven Crane Bridge with an Electric Chain Hoist**

The Contractor shall provide an electric motor driven crane bridge with an electric chain hoist to facilitate maintenance and repair of machinery in the machinery room at mid span. The bridge crane shall suit the crane beams (nominal 24'0" span) as detailed in the Plans. The crane bridge and hoist assembly shall be provided as a complete self-contained package from a single manufacturer. As a minimum, the assembly shall include the following features / characteristics:

- 5 ton capacity hoist
- Top running, single girder bridge crane
- 100 feet per minute (fpm) bridge speed
- 50 feet per minute (fpm) trolley speed
- 9 feet per minute (fpm) hoist speed
- 40 feet available lift for hoist
- Heavy duty construction
- Double flanged alloy steel wheels for bridge travel
- Heavy duty rubber bumpers at ends of travel
- Heavy duty roller bearings with inner races
- Pressure grease fitting lubrication for wearing components
- No overhung gearing
- Heavy duty crane duty motor
- Totally enclosed oil bath lubricated gear reducers with mechanical braking
- All cross shafting supported by self-aligning pressure lubricated pillow block bearings
- Heavy duty single speed bridge control with 120V control circuit
- Electronic soft start for bridge operation
- Powered by 230/460V 3-Phase 60Hz
- Heavy duty four wheel "C" track flat cable cross-bridge festooning
- Motor running overload protection
- Hanging pendant control for hoist and bridge operations
- Sufficient hoist chain length for lifting hook to reach roadway surface
- 8 to 10 fpm hoist lifting speed
- Select manufacturer's special paint process for corrosive environment

The Contractor shall fully coordinate the provision of this bridge and chain hoist with the structural details and to meet clearances or other requirements as required by the crane manufacturer. Submit complete dimensional and operational details for review as part of the shop drawing review process.

## **OPERATING ROPE SYSTEM**

### **General**

The Contractor shall supply and install sixteen (16) operating ropes and associated guide sheaves, deflector sheaves and take-ups as shown on the Contract Plans. Components subject to stipulations not detailed on the Contract Plans or addressed under the General Materials section are as follows:

### **Operating Ropes**

Sixteen (16) required. Operating ropes shall be 1-1/8" nominal diameter extra improved plow steel with hard fiber core. The minimum breaking strength of the rope shall be 115,600 lbs. Each rope shall include one (1) open spelter socket and one (1) end non-socketed. The non-socketed end shall be seized and the end wires composing the rope shall be welded together. Seizing shall be removed prior to rope installation.

The operating ropes shall be tensioned in the field following installation per the requirements identified in the Construction Submittal section of this Special Provision.

### **Guide and Deflector Sheave Groove Concentricity**

The machining procedure for the guide and deflector sheaves shall be such that the pitch circles of the completed rope grooves be concentric with the hub bores. The tolerance for sheave groove pitch diameter shall be + 0.000"/- 0.010" and sheave groove radius shall conform to the Contract Plans. For each completed drum assembly, the fabrication shop shall make a record of groove radius and concentricity for each drum groove relative to the shaft and submit this record to the Engineer for review and approval.

### **Operating Rope Anchorage and Support Plates**

Eight (8) existing assemblies. Two (2) support plates and one (1) central anchorage plate are present at each rope termination assembly. Following removal and disposal of the existing ropes and take-ups, the anchorage shall be cleaned to bare metal and the bores shall be hand polished to remove any injurious defects. The anchorage bores should then be coated with NeverSeize. The anchorage support plates shall be cleaned and painted.

## **TOWER MACHINERY**

### **General**

The Contractor shall supply and install four (4) counterweight sheave assemblies as shown on the Contract Plans. Components subject to stipulations not detailed on the Contract Plans or addressed under the General Materials section are as follows:

### **Counterweight Sheave Groove Concentricity**

The machining procedure for the sheaves and trunnions shall be such that the pitch circles of the completed rope grooves be concentric with the sheave hub bore. The tolerance for sheave groove tread diameter and sheave groove radius shall conform to the Contract Plans. For each completed sheave, the fabrication shop shall make a record of groove radius and concentricity for each sheave groove relative to the sheave hub bore and submit this record to the Engineer for review and approval.

## **COUNTERWEIGHT ROPES**

### **General**

The Contractor shall supply and install forty-eight (48) main counterweight ropes and associated take-ups, pins, spacer assemblies, anchoring billets, keeper plates and associated hardware. The Contractor shall also rehabilitate the existing counterweight splay and deflector castings, and

the existing counterweight anchorage. Components subject to stipulations not detailed on the Contract Plans or addressed under the General Materials section are as follows:

**Counterweight Ropes**

Forty-eight (48) required. Counterweight ropes shall be 1-7/8" nominal diameter extra improved plow steel with independent Wire Rope Core. The minimum breaking strength of the rope shall be 348,000 lbs. Each rope shall include two (2) open spelter sockets.

