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DIVISION 11 - EQUIPMENT

SECTION 11290

HYDRAULIC POWER SYSTEMS FOR REGULATING OUTLET GATES

SECTION 11290

HYDRAULIC POWER SYSTEMS FOR REGULATING OUTLET GATES

PART 1 GENERAL

1.1 GENERAL INFORMATION

The work covered by this section of the specifications consists of detailed requirements for the design, fabrication, shop assembly, testing, delivery and installation of the complete hydraulic power systems for operation of the regulating outlet slide gates as specified herein and as shown on the drawings.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Latest publications including all revisions and errata shall be applicable.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B93.5	(1979) Practice for the Use of Fire Resistant Fluids in Industrial Hydraulic Fluid Power Systems
ANSI/NFP(A)B93.11M	(1981) Hydraulic Fluid Power - Line Tubing - Seamless Low Carbon Steel
ANSI/NFP(A)B93.18M	(1973) Non-Integral Industrial Fluid Power Hydraulic Reservoirs
ANSI Y14.17	(1990) Fluid Power Diagrams
ANSI Y32.10	(1990) Graphical Symbols for Fluid Power Diagrams

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 181	(2000) Carbon Steel Forgings for General-Purpose Piping
ASTM A 182	(1995) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High- Temperature Service
ASTM A 193	(2000) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194	(1996) Carbon and Alloy Steel Nuts for Bolts for High- Pressure and

	High-Temperature Service
ASTM A 216	(1993) Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A 266	(1995) Forgings, Carbon Steel, for Pressure Vessel Components
ASTM A 312	(1995) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 354	(1995) Quenched and Tempered Alloy Steel Bolts, Studs, and Other External Threaded Fasteners
ASTM A 516	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 536	(1999el) Ductile Iron Castings
ASTM A 564	(1995) Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A 659	(1992) Steel, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality
ASTM A 705	(1995) Age-Hardening Stainless and Heat-Resisting Steel Forgings
ASTM A 789	(1995) Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM B 505	(1995) Copper-Base Alloy Continuous Castings
ASTM D 3951	(1995) Practice for Commercial Packaging

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME 16	(1989) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels, Division 1 - Basic Coverage
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(1998) Power Piping
ASME B36.19M	(1985) Stainless Steel Pipe

ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

FEDERAL SPECIFICATIONS (FS)

FS FF-W-92	(1975) Washer, Flat (Plain)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE ARP 598B	(1986) Determination of Particulate Contamination in Liquids by the Particle Count Method
SAE J514	(1995) Hydraulic Tube Fittings
SAE J1165	(1979) Reporting Cleanliness Levels of Hydraulic Fluids

1.3 DESIGN AND PERFORMANCE REQUIREMENTS

1.3.1 General

The Specification drawings indicate the general arrangement of the two hydraulic power systems for operation of the slide gates, clearances necessitated by the structure or other equipment, maximum overall dimensions, and other features. The Contractor shall be fully responsible for all design and shall furnish the detailed designs and shop drawings in conformity with these specifications, JIC H-1, and the following design criteria.

1.3.2 Design Parameters

Design Pressure 3,000 psi

Nominal Operating Pressure 2,000 psi

Relief Valve Setting Pressure 1,800 psi

Pressure Switch Setting Pressure 1,700 psi

Rated Raising or Retracting Force 900,000 lbs

Rated Lowering or Extending Force 900,000 lbs

Normal Operating Pressure at Cylinders 1,600 psi

Maximum Raising or Retracting Time 30 minutes

Maximum Lowering or Extending Time 30 minutes

Hoist Stroke 15 feet ±*

Critical or Limiting Dimensions

Operating Temperature Range 32 - 125 F

* Exact stroke shall be determined by manufacturer.

1.3.3 Allowable Stresses

The principal design parameters for the hydraulic power system are as follows:

1. Structural Items. Structural items associated with the hydraulic power system, such as support beams and clamps, shall be designed to withstand the maximum possible force exerted by the hydraulic cylinder plus any dead loads with a factor of safety of 2 based on the yield strength of the materials involved.

2. Hydraulic Cylinders. The hydraulic cylinders shall be designed to withstand the maximum possible operating pressure in the system with a factor of safety of 5 based on the ultimate strength of the material for 2 based on the yield strength of the material. A factor of safety of 3 shall be applied to the compression load when designing the hydraulic cylinders to resist buckling.

3. Stress Concentration Factors. Stress concentration factors shall be used where applicable. Reduction of allowable stresses to compensate for repeated cycles of loading is not required.

4. Earthquake. Forces due to earthquake shall be in accordance with the requirements of Section 13080 of these Specifications.

1.3.4 Connections

1.3.4.1 Shop Connections

Shop connections shall be designed for assembly by means of welding or by bolting.

1.3.4.2 Welded Connections

Design of welded connections shall be in accordance with the applicable provisions of AWS D1.1 except that provisions for repeated stress will not be required. Hydraulic cylinders shall be welded in accordance with ASME 16. Piping shall be welded in accordance with ASME B31.1.

1.3.4.3 Structural Bolted Connections

Structural bolted connections carrying primary loads shall be made with ASTM A 325 bolts.

1.3.5 System Operation

The six regulating outlet (RO) gates will be operated using hydraulic operators. One gate at a time or 3 gates at a time may be operated as needed. The operators will be equipped with proportional control valves to provide position control. The gates will be operated one at a time for the

first 6 inches of travel. Above 6 inches of opening, 1 or 3 gates will be operated at a time. A selector switch will be used to select single or multiple gate operations. Gate control will be from both the Local Control Cabinet (LCC) in the gate chamber and the Emergency Motor Control Center (EMCC) in the control room at El. 596. A selector switch on the local control cabinet will be used to select local control or remote control (from the control room). The gate positions will be transmitted to the control room using a 4 - 20 ma transmitter. The gate position will be determined by measuring the gate stem travel. The gate position will be displayed using a digital panel meter (DPM) located on the gate control panel. The gate position indication will be used to adjust the gates for a maximum of 1-inch difference in opening. The proportional control valves should move all three gates to the same opening. The 1-inch difference can be adjusted by controlling the speed of operation of each gate.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Detailed shop drawings shall include fabrication, shop assembly, delivery, and field installation drawings. Any component part of fabricated items whether explicitly shown or omitted on the specification drawings shall be detailed on the shop drawings. If departures from the specification drawings are deemed necessary by the contractor, details of such departures, including changes in related portions of the project, and reasons therefore, shall be submitted with the shop drawings.

