MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**HYDRAULIC CYLINDER REFURBISHMENT**

BRG:JST 1 of 14 APPR:SCK:CAI:08-22-24

**a. Description.** This work consists of refurbishing hydraulic cylinders, as specified herein, and as shown on the plans (when applicable). It is the Contractor’s responsibility to detail the shop drawings and select hydraulic components to be installed ensuring proper tolerances/clearances are maintained to install a proper working system.

1. Summary of Work.

A. Hydraulic Cylinder Removal and Reinstallation. The hydraulic cylinder rehabilitation is required to include the following items, including all incidental work associated with these tasks:

(1) Remove cylinders from the bridge, transport them to a shop for refurbishment per this special provision, and then reinstall them on the bridge.

(2) The Contractor must take care to avoid damage to the existing cylinder manifold, rod end pins, hoses, and any other components to be reused.

(3) The Contractor is required to bleed air from the cylinders.

(4) Supply Mobil DTE 24 oil and filter to at least ISO 16/14/12 upon installation to maintain adequate oil in the system.

(5) Replace existing viscous damper with new spring hanger.

(6) Replace existing cotter pins at the heel end for the cylinders to be refurbished.

B. Hydraulic Cylinder Refurbishment. The hydraulic cylinder rehabilitation is required to include the following items and all incidental work associated with these tasks:

(1) Refurbish the cylinder in a shop. Inspect the cylinder, install new seals and new in-kind manifold valves (the manifold may be replaced at the Contractor’s option). Replace bearings at both ends of the cylinder in kind. Fabricate new gland and install new gland in accordance with the original shop drawing requirements at a minimum.

(2) Perform field/shop measurements of the existing hydraulic cylinders.

(3) Inspect and perform measurements of the existing hydraulic cylinder wearing surfaces that are to remain in service.

(4) Inspect full length of cylinder rods. Re-chrome the rods. If scoring is not present, request permission from MDOT to deviate from re-chroming the cylinder rod.

(5) Based on measurements, submit marked up shop drawings for review and approval in accordance with the requirements of this special provision. Submit shop drawings and/or catalog cut for purchased components for review.

(6) Shop paint all new steel components. Field painting is limited to touch-up at the completion of the project. The shop paint coating system and field repair of damaged coatings are to be in accordance with section 716 of the Standard Specifications for Construction.

(7) Install new boots on the cylinder and new label plates showing the original manufacturer information and the date of refurbishment.

(8) Perform repairs on the cylinder including replacing all test ports, repairing damaged pipe supports, and repairing all leaks.

(9) In the shop, initially set counterbalance valves to match the settings from the near-side eastbound bridge leaf, or as designated by the Engineer. Ensure that all counterbalance valves are set the same.

(10) Deliver the refurbished cylinders to the bridge.

(11) Any material procurement and/or fabrication by the Contractor prior to shop drawing approval is considered at-risk. Payment to the Contractor for at-risk items is not guaranteed. Should a component be fabricated and/or ordered without an approved shop drawing or catalog cut, that component is subject to rejection and the Contractor will not be paid for this item.

C. Testing and Commissioning.

(1) Test hydraulic cylinders and manifolds before shipment to the site. Testing must include a 30-minute static pressure test in both the extended and retracted position at 1.5 times the maximum working pressure (not to exceed 5000 psi) per the latest *AASHTO Movable Bridge Design Specifications with interims section 7.8.4.2.2*. Furnish the Engineer with the catalog rating certification.

(2) Perform field testing (bridge operations) prior to beginning work. Record existing operating pressures. Verify settings of any adjustable components on the cylinder assembly.

(3) Perform field testing (bridge operations) at the completion of each installation. Confirm the counterbalance valves are set the same during field testing. Adjust as needed to provide smooth operation without oscillations.

(4) Perform field testing (bridge operations) at the completion of work.

D. As-Built Drawings.

(1) Furnish electronic copies of red-line mark-ups of the contract plans for as-built drawings to the MDOT. All comments and mark-ups of contract plans are to be made electronically and submitted to the Engineer for approval.