The main counterweight ropes shall be tensioned in the field following installation per the requirements identified in the Construction Submittal section of this Special Provision.

**Counterweight Splay and Deflector Castings**

Eight (8) existing. Two (2) counterweight splay and deflector castings are present at each side of each counterweight. Following removal and disposal of the existing ropes, the castings shall be cleaned to bare metal. Any defects or damage in the rope grooves discovered during the cleaning shall be hand polished to provide a smooth profile. Once cleaned, a coating of approved rope lubricant shall be applied to the grooves to protect against corrosion.

**Counterweight Anchorage**

Eight (8) existing. Two (2) anchorage plates and one (1) central web plate are present at each side of each counterweight. Following removal and disposal of the existing ropes, the plates shall be cleaned to bare metal and the bores shall be hand polished to remove any injurious defects. The anchorage bores should then be coated with NeverSeize. The web plate bores should be coated with cosmoline.

**AUXILIARY COUNTERWEIGHT SYSTEM**

**General**

The Contractor shall supply and install two (2) complete auxiliary counterweight assemblies, one (1) at each end of the lift span. The assemblies comprise wire ropes, sheaves, take-ups, anchoring pivots, and counterweights as shown on the Contract Plans. Components subject to stipulations not detailed on the Contract Plans or addressed under the General Materials section are as follows:

**Auxiliary Counterweight Ropes and Sockets**

Eight (8) required. Auxiliary counterweight ropes shall be 5/8" nominal diameter improved plow steel with hard fiber core. The minimum breaking strength of the rope shall be 33,400 lbs. Each rope shall include two (2) open spelter sockets.

The auxiliary counterweight ropes shall be tensioned in the field following installation per the requirements identified in the Construction Submittal section of this Special Provision.

**SPAN LOCK MACHINERY**

**General**

The Contractor shall supply and install two (2) span lock machinery assemblies, one (1) at each end of the lift span, as shown on the Contract Plans. The span lock machinery is provided as a safety to prevent the span from raising after it has been seated by the span drive machinery. The machinery is designed to withstand the load produced by the motor at a stalled condition. Because the locks are a safety device and are not intended to actively seat the bridge, slight clearance shall exist between the lock bar and receiver shoe under normal conditions. Total span lock bar travel, from fully retracted to fully driven, shall be twelve inches. Operation of the span lock motors at rated speed shall result in lock bar travel of twelve (12) inches in approximately five (5) seconds.

Span lock machinery components subject to stipulations not detailed on the Contract Plans or addressed under the General Materials section are as follows:

**Span Lock Motor with Integral Brake**

Motor and brake procurement, installation, and payment falls under the Electrical work. The key and keyway requirements provided in this mechanical Special Provision shall also apply to the motors.

**Span Lock Speed Reducer**

Two (2) required. Triple reduction foot mount parallel shaft reducer rated 2hp at 1200 RPM input speed with 200:1 reduction ratio. Provide general envelope dimensions as shown on the Contract Plans. Provide dual extended input and output shafts. Input shaft opposite the motor side shall be used for installation of auxiliary drive hand crank.

Mounted on one (1) reducer input shaft extension shall be a coupling hub. The opposite side input shaft extension shall be used for auxiliary drive via a hand crank, to be provided by the Contractor. Mounted on each output shaft shall be a coupling hub. All coupling hubs shall be mounted in the shop with an FN2 fit and key by the speed reducer manufacturer. Each input shaft coupling shall be secured with a single key meeting ASTM A668 CL D material requirements. Each output shaft coupling shall be secured with a single key meeting ASTM A668 CL J material requirements. The output shafts shall be long enough to permit opening the coupling half mounted on this extension to inspect the internal wearing components (gear teeth) of the coupling.

The reducer shall be lubricated via a splash oil system designed to provide ample oil to all bearings and gear meshes.

**Span Lock Motor Couplings**

Two (2) required. The motor couplings shall be double-engagement, grid-type couplings with horizontally split covers, and sized as indicated on the Contract Plans. The motor coupling hubs shall be secured to shafts with an FN2 fit and one (1) key. Motor couplings shall be Falk Type T10 Size 1040T, Amerigear, or approved equal.

**Span Lock Cross Shaft Couplings**

Eight (8) required. The cross shaft couplings shall be double-engagement gear-type couplings sized as indicated on the Contract Plans. The couplings shall have shrouded bolts. All coupling hubs shall have an FN2 fit with the shafts that they are mounted on and secured with a single key that meets ASTM A668 CL J material requirements. Span lock cross shaft couplings shall be Falk Type G10 Size 1030G, Amerigear, or approved equal.