1. Fabrication drawings shall be provided for all mechanical and structural parts or components except those which are of standard manufacture. The drawings shall show complete details of materials, tolerances, machined surface finishes, connections, and proposed welding sequences which differentiate shop welds and field welds.

2. Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to ensure satisfactory field installation.

Hydraulic Schematic; G

A complete hydraulic schematic, in accordance with ANSI Y32.10 and ANSI Y14.17, shall be provided. All hydraulic components shall be shown on the schematic, and all setpoint and size parameters shall be indicated for each component.

Delivery Drawings; G

Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent

distortion or other damage.

Field Installation Drawings; G

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment, the provisions to be taken to protect concrete and other work during installation, the method of maintaining components in correct alignment, and the methods for installing other appurtenant items.

SD-03 Product Data

Manufacturer's Catalog Data; G

Manufacturer's catalog data and descriptive literature shall be submitted for standard equipment and products to be incorporated in the work, including all materials and equipment specified in Paragraphs: MATERIALS AND MECHANICAL EQUIPMENT and ELECTRICAL EQUIPMENT. These data shall include specifications and assembly drawings showing sizes, ratings, parts and material lists, overall dimensions and mounting dimensions. Detailed piping and valve layouts, pipe connections to all valves, hydraulic control unit and hydraulic cylinders shall be shown.

Design computations shall be submitted for all items of equipment by the Contractor.

SD-06 Test Reports

Operational Test Reports

Operational test reports shall be submitted for all required shop testing and testing of the equipment after installation. Contractor's quality control reports shall be submitted in conformance with the requirements of FAR 52.246-2, INSPECTION AND ACCEPTANCE.

SD-08 Manufacturer's Instructions

Shop Assembly and Testing; G

Procedures for shop testing shall be submitted for all testing outlined in Paragraph: SHOP ASSEMBLY AND TESTING.

Cleaning and Flushing; G

Procedures for field cleaning and flushing shall be submitted as outlined in Paragraph: CLEANING AND FLUSHING THE SYSTEM. The Contractor shall submit a detailed field cleaning procedure not less than 10 days before start of cleaning operations.

Field Testing; G

Procedures for field testing shall be submitted as specified in Paragraph: FIELD TESTING. The Contractor shall submit his proposed testing program to the Contracting Officer at least 4 weeks prior to the first scheduled test to ensure agreement as to

personnel required and scope of the testing program.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G

The operation and maintenance (O&M) manual shall contain all information which may be needed or used for operation, maintenance, repair, dismantling or assembling, and for identification of parts for ordering replacements. The manual will be subject to approval by the Contracting Officer. The Contractor shall furnish five complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment to the Contracting Officer. Each set shall be permanently bound and shall have a hard cover. One complete set shall be furnished prior to field testing and the remaining sets shall be furnished before the contract is completed. The following identification shall be inscribed on the covers: "OPERATING AND MAINTENANCE INSTRUCTIONS", title of the project, location of the project, the name of the Contractor, and the contract number. A flysheet shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8-1/2 by 11 inches, with large sheets of drawings folded in. The instructions shall include, but not be limited to, the following:

1. A cross-section drawing of the hydraulic cylinder with parts list.

2. A system layout drawing showing the piping, valves, and controls.

3. A system hydraulic schematic.

4. Electrical wiring and control diagrams.

5. Operating and maintenance instructions.

6. Manufacturer's bulletins, catalog cuts, and descriptive data.

7. Parts lists and recommended spare parts.

1.5 QUALITY ASSURANCE

The Contractor shall ensure that required tests, workmanship, and other performance aspects of the work comply with the applicable quality assurance requirements specified herein. In accordance with FAR 52.246-2, INSPECTION AND ACCEPTANCE, the Contractor shall provide continuous inspection of all operations for quality control and record the results for submitting to the Contracting Officer to show compliance with the contract requirements.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Packaging

The hydraulic power systems shall not be prepared for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer or his authorized representative, unless inspection has been waived

in writing. Each hydraulic power system or subassembly shall be shipped completely assembled. The subassemblies shall be defined as the following:

1. Hydraulic cylinders.

2. Hydraulic power units.

3. Piping assemblies.

4. Local control consoles.

5. Remote control consoles.

The subassemblies shall be provided with adequate protective pads, supports, and blocking and shall be securely restrained to prevent distortion or damage to the painted surfaces in transit. Any loss or damage during shipment, including damage to the painted surfaces, will be considered the responsibility of the Contractor, and shall be replaced or repaired without cost to the Government. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY". A packing list listing the contents of each container shall be placed in a moisture-proof envelope and securely fastened to the outside of the container. Standard commercial packaging in accordance with ASTM D 3951 will be acceptable except where a different method or standard of packaging is specifically called for herein.