2. Submittals.

A. Submit Rigging and Installation Plan to the Engineer for review and approval. The Rigging Plan is required to clearly detail how the Contractor intends to safely remove and re-install the existing cylinders and the equipment to be used. Access to remove the cylinder is furnished through the rear of the bridge behind the cylinder and away from the navigation channel and may include removal of the catwalk or railing in this location as required for both removal and reinstallation once the work is complete. The Installation Plan is required to include any flushing and bleeding of the system required, as well as protections furnished to prevent contamination of the Hydraulic Power Unit.

B. The Contractor is responsible for preventing oil spills. Submit a Spill Prevention Plan to the Engineer for review/approval. Ensure containment is installed to prevent any debris and hydraulic fluid from entering the waterway. Furnish adequate quantities of oil absorbent materials and utilize oil absorbent floating booms where needed to prevent hydraulic fluid from entering the waterway.

C. Shop Drawings. Shop drawings, layout drawings, working drawings, and catalog cut sheets of all products to be utilized in this rehabilitation project are required. Submit complete layout shop drawings of the hydraulic components, together with fully detailed working drawings of all equipment and material; manufacturer’s drawings, specifications, and instructions; and installation and maintenance manuals. Ensure submittals are approved by the Engineer prior to beginning the work.

(1) Shop Drawings and submittals must meet the requirements of section 104 of the Standard Specifications for Construction.

(2) Submit shop drawings for standard lead time items within 30 days of the award of the contract. Submit shop drawings or catalog cuts within 15 days for items with long lead times that impact the construction schedule. At a minimum, the cylinder manifold block and seal kits are considered long lead time items.

(3) Submit manufacturer's data, certified prints and/or shop drawings for approval for all manufactured and purchased items of machinery. Approval is required prior to ordering or manufacturing of machinery items.

(4) If any departures from the original as built drawings or operations and maintenance manual are deemed necessary by the Contractor, details of such departures and the reasons therefore are required to be submitted to the Engineer in writing as soon as practicable for approval. No departures are allowed without the Engineer's approval.

(5) Field verify all critical dimensions prior to fabrication and coordinate the work of the machinery component manufacturers where components interface. The Contractor is required to review all shop and working drawings to coordinate the proper assembly of the various machinery components prior to submission to the Engineer for approval.

(6) Show all new parts completely detailed and dimensioned on the shop drawings. Reproduction of the contract plans is not allowed to be used as foundation sheets for detail, assembly, or erection drawings.

(7) State materials and material specifications for each part. Where *ASTM* or any other standard specifications are used, the applicable numbers of such specifications are required to be furnished.

(8) Ensure that finish machining is shown, including grade of finish in accordance with *ASME B46.1* and dimensional tolerances and allowances for specific fits in accordance with *ANSI/ASME B4.1*. *ANSI/ASME B4.1* also applies to fits for non-cylindrical parts.

(9) Ensure the fits and finishes used are in accordance with the requirements for fits and finishes given on the plans and as specified herein.

(10) For all assemblies and parts, furnish complete assembly drawings or diagrams showing each part contained therein and the manufacturer's part number assigned to each part. The drawings or diagrams are required to be sufficient to enable complete disassembly and reassembly of the assemblies covered. In the event that any part is modified in any manner from the way it is described or delivered by its original manufacturer, furnish a drawing which details each modification, and assign the part a unique part number to assure the furnishing of replacement parts are modified in similar fashion.

(11) Show all external dimensions and clearances necessary for installation and operation of all new bridge machinery on shop drawings of assemblies.

(12) Certified prints are manufacturer's drawings of proprietary products on which the manufacturer or supplier states mounting dimensions, ratios, speeds, ratings, and any other details for use on this specific project. In addition to identifying and describing each part, they are required to show:

(a) Dimensions of all principal parts comprising the assembly.

(b) Certified external dimensions affecting clearances required for installation.

(c) Capacity and normal operating ratings.

(d) Mounting details/requirements.

(e) Gross weight.

(f) Certified prints are required to be signed by an officer of the manufacturing company.

(13) Show all proprietary items in outline on the shop drawings, which will also indicate the method and sequence to be employed in assembly of bridge machinery. The assembly drawings of each item will, in addition to identifying and describing each internal part, contain dimensions of all principal elements within the item; certified external dimensions affecting interfaces or installations; gross weight capacity and normal operating ratings, and details of all fasteners used to mount the equipment to its foundation.