**Span Lock Limit Switches**

Two (2) limit switches shall be provided on each lock bar assembly as shown on the Contract Plans. The limit switches shall provide positive position indication of the lock bar and be separate from the lock bar operator.

One (1) limit switch shall be interlocked with the electric motor to:

1. Stop the lock bar when it is being driven and reaches the fully driven position.
2. Prevent the motor from driving the lock bar when it is in the fully driven position.

The second limit switch shall be interlocked with the electric motor to:

1. Stop the lock bar when it is being withdrawn and reaches the fully withdrawn position.
2. Prevent the motor from withdrawing the lock bar when it is in the fully withdrawn position.

The electrical control system shall also provide interlocks to prevent the electric motors from moving the lock bar unless the lift span is in the fully closed position and the gates are positioned to prevent vehicular traffic from passing over the span.

## **SPAN GUIDE ROLLERS**

### **General**

The Contractor shall supply and install transverse and longitudinal span guide rollers as shown on the Contract Plans. A total of four (4) longitudinal guide rollers shall be provided and located in pairs at the bottom chord at the south end of the lift span. A total of eight (8) transverse guide rollers shall be provided; one (1) guide roller shall be located at the bottom and top chord on both sides and at both ends of the lift span. All requirements for the rollers are shown on the Contract Plans or addressed under the General Materials section of this special provision.

## **COUNTERWEIGHT GUIDE ROLLERS**

### **General**

The Contractor shall supply and install counterweight guide rollers as shown on the Contract Plans. Four (4) guide rollers are required at each counterweight for a total of eight (8). All requirements for the new guide rollers are shown on the Contract Plans or addressed under the General Materials section of this special provision. The new guide rollers shall utilize the existing roller frames which are framed into the existing counterweights. The existing frames shall be cleaned per SSPC-SP3 following removal and disposal of the existing roller components.

## **LIVE LOAD SUPPORTS AND CENTERING DEVICES**

### **General**

The Contractor shall provide two (2) live load supports and one (1) centering device at each end of the lift span as shown on the Contract Plans. Expansion type live load supports shall be installed at the north end of the lift span. Fixed type live load supports shall be installed at the south end of the lift span. A common type centering device shall be installed at each end of the lift span.

Stipulations related to the live load supports and centering devices not detailed on the Contract Plans or addressed under the General Materials section are as follows:

### **Suggested Live Load Equalization Procedure**

The loading between the pair of live load supports at each end of the lift span shall be equalized at installation.

The following procedure is suggested as a basis for equalizing the loading for the two supports at one end of the lift span. The work shall be repeated to equalize the loading between the supports at the opposite end of the span.

1. Lower the lift span until there is ½ inch clearance between the live load support and strike plate.
2. Release all brakes to allow the span to settle down, bringing at least one (1) live load shoe into contact with its strike plate. Installation of temporary weights on the lift span may be required to get the span to settle onto the live load supports.
3. If both live load shoes contact their strike plates, raise the leaf and insert a temporary shim 1/2 inch thick under the east shoe (Se). Lower the leaf by releasing the brakes. Measure the clearance (Cw) under the west shoe (Sw). Raise the leaf and remove the 1/2 inch temporary shim from under the east shoe and insert it under the west shoe.

Lower the leaf by releasing the brakes. Measure the clearance ( $C_e$ ) under the east shoe. If the clearances  $C_e$  and  $C_w$  measured under the two live load shoes with the temporary shim in place are equal, no additional shim adjustment is required at this time. If  $C_e$  is greater than  $C_w$ , additional shims must be installed under  $S_e$  with a thickness of  $T=(C_e-C_w)/2$ . If  $C_w$  is greater than  $C_e$ , additional shims must be installed under  $S_w$  with a thickness of  $T=(C_w-C_e)/2$ .

4. If one of the live load shoes does not contact its strike plate, measure the clearance ( $C_1$ ) under that shoe ( $S_1$ ). Raise the leaf and install a temporary shim of thickness ( $C_1+1/2$  inch) at  $S_1$ . Lower the leaf and measure the resulting clearance  $C_2$  at the other shoe ( $S_2$ ). Install permanent shims at  $S_1$ . The thickness ( $T$ ) of the permanent shims will be  $T=[C_1+(1/2 \text{ inch}-C_2)/2]$ .
5. Following installation of shims determined above, seat the lift span and verify uniform contact at both live load supports as verified by contact across the width of the strike plates. Contact will be considered acceptable when the maximum gap between the live load shoe and the strike plate is less than 0.005 inch and contact exists at one or more points between these two surfaces.