1.6.2 Shipping, Preservation and Storage

Packing, crating, cradles, etc., necessary to ensure safe shipment re the responsibility of the Contractor and shall become the property of the Government upon delivery of the equipment. The hydraulic cylinders shall be filled with the specified hydraulic fluid and the piping connections sealed. The shipping provisions shall be such that the cylinders may be rotated in increments of 90 degrees during storage. Should the cylinders be stored by the Contractor during fabrication, shipping, or at the worksite in the horizontal position more than 30 days, they shall be rotated every 30 days as follows: first 90 degrees, then 180 degrees, then 90 degrees, and then 180 degrees. Internal rod supports shall be provided to prevent the rod from deflecting and damaging the rod and cylinder bore during handling and shipping. Machined surfaces shall be adequately protected from corrosion and physical damage. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity, temperature variation, dirt and dust, or other contaminants.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall visit the site to become thoroughly familiarized with all details of the work and working conditions, to verify dimensions in the field, and he shall then advise the Contracting Officer of any discrepancies prior to performing any work. The contractor shall be specifically responsible for the coordination and proper relation of his work to the structure and work of all trades.

1.8 WARRANTY

All equipment shall be guaranteed for a period of 2 years from the date of acceptance. Replacement parts shall be guaranteed for 2 years from date of replacement. Warranty shall be against defective materials, design and workmanship. In cases where the equipment manufacturer's advertised

minimum guarantee is in excess of 2 years, it shall remain in force for its full period. Upon receipt of notice from the Government of failure of any of the parts during the warranty period, new replacement parts shall be furnished and installed promptly at no additional cost to the Government.

PART 2 PRODUCTS

2.1 MATERIALS AND MECHANICAL EQUIPMENT

2.1.1 General

Materials and mechanical equipment shall conform to the requirements indicated on the drawings or referred to herein, and when not covered thereby, materials and mechanical equipment of the best commercial grade quality suited to the intended use and as approved by the Contracting Officer shall be furnished. The manufacturer's name, address, and catalog number shall be permanently displayed on a nameplate securely attached to each major item of equipment.

2.1.2 Standard Products

Where items are referred to hereinafter as "similar and equal to" a particular manufacturer's product, such references have been made merely as a convenient method of indicating the type of material or equipment required, with no intention of asserting superiority thereof. The standard product of any reputable manufacturer regularly engaged in the commercial production of the type and quality of material or equipment referred to will not be excluded on the basis of minor differences, provided essential requirements of the specifications relative to materials, capacity, and performance are met. The Contractor shall, in accordance with Paragraph: SUBMITTALS, furnish for approval, performance capacities and other pertinent information concerning the manufacturer's "equal to" standard products which he intends to incorporate in the work. "Equal to" standard products installed or used without such approval shall be at the risk of subsequent rejection. Such components as described below but not shown on the drawings or hydraulic schematic may be used with prior approval of the Contracting Officer but shall conform to the following specifications.

2.1.3 Hydraulic Cylinders

2.1.3.1 General

The outside of the finished cylinder shall be turned concentric with the bore and the interior shall be honed to the dimensions, tolerances, and finish shown on the shop drawings. The finished wall thickness shall not be less than that shown on the approved shop drawings. Flanges shall be welded to the cylinder parallel with each other and perpendicular to the cylinder centerline. Tolerances shall be as shown on the drawings. After completion of all welding, the cylinder shall be stress relief heat treated. All welds shall be radiographed including those on the end mounts. The assembled cylinder shall be of such straightness that the piston and rod move smoothly therein without any indication of binding or tight spots. Surface finishes shall be as indicated on the drawings. The cylinder material shall be steel conforming to one of the following options:

a. Option A: Rolled steel plate conforming to the requirements of ASTM A 516, Grade 70, and welded flanges conforming to ASTM A 181, Class 70.

b. Option B: The shell shall be centrifugal cast steel conforming to the

requirements of ASTM A 216, Grade WCC, and welded flanges conforming to ASTM A 181, Class 70, or cast from ASTM A 216, Grade WWC steel.

c. Option C: The shell and flanges shall be a solid trepanned forging conforming to the requirements of ASTM A 266, Class 1.

2.1.3.2 Piston Rods

The piston rod shall be fabricated from stainless steel conforming to ASTM A 564 or 705, Type 630 or XM-12. The piston rod shall be heat treated to a condition of H-1150 before final machining. If the piston rod is composed of two or more pieces, the welds shall be radiographed. The piston rod shall have a ceramic coating with a minimum thickness of 0.008 inch, a surface finish of 12-14 microinches rms, surface hardness of 67 Rc minimum, impact resistance of 5-11 lb- ft, modulus of elasticity of 52 x 10^6 - 60 x 10^6 psi, linear expansion coefficient of 4.0 x 10^-6 degrees F, and be capable of withstanding a fracture force of 41 ksi minimum. Gate stem sections which do not retract into the cylinder shall be of the same material as above except that ceramic coating is not required and the final finish shall have a roughness of not more than 32 microinches rms.

2.1.3.3 Pistons

The piston shall be cast iron conforming to ASTM A 536, Grade 80-55-06 or 10-50-05.

2.1.3.4 Piston Wear Rings

The piston ring shall be a one-piece bronze type, suitable for soil hydraulic service at 2,000-pounds-per-square-inch pressure. The piston ring joint shall be an angled or overlapped step-cut type which will minimize the areas of leakage through the joint and provide an effective seal for hydraulic service.

2.1.3.5 O-Ring Seals

The O-ring seals shall be as recommended by the manufacturer and designed for 3,000 psi service.

2.1.3.6 Stem Wiper-Scraper

The stem wiper-scraper shall have one or two flexible corrosion-resisting, metal- spring scraper rings mounted with a synthetic rubber ring. The scraper shall have a snug fit on the stem and shall have sufficient play to permit alignment under normal working clearances. It shall be capable of removing materials stuck or frozen to the stem. The wiper-scraper shall be securely mounted in the bushings as shown on the drawings and shall be equal to Hercules Products Division of Richardson Company, 11063 Walden Road, Alden, New York 14004.

2.1.3.7 Piston and Piston Rod Seals

Piston and piston rod seals shall be of the low leakage V-ring, nonadjustable gland type, designed for 3,000 psi service.