(14) Ensure shop bills of materials are made for all machinery parts and shown on the shop drawings. If the bills are not shown on the shop drawings, prints of the bills are required to be furnished for approval in the same manner as specified for the shop drawings.

(15) The weight of each piece of machinery is required to be stated on the shop drawing upon which it is detailed or billed.

(16) Ensure complete assembly and erection drawings are furnished. These drawings are required to give part numbers, match marks, and essential dimensions for locating each part or assembled unit with respect to the bridge structure or foundation.

(17) Clearly show any detail marks or indentations of any type on the drawings. In general, die-stamping or scoring is prohibited unless otherwise called for on the plans. All components and assemblies are required to be detailed separately to assure correct fabrication, assembly, and erection. Mirror image or opposite hand erection drawings are prohibited.

(18) Ensure that the shop drawings are given a suitable title to describe the parts detailed thereon and clearly state who will conduct the shop inspection.

(19) Submit for approval proof of conformance where equipment or materials are specified to conform to requirements of the standards of an organization, such as *ASME* or *UL*, that use a label or listing as method of indicating compliance. The label or listing of the specified organization is acceptable evidence. In lieu of the label or listing, submit a certificate from an independent testing organization adequately equipped and competent to perform such services and approved by the Engineer, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code.

D. Machinery Submittals. The following list of submittals is intended as a minimum guide and does not relieve the Contractor from furnishing the required information and working drawings as described within this contract or as otherwise required for a successful project. Any additional submittals not included in the list below will not be an additional cost to the contract.

(1) Hydraulic Cylinder Refurbishment.

(a) Submit all catalog cuts, shop drawings, material test results, etc. defined within the scope of work for all materials/components furnished.

(b) Submit all field measurements defined within the scope of work.

(c) Submit removal and installation rigging plan clearly detailing how the cylinders will be removed and reinstalled safely, and what modifications need to be made to the walkways to provide access.

(d) Submit construction sequence for performing the work.

(e) Submit containment, temporary storage, and filtering/cleanliness requirements for hydraulic fluid during cylinder rod seal replacement work.

(f) Submit paint system for shop painting and field touch-up.

(g) Submit red-lines of the repair plans to serve as as-built drawings.

(h) Submit proposed procedure for re-chroming the cylinder rod. Ensure the work is performed by a shop that specializes in this work and has performed this work for at least 5 years.

3. Standards.

A. Codes and Standards. Ensure work is in accordance with all applicable requirements of the following codes and standards and their abbreviations used in this special provision, including but not limited to:

*(1) American Association of State Highway and Transportation Officials (AASHTO)*

*(2) American National Standards Institute (ANSI)*

*(3) American Society of Mechanical Engineers (ASME)*

*(4) American Society for Testing and Materials (ASTM)*

*(5) Anti-Friction Bearing Manufacturers Association (AFBMA)*

*(6) Steel Structures Painting Council (SSPC)*

*(7) Steel Construction Manual (SCM)*

B. Ensure the work meets the requirements of all other codes and standards as specified elsewhere in this special provision. Where codes and standards are mentioned for any pay item, it is intended to call particular attention to them; it is not intended that any other codes and standards will be assumed to be omitted if not mentioned.

C. Rules, Regulations and Ordinances. Comply with all applicable Federal, State, and local rules, regulations, and ordinances. In the event of a conflict between this special provision and the above-mentioned codes, standards, rules, regulations, and ordinances, the most stringent requirement will apply.

D. Manufacturer's Recommendations. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations are required to be furnished to the Engineer prior to installation. Installation of the item is not allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

**b. Materials.**

1. Standard Products. Products used in the work under this special provision are required to be produced by manufacturers regularly engaged in the manufacture of the specified products. Materials and equipment are required to be the standard products of manufacturers regularly engaged in production of such materials or equipment. Ensure they are the manufacturer's latest standard design that complies with the contract specification requirements. Materials and equipment must essentially duplicate items that have been in satisfactory commercial or industrial use at least 3 years prior to bid opening. Where two units of the same class of equipment are required, ensure the units are products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address and the model and serial number on a nameplate, securely affixed in a conspicuous place. The name plate of the distributing agent is not acceptable.