Note that this work will require the expansion end pin nuts and washers be removed to ensure that there is contact between the pins and the upper and lower castings at both ends of each pin when the span is fully seated on the strike plates.

6. After acceptable live load equalization has been obtained, uniform shim adjustments may be required at both live load supports if the engineer determines that the elevation of the roadway joint does not meet the approach joint.

## **AIR BUFFERS**

### **General**

The Contractor shall supply and install four (4) new air buffers. The air buffers are designed to limit damage to the lift span in the event that the span reaches the fully closed position at excessive speed due to a mechanical or electrical malfunction. The buffers are designed to absorb the full inertia of the lift span as it decelerates from full speed to 0 speed over 24" of travel.

Stipulations related to the air buffers not detailed on the Contract Plans or addressed under the Materials section are as follows:

### **Buffer Shop Testing**

Each buffer shall be shop tested after assembly to verify the accuracy of machining and air leakage between the cylinder wall and the piston rings. The weight of the cylinder and its attachments must be sustained by the confined air for six (6) minutes, with piston travel not more than 24 inches. At the initiation of the test, the piston rod must be fully extended, the valves must be closed and the buffers balanced or so secured that the whole weight is carried by the piston rod. The Contractor is advised that special tooling fixtures may be required to meet the requirements of this testing.

### **Buffer Field Adjustment**

The egress of air from the buffers is controlled via a needle valve. The Contractor shall adjust the needle valves to equalize the loading between the two buffers at each end of the lift span during seating and to obtain satisfactory performance of the bridge upon closing, as determined by the Engineer. The Contractor shall record the needle valve settings (i.e., number of turns from valve seated position) and buffer pressures at the time of acceptance testing for permanent record.

### **Buffer Alignment**

With the span fully seated and the air buffer compressed, the air buffers shall be plumb within 1/16 inch over the length of the air buffer.

**SPAN BALANCE**

**General**

The Contractor shall perform all work necessary to balance the new lift span and existing counterweights as described herein. This work shall comprise performing full balance calculations of all new components based on approved shop drawings, weighing the new lift span, new auxiliary counterweights and existing counterweights with calibrated jacks and/or load cells, maintaining the span imbalance, as well performing dynamic strain gage testing once the machinery is authorized for operation.

Under this item the contractor shall provide:

- 1 The services of a licensed Professional Engineer to prepare calculations and an electronic spreadsheet for maintaining the balance of the lift span throughout the construction work
- 2 Initial measurement of imbalance by jacking the lift span and the counterweights through the various stages of erection.
- 3 The services of an approved testing company to perform complete dynamic strain gage testing and reporting
- 4 All labor required to add or remove balance blocks to obtain the required balance condition.
- 5 All labor required to provide and install temporary ballast to simulate the loading conditions in accordance to AASHTO. Supplying and disposing of ballast material to accomplish this work is incidental

**Balance Requirements**

The balance of the movable span is dependent upon the differential in weight of the lift span and counterweights, as well as the counterweight ropes and the auxiliary counterweight system. Balance requirements are provided to monitor the balance condition of the lift span at the various stages of construction prior to operation via the drive machinery, and then to finalize the balance of the lift span through strain gage testing. Weight adjustments shall be implemented as necessary to conform to the balance requirements provided in the following table prior to advancing to each subsequent stage of construction

Bridge Status		Required Balance Condition per Corner	
		Maximum	Minimum
Construction Float-In	No Ropes or Aux Cwt	-2,525 lbs	-7,000 lbs
	Ropes Connected, No Aux Cwt	+10,225 lbs	+5,750 lbs
	Ropes Connected, Aux Cwt Connected	+5,000 lbs	+500 lbs
Span Operational	Construction Balance	+5,000 lbs	+500 lbs
	Final Balance	+3,000 lbs	+2,500 lbs

Positive (+) reaction indicates span heavy condition.  
Negative (-) reaction indicates counterweight condition.

### **Balance Calculations**

The Contractor shall submit balance calculations as specified herein to the Engineer for review and approval. A Professional Engineer licensed in Ohio shall perform the balance calculations.

Compute the weights of all components (structural, architectural, mechanical and electrical, etc.) that will be raised as part of the lift span or lowered as part of the main counterweights based on approved shop details and material tests for the actual material. Compute weights of individual components to the nearest 0.1 lb accuracy. Summarize weights of assemblies to the nearest 1.0 lb accuracy. Summarize lift span weight to the nearest 0.1 kip accuracy. Compute the quantity and location of balance material required within the counterweight and counterweight pockets, including concrete and balance blocks, based on the specified balance requirements and the weight and center of gravity of the lift span. The balance calculations shall incorporate the distributions of weight in the longitudinal and transverse directions.