2.1.3.8 Rod Seal Gland and Locking Device Flange

The rod seal gland and locking device flange shall be fabricated from bronze conforming to ASTM B 505, Alloy No. C95400 or C93200.

2.1.3.9 Hoist Locking Device

The hoist locking device shall be fabricated from stainless steel conforming to ASTM A 564 or ASTM A 705, Type 630 or XM-12, condition H-1150.

2.1.3.10 Hydraulic Packings

The piston and piston stem shall be provided with hydraulic packings to prevent oil leakage when the hydraulic cylinder is subjected to a pressure up to 2,000 pounds per square inch during gate opening and closing. The oil leakage shall not exceed the requirements of the shop test procedure. The hydraulic packings shall be suitable for use with hydraulic oil and shall be equal to Garlock, Inc., Palmyra, New York, Style 432. The piston packing shall be equal to Polypack, as manufactured by Parker Packing Company, P.O. Box 1505, Salt Lake City, Utah.

2.1.4 Hydraulic Power Unit

The hydraulic power unit shall be a self-contained, packaged unit with all piping, valving and electrical components designed by the Contractor to operate the hydraulic cylinders in accordance with the criteria stated in Paragraph: DESIGN PARAMETERS. The power unit shall be designed to meet the space limitations shown on the drawings and shall be configured essentially as shown. The hydraulic power unit shall have the following features:

1. The system shall be capable of operating one gate at a time or three gates at a time as needed.

2. Each hydraulic system shall operate at 2,000 psig, with a design pressure of 3,000 psig. The test and maximum pressure for the system shall be 3,000 psig.

3. Each hydraulic pump shall be rated for 25 gpm at 2,000 psig.

4. The capacity of the system with one pump running shall provide a gate lift speed of approximately 1 foot per minute (fpm) for one gate with a pump speed not to exceed 1,800 rpm.

5. The system shall be designed so that one pump and motor can be removed while the other pump is operating or both pumps can be run simultaneously.

6. The oil reservoir shall be sized to contain the volume of oil required to store all of the oil used when closing three gates. The reservoir is to have a minimum capacity of 500 gallons, and shall be appropriately sized by the Contractor.

7. Pumps, motors, and pressure relief valves shall be mounted directly to the respective reservoir.

8. The oil storage reservoir shall include suction line indicating filters, return line filters, air vent and level site gage.

9. Piping and fittings shall be stainless steel with a design pressure of 3,000 psig.

10. Solenoid controlled proportional directional control valves shall throttle flow in proportion to raise or lower commands.

11. A hydraulic pressure switch shall disconnect the pump motor circuit when the gate leaf hits the bottom seal or the bonnet cover.

12. The RO slide gates shall have 2 sets of fully-open and fully-closed limit switches.

13. The hydraulic power unit shall have local hand operated four-way valve for gate raise/lower control.

14. All exposed steel shall be coated to protect against corrosion.

15. Provide all equipment to mechanically operate the stem position transmitting device described in Section 16051.

2.1.5 Oil Reservoirs

2.1.5.1 General

The oil reservoir shall be dimensioned by the Contractor to meet the space limitations on the platform at El. 512.0 shown on the specification drawings. The reservoir shall be made of steel with welded joints and shall conform to the requirements of ANSI/NFP(A)B93.18M and as shown on the shop drawings. The reservoir shall be equipped with a fluid level indicator and filler with built-in strainer. There shall be a baffle provided between the intake and return lines to facilitate the separation of air and foreign matter from the hydraulic fluid. Both the intake and return pipes shall be brought down to a distance of 1-1/2 pipe diameters above the tank bottom. Interior surfaces of the reservoir shall be cleaned down to bright metal and coated with any epoxy-based urethane finish or an approved alternate that is compatible with oil and water.

2.1.5.2 Reservoir Heater

The reservoir shall be provided with one or more screw plug type immersion heaters with a watt density not to exceed 11 watts per square inch and a built-in thermostat set to maintain the hydraulic oil at 60 degrees F. The heater sheath and screwplug shall be fabricated from stainless steel. Total heating output shall be calculated by the manufacturer. The heater shall be supplied with a watertight, stainless steel, NEMA 4X terminal housing as a minimum.

2.1.5.3 Magnetic Separators

The manufacturer's standard magnetic separator shall be provided in the reservoir. The magnetic separator shall consist of a high-strength permanent magnet arranged for rigid mounting with the poles of the magnet exposed to the fluid in the reservoir. The magnet shall be mounted on a removable rod assembly installed through the top of the reservoir.

2.1.5.4 Air Breather

The reservoir shall be provided with an air breather which removes dirt and moisture from the incoming air. The incoming air shall first pass through a desiccant bed to remove the moisture, and then pass through a filter to eliminate the solid contaminants before entering the reservoir. Outgoing air shall pass directly to the atmosphere through a check valve. The breather shall also provide visual indication of the desiccant and filter condition. The breather shall conform to applicable provisions of Joint

Industry Conference (JIC) Standards for Industrial Equipment.

2.1.6 Pumps

The pumps for the hydraulic system shall be electric motor-driven, fixed displacement, piston type rated to deliver a nominal 52 gpm at 2,000 psi while operating with the specified oil in the specified temperature range. The pump delivery capacity and pressure shall be finalized based upon Contractor's design and approved shop drawings. Maximum rotating speed shall be 1,800 rpm. Exposed rotating parts shall be properly safety guarded. The pumps shall mount on the reservoir in a manner similar to that shown on the shop drawings so that the pump suction is flooded. The pumps shall operate on 480 volts, 60 Hz, three-phase power. The pumps shall be rated for continuous operation at a discharge pressure equal to or greater than the system design pressure. The rated discharge capacity of each pump shall not be less than required by approved shop drawings when the pump is operated at the design input speed and discharge pressure. The pumps shall conform to Joint Industry Conference (JIC) Standards for Hydraulic Equipment.