2. Substitutions. Where a particular product is specified by a manufacturer's name and catalog or part number in the contract, it is so specified to establish quality, configuration, and arrangement of parts. An equivalent product made by another manufacturer may be substituted for the specified product subject to the approval of the Engineer; however, all necessary changes required by the substitution in related machinery, structural, architectural, and electrical parts are required to be made at no additional cost.

Prior to ordering any substitute product, ensure the Engineer's approval of the equivalence of the substitute product is obtained in writing. Accepting the substitute products is at the sole discretion of the Engineer who will establish the basis for equivalence and review the quality of the materials and products described in detail on the submitted shop drawings and product data.

Approval by the Engineer of any substitute products will not relieve the Contractor of responsibility for the proper operation, performance, or function of that product.

3. Rod Seals. The intention is to replace the rod seals in kind. Verify that the replacement seals match the existing seals in size, type, and material.

Ensure the seals are rated for a working pressure of 3,000 psi or the relief valve setting in the hydraulic cylinder, whichever is greater.

Ensure seals are capable of being hydrostatically tested to 5000 psi.

Furnish seven seal kits to be installed as well as two complete spare seal kits.

4. Shafting and Pins. All shafts and pins are required to be accurately finished, round, smooth, and straight and, when turned to different diameters, furnish rounded fillets at the shoulders.

A. Ensure all shafts and pins conform to tolerances in *ASTM A29/A29M* unless otherwise indicated. Turned, ground and polished straightness tolerances are required to be 0.002 inches per foot for shafts up to and including 1½ inch in diameter and 0.003 inches per foot for shafts over 1½ inches in diameter.

B. Each end of all shafts, when finished to the required lengths, are required to have a 60-degree lathe center, with clearance hole, at the exact center of the shaft. Shafts that are bored with an inspection hole are required to have the ends prepared for the attachment of a centering device equivalent to the lathe center. All such devices are to be furnished as part of the work.

C. Ensure stepped shafts have fillets blended in smoothly to adjacent surfaces without tool marks or scratches. Surfaces are required to have an *ANSI* maximum roughness of 63 micro inches, unless otherwise required herein or on the plans to have a finer finish.

D. Ensure that cold-finished shafting steel is of the type and grade shown on the plans. All shafting steel is required to undergo mechanical property testing with all test certifications furnished to the Engineer. Ensure each cold-finished shaft is free from camber and will run without vibration, noise, or chatter at all speeds up to and including the maximum rated speed.

E. Ensure that all hubs mounted on the ends of cold-finished shafts have the fit specified herein or on the drawings. To obtain the required fit between hub and shaft, furnish the cold-finished shaft 1/16 inch larger than the nominal diameter specified with the ends turned to the required dimension for the hub.

F. Ensure that turned, ground, and polished commercial shafting of the grade specified on the plans is utilized.

G. Pin Journals. Accurately machine and polish all journal bearing areas on shafts and pins, with no trace of tool marks or scratches on the journal surface or adjoining shoulder fillets. Burnishing the shaft journal areas and adjoining shoulder fillets will be considered in lieu of polishing, provided that the burnishing is done with a Stellite roller or equal and finished to a mirror surface. Ensure that the surface finish of shaft journals is detailed per the plans.

5. Manifold. The existing manifolds are to be reused. However, if the Contractor chooses new manifolds may be furnished. The new manifold when furnished is required to fit up with the existing cylinder.

A. Field verify the existing manifold to confirm that the new manifold has the proper fit.

B. Manifold valves are required to be manufactured by Sun Hydraulics, Bosch Rexroth, Parker Hannifin or equal as approved by the Engineer. For a component to be considered as an equivalent, documentation is required showing that the component has been used in similar applications and environments and has provided a minimum of 30 years of reliable operation. In addition, ensure the quality assurance requirements are equivalent to the quality assurance performed by the 3 listed sources of supply.