Prepare a balance spreadsheet to monitor the lift span balance. The spreadsheet shall itemize all additions and removals that are required as part of this work including any temporary removals or additions. The spreadsheet shall include the location of all weight added or removed and calculate the effect of individual weight changes and be capable of calculating a running tabulation of the balance at each corner of the movable span as the work progresses. The spreadsheet shall be updated on a daily basis to track construction activities prior to the start of that construction activity at the bridge site in order to demonstrate that at no time will a construction activity result in an unacceptable balance condition. A narrative shall be included with the outline of the proposed 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 and shall be submitted to the Engineer for review along with an electronic copy of the spreadsheet. Summary tables shall be developed using the spreadsheet for all phases of the balance and the proposed imbalances. Temporary balance material, if used, shall be accounted for in the summary tables. All summary tables and back-up materials shall be submitted for review.

It shall be the Contractor's responsibility to provide temporary bracing and supports and/or temporary balance material as required to stabilize the movable span during construction.

Review of the balance calculations, counterweight details, and quantity and location of balance material does not relieve the Contractor from making such changes in the counterweights and balance material as deemed essential to balance the lift span in accordance with the final balance requirements. All changes shall be submitted for approval.

### **Initial Balance Measurements with Jacks**

The Contractor shall determine via calibrated jacks and/or load cells the differential in weight between the new lift span and existing counterweights prior to full transfer of the counterweight and lift span loads to the counterweight ropes. It is anticipated that the existing counterweights shall be weighed using the strand jacks shown in the Contract Plans. The Contractor shall devise the means of lifting and weighing the lift span in conjunction with the required cribbing design for the float-in. Regardless of method chosen for weighing the lift span and counterweights, full calibration details shall be submitted to demonstrate to the Engineer's satisfaction that the jacks and/or load cells are appropriately calibrated through the anticipated load region.

The differential in weight between the lift span and counterweight shall be equated to corner reactions and shall meet the Balance Requirements described herein. The addition or removal of balance blocks from each counterweight shall be used to correct the deviation from the desired imbalance.

### **Dynamic Strain Gage Balance Measurements**

The lift span imbalance shall be measured a minimum of three (3) times using the dynamic strain gage method:

- 1 Strain gage testing shall be performed concurrent with the initial start-up and operation of the drive machinery. The balance shall be adjusted to conform to the construction balance requirements.
- 2 Strain gage testing shall be performed following all construction activities. The balance shall be adjusted to conform to the final imbalance requirements
- 3 Additional strain gage testing shall be performed as part of Acceptance testing to demonstrate and document lift span operation under AASHTO imposed wind and ice loading

Strain gage testing shall be performed under the direct supervision of a licensed professional engineer who has prior hands-on experience with imbalance testing, as demonstrated by successful completion of testing at a minimum of six (6) movable bridges at least two (2) of which are span drive vertical lift bridges

Two (2) strain gages shall be mounted on each operating drum shaft between the coupling and the inboard bearing. The gages shall be mounted back to back (i.e. spaced 180 degrees circumferentially on the shaft) and wired in a Wheatstone bridge configuration so as to measure torsion only. After the gages are installed they shall be protected in accordance with the strain gage manufacturer's recommendations

The gages from the four (4) operating drum shafts shall be connected to a recording device capable of providing a permanent record of the strain in the shaft versus span lift height. The span lift height shall be recorded using an event marker mounted on an appropriate shaft. The output for the span lift height shall be recorded simultaneously and on the same device with the imbalance strain.

Imbalance recordings shall be recorded through at least three (3) complete operations and a permanent record of each test shall be maintained. The data collected shall be used to determine the span imbalance. The Contractor shall make balance adjustments to meet the Balance Requirements as listed in these Special Provisions. Following each balance adjustment the Contractor shall conduct additional strain gage testing and analysis to verify the span balance condition. The Contractor shall repeat the testing until the desired balance conditions have been achieved

### **Strain Gage Balance Testing Submittals**

A complete test procedure along with the resume of the Engineer conducting the tests shall be submitted for approval prior to any balance testing. The test procedure shall include the following:

- 1 Prior strain gage test experience
- 2 Test method
- 3 List of equipment
- 4 Gage protection endorsed by gage manufacturer
- 5 Sample calculations relating strain in the instrumented shaft to imbalance about the sheave trunnions for this structure
- 6 Report format

After the balance tests have been completed, the Contractor shall submit a formal report signed and sealed by the Professional Engineer who conducted the tests. The report shall include the following:

- 1 Introduction
- 2 Test procedure and equipment
- 3 Method of analyzing recorded data
- 4 Presentation of final balance results
- 5 Discussion of error
- 6 Figures depicting the location of the strain gages and basic wiring schematics
- 7 Calculations
- 8 Strip charts of the raw strain data and lift height event graphed against a time based scale for each of the three (3) test runs
- 9 Graphical representation of span balance vs lift height for each of the three (3) test runs
- 10 Table summarizing the results of the load testing as detailed below.
- 11 The electronic raw data files for the final balance condition and the load tests The files shall be sufficiently annotated to identify the appropriate channels and units of measure

All calculations shall be prepared in English units

#### **Balance Blocks**

The existing balance blocks inside the counterweight pockets are deteriorated and are to be removed under *Item 202*. New balance blocks shall be provided per the detail provided on the structural plans in the quantity required on the plans

#### **Weight Adjustments and Test for Simulated Ice and Wind Loading**

After the lift span has been properly balanced, additional strain gage testing shall be conducted to document load testing of the lift span as part of the acceptance testing for the electrical system. The Contractor shall add temporary ballast to the lift span in incremental amounts to simulate AASHTO wind and ice loading requirements. Weight shall be uniformly added to the lift span in 12,000 lbs increments (3 kips per corner) up to a total addition of 60,000 lbs. The lift span shall be operated to the normal full open lift height under each weight addition to verify proper function of the mechanical and electrical systems. Strain gage and motor amperage readings shall be recorded throughout the testing. Strip chart printouts of the strain and motor amperage shall be provided for each test case; each strip chart shall have bar lines representing 100% full load motor torque and/or motor amperage for reference. A table shall be provided to summarize the test results as compared to the physical weight additions. These load testing strip charts and results shall be appended to the final balance report.

## CONSTRUCTION DETAILS

### General

The Contractor shall supply all apparatus, tools, devices, materials and labor to remove and install span drive machinery, span lock machinery, span guides, air buffers, live load supports, centering devices, counterweight sheaves, counterweight ropes and their attachments, and the auxiliary counterweight system as noted herein and on the Contract Plans. Any apparatus, tools, devices, materials and labor incidental to the work but not specifically stated or included, which may be necessary for the work, shall be furnished by the Contractor at no additional cost to the County. The installation and adjustment of all machinery shall be done by millwrights experienced in this class of work. The installation and alignment of machinery shall not be done by workers of any trade other than the millwright trade. The Contractor shall submit the resumes of the millwrights to the Engineer for approval.

The Contractor shall coordinate and schedule work to suit requirements of the County and the U.S Coast Guard, as directed and approved by the Engineer.

### Delivery, Storage, and Handling

All machinery items and material shall be delivered to the off-site assembly location in accordance with the approved schedule of work. All machinery, materials and items, shall be properly protected for shipment and storage.

All machinery items shall be stored so as to permit easy access for inspection and identification. Material shall be stored in a building in manner that will cause no distortion or damage. No outdoor storage of machinery components shall be used regardless of the methods of protection provided.

All finished metal surfaces and unpainted metal surfaces that would be damaged by corrosion, shall be coated as soon as practical after finishing with a protective coating such as No-Ox-Id, A-Special, as manufactured by Sanchem, Inc. of Chicago, IL or approved equal. This coating shall be removed from all surfaces prior to lubrication for operation and from all surfaces prior to painting after erection.

Assembled units shall be mounted on skids or otherwise crated for protection from weather, dirt and all other injurious conditions during shipment and storage as approved by the machinery manufacturer. The Contractor shall submit advance information as to methods and materials which will be used for protection for approval by the Engineer.

Any damage that occurs to the machinery components as a result of improper protection during shipment or storage shall be corrected by the Contractor to the satisfaction of the Engineer at no cost to the County.

### Installation

Machinery installation shall not commence until all required components have been completed and approved for installation, all required procedures and schedules have been approved and preparations by others where required have been satisfactorily completed.

During installation, the Contractor shall maintain and lubricate all rotating and sliding parts of the machinery, including span drive machinery, lock machinery, sheaves, ropes, wire rope assemblies, counterweight sheave assemblies, span and guide rollers, and air buffers. The surfaces of new components which will rotate or slide relative to one another once assembled shall be lubricated prior to assembly. Any corrosion which should occur on machinery during the construction/installation period shall be removed and the surface returned to bare metal prior to applying fresh lubricant. Machinery disassembly may be required to facilitate this repair work if so directed by the Engineer. Where corrosion is extensive and cannot be removed without marring the base surface, or where the machinery surface is marred by corrosive pitting, the component shall be returned to the shop for repair.