2.1.7 Filters

The filters shall be located in the return line to the reservoir and in the pump discharge line and shall be of the duplex type with a differential pressure device to indicate the need for filter element service. The filter element shall have a rating of 10 microns absolute unless a smaller mesh is recommended by the pump manufacturer. The filter shall be rated for use with hydraulic oil and the pressure drop should not exceed 6 psi in the clean condition. The return filter shall be pressure rated for 200 psi and a flow rate required for satisfactory operation of system. The discharge line filters shall be pressure rated for 2,000 psi and a flow rate required for satisfactory operation of system. The filters shall conform to applicable provisions of ASME HPS-1994 High Pressure Systems.

2.1.8 Gauges

2.1.8.1 Pressure Gauges

Pressure gauges shall conform to ASME B40.1, have a black enameled metal case, a 4-1/2-inch dial, and a stainless steel Bourdon tube. The scale range of the gauge shall be approximately 150 percent of the maximum pressure of the line in which installed. Gauges shall be the safety type with solid fronts and blowout backs. Each gauge shall be provided with a pressure snubber. Gauge mounting shall be as indicated on the approved shop drawings.

2.1.8.2 Thermometer

A direct indicating thermometer shall be provided to indicate fluid temperature in the reservoir. The thermometer shall be of the bimetallic type mounted directly on the reservoir. The thermometer shall have a minimum 3-inch dial with black markings on a white background. The scale range shall be 20 to 240 degrees F. The case and stem shall be corrosion resistant and the wetted components shall be stainless steel. Thermometer wells of the separable socket type shall be provided for each thermometer with a direct type bulb. The thermometer shall conform to ASME PTC 19.3, Temperature Measurement.

2.1.9 Valves

2.1.9.1 General

Valves shall have a minimum pressure rating of 3,000 psi unless stated otherwise. Valves 1 inch or larger shall have socket-welded piping connections. Valves less than 1 inch shall have SAE straight thread ends and O-rings with tube fittings. Valves shall be specifically designed and rated for hydraulic system applications.

2.1.9.2 Ball Valves

Ball valves shall be made of stainless steel and designed for use with hydraulic oil. Pipe connections shall be socket welded. The valves shall have replaceable seats and be repairable without disturbing the welded connections.

2.1.9.3 Flow Control Valves

The hydraulic operators shall be equipped with flow control valves to allow throttling the oil flow in proportion to raise-lower commands. The Contractor shall furnish all required flow control valves to provide a hydraulic control system to operate the RO gates in accordance with the Specifications. A typical hydraulic control schematic is shown in the specification drawings. All hydraulic control valves furnished shall meet the following minimum requirements.

a. Four-Way Valve - Four-way valves shall be lever operated, three position detent, with a minimum flow capacity as required for specified gate operation. Working pressure shall be compatible to the overall hydraulic system pressure for satisfactory gate operation. The valves shall operate so that pressure may be directed to either of two ports by shifting the lever. The center position shall block all ports.

b. Solenoid-Operated, Two-Way Valve - Solenoid-operated, two-way valves shall be single solenoid operated. The valve shall have a minimum flow capacity as required for specified gate operation. Working pressure shall be compatible to overall hydraulic system pressure for satisfactory gate operation.

c. Proportional Directional Control Valves - Proportional direction valves shall be solenoid operated, two stage, with feedback transducers. The valves shall be furnished with compatible power amplifier to operate the solenoid. The throttling of the valve shall be controlled using multiturn potentiometers. Single potentiometers or dual potentiometer shall be used to control throttling in both raise and lower directions. The power amplifiers shall operate from 120 volts A.C. power.

The valve flow capacity and operating pressure shall be selected as required for specified gate operation. Valve electronic controls shall be selected to allow three RO gates to be operated and the gate opening or closing shall not vary more than 1 inch between all three gates.

2.1.9.4 Pressure Relief Valves

Pressure relief valves shall be adjustable with a body designed for a set pressure of 2,200 psi. The valve shall have the capacity required for satisfactory gate operation. The normal setting pressure will be at about 1,800 psi.

2.1.9.5 Supply Spring Loaded Check Valves

Supply spring loaded check valves shall be of stainless steel construction and shall be the ball or poppet type with a body designed for high shock and 3,000 psi service.

2.1.9.6 Return Spring Loaded Check Valves

Return spring loaded check valves shall be of stainless steel construction and shall be the ball or poppet type with a body designed for 3,000 psi service. Cracking pressure shall be 75 psi.

2.1.9.7 Bleeder Valves

Bleeder valves shall be 1/4 inch, stainless steel construction and wrench operated.

2.1.9.8 Pressure Snubbers

Pressure snubbers shall be provided for all pressure gauges and pressure switches to protect against shock and provide more stable instrument operation. Snubbers shall be of stainless steel construction.

2.1.9.9 Counterbalance Valve

A counterbalance valve, if used, shall be installed in the oil line to the bottom side of the hoist piston as indicated on the shop drawings to balance the load being held by the cylinder. The valve shall be directly operated, have an external type drain, and shall be adjustable for operating over a pressure range of 1,000 psi to 2,500 psi. The valve shall be designed for a system operating pressure of 2,000 psi. The valve shall permit unrestrained flow to the underside of the hoist piston and shall function to retain pressure of 1,600 psi in the hoist cylinder.

2.1.9.10 Flow Switches

The Contractor shall furnish and install a flow switch in-line ahead of the check valve in each oil pump main supply line. This switch shall be as shown on the shop drawings approved by the Contracting Officer. The flow switch shall be suitable for flow rates of 0-40 gallons per minute. The flow switch shall be set for 20 gallons per minute. The flow switch shall have a minimum working pressure compatible to the overall hydraulic system pressure. The flow switch shall have a minimum of two Form C contacts rated 5 amps at 125/250 volts A.C.