6. Fasteners. Ensure that all bolts for connecting machinery parts to each other or to supporting members are as shown on the plans or as specified otherwise and conform to one of the following types:

A. High strength finished body bolts, hex head cap screw, and studs.

B. High strength turned bolts, turned cap screws, and turned studs.

C. High strength bolts.

D. Hex socket flat countersunk head cap screw.

Ensure high strength finished body bolts, hex head cap screws, and studs meet the requirements of *ASTM A449*. Finished body bolts are required to have finished bodies and regular hexagonal heads. The finished body diameter is required to be equal to or greater than the thread major diameter. Ensure holes for finished body bolts are not more than 0.010-inch larger than the actual diameter of individual fasteners. Check the clearance with 0.011-inch wire. The hole is considered too large if the wire can be inserted in the hole together with the bolt. Ensure that finished body bolts connecting machinery components to structural elements or to other machinery components comprised of different thicknesses are installed such that the bolt head is adjacent to the connected element with the least thickness.

Unless otherwise specified, high strength fasteners used for connecting machinery parts to each other and to supporting steelwork are required to be bolts that conform to the minimum specified physical requirements of high strength*, ASTM F3125/F3125M, Grade A325, Type 1* or *ASTM A449,* *Type 1* cut thread, washer faced, heavy hexagonal head bolts. Ensure that the nuts conform to *ASTM A563/A563M* or *A194/A194M*, *Grade DH* or *2H*, heavy hex series unless otherwise noted.

Ensure the dimensions of all bolt heads, nuts, castle nuts, and hexagonal head cap screws are in accordance with *ASME Standard B18.2.2*. Ensure that the heads and nuts for turned bolts, screws and studs are heavy series.

The dimensions of socket-head cap screws, socket flathead cap screws, and socket-set screws are required to conform to *ASME Standard B18.3*. Unless otherwise noted on the plans, such screws are required to be *SAE* *Grade 8*, heat treated medium carbon-alloy steel. Unless otherwise called for in the contract, set screws are required to be of the headless safety type with cup points. Set screws are not permitted to be used to transmit torsion nor as the fastening or stop for any equipment that contributes to the stability or operation of the bridge.

Threads for bolts, nuts, cap screws, and tapped holes are required to conform to the coarse thread series unless otherwise noted and have a Class 2A tolerance for external threads and Class 2B tolerance for internal threads in accordance with the *ASME Standard B1.1*.

Ensure bolt holes through unfinished surfaces are spot faced for the head and nut and square with the axis of the hole.

7. Machinery Paint. Unless otherwise noted or approved, the shop paint coating system is required to be in accordance with section 716 of the Standard Specifications for Construction. Paint color is required to match the existing color at the bridge.

8. Coatings. Ensure that the threads of all mounting bolts, the shanks and threads of all turned and fitted bolts, and threads of all tension rods and adjustable linkage rod ends are coated with anti-seize compound before assembly of the nuts to prevent corrosion or galling and to facilitate future removal if necessary. Anti-seize compounds are required to be manufactured by the following companies, or an approved equal:

A. A.W. Chesterton, Co., Stoneham, MA (783 ACR)

B. Henkel Corp., Rocky Hill, CT (Loctite LB8023 Marine Grade Anti-Seize)

Rust inhibiting coatings are required for the temporary protection of machined surfaces. Rust-inhibiting coatings are required to be manufactured by one of the following companies, or an approved equal:

C. E.F. Houghton & Co., Valley Forge, PA (Rust Veto 344)

D. A.W. Chesterton, Co., Stoneham, MA (740 Heavy-Duty RustGuard)

9. Spare Parts. Furnish four manifold valves as spare parts. Package for long term storage. Set spare valves at the correct settings to allow future replacement without adjustment. Furnish one full seat kit. Furnish one spare custom 72 mm tapered bolt that is currently used at the rod end. Furnish with three nuts. Available drawings for this custom 72 mm bolt will be furnished by MDOT.

**c. Construction.**

1. Qualifications, Personnel, and Facilities. For the fabrication, installation, and testing of work required by the machinery items, use adequate numbers of skilled, trained, and experienced mechanics and millwrights who are thoroughly familiar with the requirements and methods specified for the proper execution of the specified work. Furnish personnel, including supervisory personnel, with a minimum of two movable bridge jobs (including at least one hydraulically operated bridge) as previous experience in the installation of the bearings.