### **Alignment**

All components of standard manufacture (i.e., couplings, rolling element bearings, brakes, etc) shall be aligned to the tolerances specified by the manufacturer of that component. The manufacturer's recommended alignment tolerances for a new installation shall be the basis for alignment and shall be included in the relevant procedures.

All components of custom manufacture (i.e. live load supports, buffers, etc) shall be aligned to the tolerances provide in these Contract Documents.

Final reaming of holes for turned bolts shall occur only after the Engineer's approval of the field alignment.

1. Plain Bearings

The alignment of a plain bearing will be considered acceptable when the taper in the bearing, determined by feeler gage measurements does not exceed 0.001" over the length of the bearing.

2. Span Drive Operating Rope Drums

The operating rope drums shall be located as shown on the Contract Plans. The two drums connected to each secondary reducer shall be in-line and at the same elevation, and located as shown on the Contract Plans. The Contractor shall establish a theoretical straight line that passes through the center of the outboard sides of the two drum trunnions. The established line shall be at a right angle to the bridge centerline and at the elevation shown on the Contract Plans. The maximum variation of the actual trunnion centerline shall be 1/32" in at any point.

A machinery installation and alignment procedure shall be provided for review. The submittal must include complete details regarding the installation of the drums for review. Sufficient advance notice shall be provided to allow the Engineer to witness any alignment measurements.

3. Span Locks

The final adjustment of the lock bars shall take place after the live load supports are properly adjusted and the elevations at the lift span meets alignment requirements with approach span.

Acceptable alignment of the lock bar to the front and rear guides shall be measured in the engaged position and shall include:

- a. Full contact of the bottom of the lock bar with the bottom wear plates at both the front and rear guides. Contact will be considered full when a 0.003 inch feeler gage cannot be inserted at any location between the bottom of the lock bar and the guide wear plates.
- b. RC6 clearance between the top of the lock bar and the top guide wear plates at both the front and rear guides. Taper in this clearance shall not exceed 0.003 inch over the length and width of the lock bar.
- c. Uniform gap between the top of the lock bar and the lock bar receiver. Taper in this clearance should not exceed 1/32 inch across the length and width of the lock bar.

The lock bar/link/crank alignment shall be within the manufacturer's limits for the spherical plain bearings and within the limits of the dimensions of the bearing housings such that, with the exception of the bearing components, no binding or rubbing of the components occurs during operation.

4 Counterweight Sheave Trunnion Alignment

The counterweight sheaves shall be centered on a theoretical straight line that is at right angles to the centerline of the bridge and at the elevation shown on the Contract Plans. The initial installation of the sheave assemblies shall account for anticipated transverse and longitudinal deformation of the towers that is expected due to transferring the load of the counterweights and the lift span to the counterweight ropes.

Acceptable trunnion alignment shall be demonstrated through piano wire alignment measurements. The piano wire shall be used to establish a line against which the alignment of the trunnions can be measured. In each tower, the established line shall pass through the center of the outboard end of both sheave trunnions. A theoretical straight line shall be established from the piano wire line by accounting for wire thickness, wire sag, and any installation offsets from true center.

Final alignment measurements shall be taken with full counterweight and span loading on the counterweight sheaves. The maximum variation of the trunnion centerlines from the established theoretical straight line shall be 0.020 inch at any point. The Contractor should note that it may be necessary to load and unload the counterweight sheaves several times in order to meet the required alignment tolerances.

A sheave/trunnion assembly installation and alignment procedure shall be provided for review. The procedure must completely describe the sequence of installation of the sheaves and anticipated deflection changes at the sheave supports and how the final alignment criteria will be achieved. The submittal must include deflection calculations, complete piano wire installation details and supporting calculations for review. Sufficient advance notice shall be provided to allow the Engineer to witness any alignment measurements.

5 Wire ropes

Wire ropes shall be installed with the correct twist of lay that they had at the time of measurement at the factory. The paint stripe applied to ropes shall be straight after installation.

**Rope Tensioning**

Tension at the main counterweight ropes, auxiliary counterweight ropes, and operating ropes shall be measured and adjusted as described herein immediately following installation, one (1) month following installation and again six (6) months following installation.

All rope tensions shall be measured through their fundamental frequency using the vibration method. Rope tension measurements and direction shall be provided by an engineer licensed in the state of Ohio. The Contractor's engineer shall provide a detailed procedure outlining the procedure, the method that will be used to record rope frequencies, and the calculation for rope tension for each rope type. A formal report shall be prepared by the contractor's engineer to document the final rope tensions at each indicated time frame.

The Contractor shall supply all necessary equipment and personnel to make the necessary rope tension adjustments including equipment to adjust the rope tensions.