2.1.10 Piping

2.1.10.1 General

Piping, tubing and hose shall be designed for a working pressure of 3,000 psi. Pipe shall be used when a 1 inch or larger diameter is required. External cylinder piping shall be as shown on the shop drawings. Pipe shall be welded or threaded as required on the approved shop drawings.

2.1.10.2 Pipe

Pipe shall be seamless stainless steel conforming to ASME B36.19M and ASTM A 312, Grade TP304. The piping weight class shall be Schedule 80s. The pipe shall conform to the cleanliness requirements of ANSI/NFP(A)B93.11M.

2.1.10.3 Pipe Fittings

Pipe fittings shall be the socket welding type conforming to ASME B16.11 and made of stainless steel conforming to and ASTM A 182, Grade F304. The pressure class shall be 3,000 pounds. Flanges shall conform to ASTM A 182 with the grade suitable for the pipe to which attached. Threaded fittings shall also conform to the above, but shall be used only where absolutely necessary for the application.

2.1.10.4 Unions

Unions shall be the O-ring type made of stainless steel with socket-welding ends. The Contractor may, at his option, substitute four bolt split flanges with O-rings for the unions.

2.1.10.5 Hydraulic Tubing

Tubing shall be seamless stainless steel tubing conforming to ASTM A 789. The wall thickness shall be selected to provide a safety factor of 6 based on the manufacturer's ratings for burst strength.

2.1.10.6 Tube Fittings

Tube fittings shall be made of stainless steel and be the flareless type with SAE straight threads and O-ring seals. The fittings shall conform with SAE J514.

2.1.10.7 Hose

Flexible hydraulic lines, if permitted by the Contracting Officer, shall be wire- reinforced, high-pressure type hose made of neoprene or Buna N. Flexible hose shall be rated by the manufacturer for a working pressure not lower than the system operating pressure indicated above with a factor of safety of 4. Fittings shall be specifically designed for use with the hose selected and shall be as recommended by the hose manufacturer. Fittings shall be made of stainless steel and shall be the reusable type.

2.1.11 Bolts, Nuts and Washers

2.1.11.1 Carbon Steel Bolts and Nuts

Carbon steel bolts and nuts shall conform to ASTM A 354, Grade BC, with ASTM A 194, Grade 2H nuts. Structural bolted connections carrying primary loads shall be made with ASTM A 325 bolts.

2.1.11.2 Stainless Steel Bolts and Nuts

Stainless steel bolts and nuts shall conform to ASTM A 193, Grade B7 or B16, with ASTM A 194, Grade 8 nuts.

2.1.11.3 Flat Washers

Flat washers shall conform to FS FF-W-92, Type A, Grade I, Class A or B.

2.1.12 Hydraulic Fluid

The hydraulic fluid to be used during shop testing to fill the cylinders before shipment, flush the system after installation, and to fill the

complete hydraulic system shall be an all-weather type hydraulic oil which has a high viscosity index, low pour point, rust and oxidation inhibitors, and antifoam properties. The oil shall also be formulated to separate quickly from water to prevent formation of emulsions. The hydraulic fluid shall be certified by the manufacturer as fire resistant in conformance with ANSI B93.5. Fresh hydraulic fluid shall be filtered through a 10 micron filter before it is added to the system. All oil shall be supplied by the Contractor and two 55 gallon containers shall be furnished to the Contracting Officer for a reserve supply.

2.2 ELECTRICAL EQUIPMENT

2.2.1 General

The electrical equipment for the hydraulic power systems shall comply with the specification drawings and the specifications herein. Other electrical materials and equipment required for the installation of the hydraulic power systems shall be as specified in SECTION 16415: ELECTRICAL WORK, INTERIOR. All electrical equipment furnished shall be standard catalog items under regular manufacture with pre-existing catalog ratings equal to or better than the requirements of the specification drawings and specifications. The Contractor's request for approval of equipment other than as specified herein or as shown on the specification drawings shall be accompanied by technical and descriptive data and specifications sufficient for the Contracting Officer to determine its adequacy. Unless otherwise specified herein or indicated on the specification drawings, all electrical materials and equipment shall meet the standards, specifications, and tests referred to herein.

2.2.2 Standard Products

Where its are referred to hereinafter as "similar and equal to" a particular manufacturer's product, such references have been made merely as a convenient method of indicating the type of material or equipment required, with no intention of asserting superiority thereof. The standard product of any reputable manufacturer regularly engaged in the commercial production of the type and quality of material or equipment referred to will not be excluded on the basis of minor differences, provided essential requirements of the specifications relative to materials, capacity, and performance are met. The Contractor shall, in accordance with Paragraph: SUBMITTALS, furnish for approval performance capacities and other pertinent information concerning the manufacturer's "equal to" standard products which he intends to incorporate in the work. "Equal to" standard products installed or used without such approval shall be at the risk of subsequent rejection.

2.2.3 Pump Motors

2.2.3.1 General

The pump motors shall conform to the applicable requirements of NEMA MG1, except as hereinafter specified, and shall be designed to withstand full voltage starting. The motor shall be of totally enclosed frame construction and shall be air cooled. A stainless steel drain-breather similar and equal to Crouse-Hinds type "ECD Universal" shall be provided and located so that any water present can be drained from inside the motor. The motors shall have encapsulated windings. Motor starters shall be provided complete with properly sized thermal overload protection and other appurtenances necessary for the motors specified. Manual or automatic

control and protective or signal devices required for the operation, and any control wiring required for controls and devices but not shown on the electrical drawings, shall be provided.

2.2.3.2 Rating

The motors shall operate on 480 volts, 60 Hz, 3 phase power and shall be sized to operate the pumps specified in Paragraph: PUMPS. The motor shall be designed to operate continuously without exceeding the temperature rise permitted by the applicable NEMA standards for the class of insulation and frame construction used.