2. Ensure the cylinder rod seal replacement work is performed by the cylinder manufacturer’s representative or by a hydraulic specialist with prior experience with at least five similar projects.

3. Submit certifications for individuals performing the cylinder rod seal replacement work.

4. The machinery installation supervisor is required to be on-site for all work including jacking, measurements, bearing replacement, and cylinder rod seal replacement, and will have at least 10 years of similar experience aligning machinery, including at least two movable bridge jobs, unless otherwise approved by the Engineer.

5. Furnish all facilities, necessary tools and instruments required for the proper performance of the personnel engaged in the execution of the specified work.

A. Measurements and Verification. Dimensions shown on the plans are nominal and are intended for guidance only. All variations from the nominal dimensions on the plans are required to be noted on the shop drawings.

B. Defective Materials and Workmanship. All machinery rejected during inspection and testing is required to be removed from the work site and replaced without additional cost.

6. Delays resulting from the rejection of material, equipment or work cannot be the basis of any claim.

7. Delivery and Storage.

A. Protection for shipment and storage.

(1) Ensure machined surfaces are cleaned of dirt, chips, grit, and all other injurious materials prior to shipping and are to be given a coat of corrosion-inhibiting preservative.

(2) Finished metal surfaces and unpainted metal surfaces that would be damaged by corrosion are required to be coated as soon as practicable after finishing with a rust-inhibiting preservative. Except for unfinished metal surfaces inside of gear reducers, this coating is required to be removed from all surfaces prior to lubrication of machinery.

(3) Completely protect machinery parts from weather, dirt, and all other injurious conditions during manufacture, shipment, and storage.

(4) Shaft journals and pins that are shipped disassembled from their bearings are required to be protected during shipment and before erection by a packing of oil-soaked canvas secured in place by burlap and covered with heavy metal thimbles or heavy timber lagging securely attached. Every precaution is to be taken to ensure that the bearing surfaces are not damaged and that all parts arrive at their destination in satisfactory condition.

(5) Ensure that assembled units are mounted on skids or otherwise crated for protection during handling and shipment.

B. Packaging and delivery of spare parts. Spares are to be clearly marked and packaged for long term storage.

8. Erection.

A. General. Construction and installation are required to be done in a coordinated manner to ensure that the machinery components fit the adjacent material furnished under other items.

Ensure that the machinery is erected and adjusted by millwrights competent in the type of work involved. They are required to be furnished with all necessary measuring and leveling instruments as may be required.

B. Only one cylinder may be out of service while the work is being performed. Replacing bearings on two or more cylinders simultaneously is prohibited.

C. Bolting. Ensure that bolt holes in new structural steel for connecting machinery are drilled from the solid after final alignment of the machinery. Sufficient erection holes, subdrilled 1/4 inch undersize, for temporary bolts may be used for erection and alignment of the machinery. When the machinery is aligned in its final position, full-size holes for the remaining bolts are required to be subdrilled and reamed, the temporary bolts removed, and the full-size bolts installed.

For new turned bolts in existing structural steel holes, ream the existing holes in the support and connected components to increase the existing hole diameter by 0.010 inch and furnish new turned bolts with shank diameters as needed to provide the specified fit. If the existing bolt holes are increased by more than 0.010 inch to properly realign the machinery components to the specified requirements, notify the Engineer.

Wherever possible, high-strength bolts connecting machinery components to structural elements or to other machinery components comprised of different thicknesses are required to be installed such that the bolt head is adjacent to the connected element with the least thickness.

Ensure that finished body bolts and high strength bolts are torqued to the same tension required for *ASTM F3125/F3125M,* *Grade A325* bolts specified in the standard specifications.

Torques for high strength turned bolts and other grades of bolts installed with single nuts are required to be proportioned to develop a preload of 65 percent of their yield strength, unless otherwise noted, and specified on the erection drawings.

For *ASTM A449* fasteners installed with double nuts, the first nut is required to be pretensioned to 50 percent of the yield strength of *F3125/F3125M,* *Grade A325* fastener with equal thread size and the top nut pretensioned to 65 percent of the yield strength of an *F3125/F3125M,* *Grade A325* with equal thread size. While preventing rotation of the second nut reverse the first nut against the second until the thread clearance is taken up and the nut jams.