**Main Counterweight Rope Tensions**

The main counterweight ropes shall be adjusted at each required tensioning interval until all ropes in a given rope group are within +/- 5 percent of the average tension for the relevant rope group. Average tension for the rope group is determined by summing the tension of each rope in given group and dividing by the total number of ropes in that group. Following any tension adjustments, the bridge shall be operated through five (5) complete operating cycles after which the tensions of

the ropes shall be checked. This procedure shall be repeated until the tensions of the wire ropes at the relevant corner are within +/- 5 percent of average.

**Auxiliary Counterweight Rope Tensions**

Auxiliary counterweight rope tensions shall be adjusted at each required tensioning interval such that the two (2) ropes at a given counterweight are within +/- 5 percent of the average tension. Following any tension adjustments, the bridge shall be operated through five (5) complete operating cycles after which the tensions of the ropes shall be checked. Adjustments shall be performed as warranted. This procedure shall be repeated until the tensions of the two (2) wire ropes at each auxiliary counterweight are within +/- 5 percent of the average.

**Operating Rope Tensions**

Operating ropes shall be pre-tensioned to a nominal value of 5 percent of the breaking strength of the ropes. The tolerance on the pre-tensioning shall be +/-5 percent of the nominal tension. Adjustments will be made at the downhaul and uphaul rope terminations as detailed on the Contract Plans. Pre-tensioning of the ropes shall be performed with the span seated and with no wind-up in the machinery and with the all of the span drive machinery brakes set.

**Field Installation**

All mechanical components shall be erected, located, adjusted, leveled and plumbed to the position and tolerances as shown on the Contract Plans by competent millwrights skilled in the type of work involved.

Any mechanical components not erected to the specified tolerance will be rejected. Rejection shall be due caused for the Engineer to stop future work, which would be constructed using, or with reference to, these parts until such parts are properly aligned.

**Coordination**

The Contractor shall be responsible for the coordination of the machinery installation with all other aspects of the construction project. This coordination relates to the sequencing of work so that all machinery can be installed in a safe and effective manner. Certain sequences of installation may be required in order to ensure that all items can be installed on the bridge.

## METHOD OF MEASUREMENT

### Method of Measurement

The Contractor shall complete all work specified in these Special Provisions and as shown on Sheets M1 to M46 of the Contract Plans. The lump sum prices for these items shall constitute full compensation for all material, labor and equipment required or incidental to the satisfactory completion of the work in accordance with the requirements of the contract plans and specifications, including but not necessarily limited to work associated with the following:

- Special - Misc : Mechanical Work – Counterweight Jacking
- Special - Misc : Mechanical Work – Span Drive Machinery
- Special - Misc : Mechanical Work – Operating Rope System
- Special - Misc : Mechanical Work – Tower Machinery
- Special - Misc : Mechanical Work – Counterweight Ropes
- Special - Misc : Mechanical Work – Auxiliary Counterweight System
- Special - Misc : Mechanical Work – Span Lock Machinery
- Special - Misc : Mechanical Work – Span Guide Rollers
- Special - Misc : Mechanical Work – Counterweight Guide Rollers
- Special - Misc : Mechanical Work – Live Load Supports and Centering Devices
- Special - Misc : Mechanical Work – Air Buffers
- Special - Misc : Mechanical Work – Span Balance

The locations are listed only for the Contractor's convenience in determining the volume of work involved and are not guaranteed to be accurate. Prospective bidders shall verify these quantities before submitting a bid. No adjustments other than for approved changes will be made in the lump sum contract prices, even though the actual locations required may deviate from those listed.

## BASIS OF PAYMENT

### Basis of Payment

The lump sum contract price for each pay item shall be full compensation for the work as specified and detailed in the Contract Documents as follows:

<u>Item</u>	<u>Unit</u>	<u>Description</u>
Special	Lump	Misc.: Mechanical Work – Counterweight Jacking
Special	Lump	Misc.: Mechanical Work – Span Drive Machinery
Special	Lump	Misc.: Mechanical Work – Operating Rope System
Special	Lump	Misc.: Mechanical Work – Tower Machinery
Special	Lump	Misc.: Mechanical Work – Counterweight Ropes
Special	Lump	Misc.: Mechanical Work – Auxiliary Counterweight System
Special	Lump	Misc.: Mechanical Work – Span Lock Machinery
Special	Lump	Misc.: Mechanical Work – Span Guide Rollers
Special	Lump	Misc.: Mechanical Work – Counterweight Guide Rollers
Special	Lump	Misc.: Mechanical Work – Live Load Supports and Centering Devices
Special	Lump	Misc.: Mechanical Work – Air Buffers
Special	Lump	Misc.: Mechanical Work – Span Balance