2.2.4 Control Components

2.2.4.1 Control Devices and Wiring

Manual or automatic control protective or signal devices required for the specified operation and all control wiring for these controls and devices shall be provided whether or not indicated on the specification drawings. Electrical control devices shall have minimum current and voltage ratings in accordance with the requirements of NEMA ICS 2 contact rating designation A 300, as applicable, unless larger ratings are indicated on the drawings or are required. Control devices shall be provided with the number and arrangement of contacts required to perform the specified control functions. Devices shall be provided with or installed in NEMA 4X enclosures.

2.2.4.2 Pressure Switches

Pressure switches shall have a minimum pressure rating of 1,000 psi and maximum of 2,000 psi with set point operating as shown on the shop drawings approved by the Contracting Officer. The switches shall be enclosed in watertight, galvanized steel, NEMA 4X housings. The switches shall be provided with a normally open, normally contact having a minimum rating of 5 amps, 125/250 volts A.C. The setting pressure shall be at about 1,700 psi.

2.2.5 Control Consoles and Valve and Gauge Panels

2.2.5.1 Control Console Construction

The control console shall include a basic frame with metal panels fully custom fabricated or it may consist of custom modules using standardized components where available to meet the dimensional and functional characteristics shown on the specification drawings and specified herein. The console shall be constructed of steel meeting the requirements of NEMA ICS 6. Steel sheet shall conform to ASTM A 659. Removable nuts and hardened sheet metal screws. Screws and nuts shall be stainless steel. Access panels shall be secured with spring-loaded, quarter-turn, fasteners with studs held captive in the removable panel. The console shall be equipped with adequate louvered panels to ventilate the interior and dissipate the heat generated within the console. Special equipment supports and guides shall be provided as required to support the equipment and other components within the console. The interior and exterior surfaces shall be finished with one coat of primer and two coats of the manufacturer's standard baked-on white enamel finish.

2.2.5.2 Valve and Gauge Panel Construction

Valve and gauge panels shall be constructed of steel plate thick enough to provide rigid support for the valves and other components mounted thereon. All piping shall be terminated with bulkhead type connections in a position convenient for the connection of external lines. Primer and finish shall be the manufacturer's standard coating.

2.2.5.3 Nameplates and Instruction Plates

Nameplates shall be provided for each device on the control console, valve panels, and gauge panels. Nameplates shall clearly indicate the function of each device and, in the case of manually operated controls, shall indicate the condition established for each position of the control. Instruction plates shall clearly indicate the proper procedures and sequences of operations to activate the system, to operate the system, and to secure the system after completion of operation. Lettering on nameplates shall be machine engraved on plastic laminate with white characters on a black background. Instruction plates shall be mounted on a rigid backing and covered with clear, rigid plastic sheeting. Instruction plates shall be mounted in a location easily visible to an operator stationed at the console or panel.

2.3 SHOP ASSEMBLY AND TESTING

2.3.1 General

Each hydraulic power system shall be completely shop assembled and tested using temporary piping and wiring, as approved by the Contracting Officer, to determine the correctness of fabrication and the matching of component parts to ensure acceptable operation after field erection. Shop tests shall be made in the presence of the Contracting Officer, unless otherwise authorized in writing. Upon satisfactory completion of the tests, preliminary acceptance will be made by the Contracting Officer.

2.3.2 Cleaning

Extreme care shall be taken during shop assembly to avoid inclusion of foreign materials into the equipment. The interior of the piping shall be cleaned with lint free cloths and flushed with oil at a minimum velocity of 15 fps which has passed through a 10 micron filter. The cleaning procedure shall clean the system of particles so that the contamination level is below 17/14 in accordance with SAE J1165. The manufacturer shall take three 500-milliliter samples at random locations according to ANSI B93.19. Particle counting on each sample shall be performed in accordance with SAE ARP 598B by an approved independent test laboratory. Water content of each sample shall be below 200 ppm. If any sample does not comply with the permissible contamination limits, the system shall be recleaned and reinspected. The piping and valves shall be sealed with enough oil in the system to protect the metal surfaces.

2.3.3 Cylinder Tests

Each cylinder shall be filled with the specified hydraulic fluid filtered to 10 microns, taking care to exclude all air. Each cylinder shall then be hydrostatically tested at 2,500 psi for a minimum of 4 hours. With the rod and piston fully retracted, and the pressure applied to the lower side of the piston, the upper end shall be observed for leakage past the piston. Any leakage past the seals shall be cause for rejection. The cylinder rod and piston shall then be extended and observed for smooth, even travel. Any operational problems or source of leakage to the outside of the

cylinder will be cause for rejection. The Contractor shall submit specifications for the hydraulic fluid recommended by the cylinder manufacturer for the approval of the Contracting Officer.

2.3.4 Hydraulic Power Units

Shop fabricated power and control units and piping shall be hydrostatically tested at the maximum pressure allowed by the installed equipment. Valves and operators shall undergo a functional test and the pumps shall be tested to verify flow and pressure ratings. The power unit shall then be connected to the hydraulic cylinder and operationally tested at 2,000 psi. Any operational problems will be cause for rejection.

2.4 SPECIAL TOOLS

One set of special tools required for assembly or disassembly of any of the equipment being supplied shall be furnished on an approved tool board. A list of all such tools shall be included in the Bid.