9. Spring hanger. Select spring hanger that will fit in the existing location with 1 inch of travel, and a rated capacity equal to or greater than the weight of the cylinder rod and rod end. Furnish all hardware required to install the spring hanger and paint/lubricate to provide long life in a marine environment. Set the spring hanger as follows:

A. Install snug tight with the cylinder fully retracted (bridge in the fully raised position).

B. Measure the movement in the spring hanger when lowering the bridge to the fully seated position.

C. If movement is 1/16 inch or less, no additional adjustments are required. If movement is greater than 1/16 inch, tighten the spring by 1/4 of the movement in the spring hanger. Retract cylinder and confirm that the spring does not raise the cylinder beyond the initial elevation.

D. Perform steps c.9.B and c.9.C as needed to determine the ideal setting of the spring hanger. The ideal setting will minimize the amount of sag when the cylinder is extended while not raising the cylinder from the initial position when the cylinder is retracted.

10. Disposal. All structural steel, machinery, and other material removed as part of this work, that the MDOT determines they do not want, becomes the property of the Contractor and is to be removed from the project site. All materials removed from the project site for disposal, including machinery which contains lubricating oil and grease, is required to be disposed of in accordance with all local and federal regulations.

11. Field Testing. During the test lifts, inspect each bearing assembly to determine whether everything is in proper working order and fully meets the requirements of the contract. All test operations are required to be performed in the presence of the Engineer. If any tests show that any components are defective, inadequate, or function improperly, make all corrections, adjustments, or replacement required before restarting the testing at no additional cost. A minimum of five test lifts are required to be performed after the cylinders are installed in each phase of work.

**d. Guarantee and Warranties.**

1. Manufacturer's warranties or guarantees on equipment, materials or products purchased for use on the contract which are consistent with those furnished as customary trade practice, are required to be obtained by the Contractor and, upon acceptance of the contract, the Contractor is required to assign to the MDOT, all manufacturer's warranties or guarantees on all such equipment, material or products furnished or installed.

2. Warrant the satisfactory in-service operation of the mechanical equipment, material, products, and related components. This warranty will extend for a period of 1 year following the date of final acceptance of the project.

**e. Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

**Pay Item Pay Unit**

Hydraulic Cylinder, Rem Each

Hydraulic Cylinder Reinstallation Each

Hydraulic Cylinder Refurbishment Each

Spring Hanger, Furn, Fab, and Erect Each

Valve Replacement Each

Spare Parts (Structure Identification) Lump Sum

1. **Hydraulic Cylinder, Rem** includes all labor, new materials, equipment, preparation, incidentals, adjustment, and inspection required to remove existing hydraulic cylinders from the bridge. This item also includes temporary removal of any appurtenances such as catwalk handrails or other non-structural components that must be removed for access purposes.

2. **Hydraulic Cylinder Reinstallation** includes all labor, new materials, equipment, preparation, incidentals, adjustment, and inspection required to reinstall the refurbished hydraulic cylinders. This item also includes all field testing required for final acceptance. This item also includes re-installation of any appurtenances such as catwalk handrails that were removed for access purposes.

3. **Hydraulic Cylinder Refurbishment** includes all labor, new materials, equipment, preparation, incidentals, adjustment, inspection, and shop testing required to refurbish the hydraulic cylinders from the bridge. This item also includes all labor, equipment, and materials required to deliver refurbished hydraulic cylinders to and from the bridge.

4. **Spring Hanger, Furn, Fab, and Erect** includes all labor, new materials, equipment, preparation, incidentals, adjustment, inspection, and testing required to remove existing viscous dampers and install spring hangers at each hydraulic cylinder.

5. **Valve Replacement** includes all labor, new materials, equipment, preparation, incidentals, adjustment, inspection, and testing required to remove existing valves within the cylinder’s manifold and install new valves. If existing manifolds are found to be defective, then manifold replacement will be paid as extra work.

6. **Spare Parts** includes new materials, equipment, incidentals, inspection, and testing required to furnish spare parts as specified. Delivery to the project site is included with this item.