2.5 SPARE PARTS

A set of spare parts as recommended by the manufacturers shall be supplied. All spare parts shall be duplicates of the original parts they are intended to replace. Each spare part shall bear a tag or label securely attached clearly identifying the component for which it is intended. Spare parts shall include as a minimum:

1. One spare set motor and pumps for control unit.

2. One spare motor starter for each hoist control unit.

3. One spare switch of each type.

4. One set of packings for each hydraulic cylinders and piston.

5. One set of hydraulic control valves.

6. One power amplifier suitable for control valves furnished.

A complete list of spare parts shall be submitted with the Bid.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

The Contractor shall install the equipment specified and as shown on the shop drawings approved by the Contracting Officer to complete the hydraulic power systems for operation of the slide gates. Installation of hydraulic components shall be in accordance with the manufacturer's written instructions and under the direction of the erection engineer or manufacturer's representative. Complete units or assemblies shall be installed without disassembly. Necessary supports for all appurtenances, pumps, motors, and other equipment or components shall be provided as shown on the shop drawings. Floor-mounted equipment shall be anchored to concrete pads by anchor bolts or expansion anchors as shown on the drawings. Installation shall be in accordance with SECTION 05501: METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS and

SECTION 16415: ELECTRICAL WORK, INTERIOR.

3.1.2 Cleaning and Flushing the System

Extreme care shall be taken during assembly to avoid the entrance of abrasives, dirt, metal chips, and other foreign materials into the hydraulic system through open ends of piping, tubing, and ports of the components. The Contractor shall submit a detailed cleaning and flushing procedure for approval in accordance with Paragraph: SUBMITTALS. The procedure shall include a detailed description of the equipment, materials, formulations of cleaning agents, solution temperatures, duration of each phase of the cleaning operation, method of removal of cleaning agents, and method of drying after cleaning. The procedure shall clean the system of particles so that the contamination level is below 17/14 in accordance with SAE J1165. The Contractor shall take three 500-milliliter samples at approved locations according to ANSI B93.19. Particle counting on each sample shall be performed in accordance with SAE ARP 598B by an approved independent test laboratory. Water content of each sample shall be below 200 ppm. If any sample does not comply with the permissible contamination limits, the system shall be recleaned and reinspected. When flushing is completed, the system shall be drained and then filled with the specified hydraulic fluid.

3.1.3 Filling and Bleeding the System

Oil used to fill the system shall be filtered through a 10-micron filter. The complete hydraulic power system shall be bled to remove all air from the system. Care shall be taken to exclude as much air as possible during initial filling. The hydraulic cylinders shall be filled in the horizontal position with the piping connections up to allow air to escape, and the piping shall be filled in a manner that excludes as much air as possible. The system, once filled, shall be bled of air, operated, and periodically bled during the first week of operation to remove any air that might have been entrained in the system.

3.2 PAINTING

All exposed exterior surfaces of assemblies and equipment, except stainless steel, synthetic rubber, and plastic, shall be shop primed and coated as specified in SECTION 09940: PAINTING: HYDRAULIC STRUCTURES AND APPURTENANT WORKS unless the equipment is given a standard factory finish as allowed by other paragraphs of this specification. Insofar as is practicable, the complete coating system shall be applied to individual components and items before assembly to ensure complete coverage and maximum protection against corrosion. Equipment such as the pumps which have a factory-finished coating do not need to be recoated. Chips, scratches, and other damage to shop-applied painted surfaces shall be repainted in the field.

3.3 FIELD TESTS AND INSPECTIONS

3.3.1 Field Testing

The Contracting Officer shall be given 2 weeks notice before any test is to be conducted. Any material, equipment, instruments, and personnel required for the tests shall be provided by the Contractor. Testing shall be conducted in the presence of the Contracting Officer unless waived in writing and then a certified test report shall be submitted in accordance with Paragraph: SUBMITTALS. Testing shall be done under the direction of the erection engineer or manufacturer's representative.

3.3.2 Proof Testing

The piping system shall be hydrostatically tested to not less than 125 percent of the design working pressure. Any equipment that might be damaged by this pressure shall be isolated or removed to prevent damage. The proof test pressure shall be maintained for 12 hours. All welded, flanged, flared, and threaded connections shall be carefully examined for leakage and all lines shall be inspected for evidence of deflection caused by inadequate anchorage. No leakage or deflection will be allowed.

3.3.3 Final Acceptance Tests

3.3.3.1 General

In preparation for the final acceptance tests, and after completion of the installation and proof tests, the Contractor shall operate the hydraulic power system to prove acceptability. Preliminary tests shall be conducted at minimum pressures and velocities until initial adjustments have been proven safe for normal operation. Details of all operations shall be constantly monitored for signs of impending trouble and corrections shall be made as necessary to prevent damage to the equipment. At such time as the Contracting Officer may direct, the Contractor shall conduct the following complete acceptance tests on the hydraulic power system for approval. Any deficiency or maladjustment disclosed by the tests shall be corrected immediately and the test repeated until satisfactory results are obtained. No subsequent tests will be permitted until all preceding tests have been completed satisfactorily. Upon completion of the final acceptance tests, the Contractor shall furnish to the Contracting Officer a written statement that the hydraulic power system has been field tested and meets all operational requirements.

3.3.3.2 Initial Start-Up

The hydraulic reservoir shall be inspected to ensure that the fluid is at the proper level. The accumulator precharge pressure shall be inspected and adjusted to the specified value. The hydraulic pumps shall be test started using both the controls at the control console and the remote controls. The pump shall be inspected for proper operation and discharge pressure. The discharge pressure of each pump shall be read and recorded. The pressure relief valves shall be adjusted to limit the system pressure to the specified value. The hydraulic lines and components which are under pressure shall be inspected for evidence of leakage and corrective measures taken to the satisfaction of the Government.

3.3.3.3 Combined System Tests

Tests and inspections of each hydraulic power system shall be performed concurrently with the testing specified under other sections of these specifications which test the mechanism operated by the hydraulic system. The hydraulic system shall be tested by operating the mechanism through a minimum of four complete cycles. During each test operation, the hydraulic lines and components shall be inspected for evidence of leakage. The pressure in the supply and return lines for each direction of operation shall be read and recorded. Response of components to operation of applicable controls shall be inspected to ensure that all connections have been made properly. Flow control valves shall be checked and adjusted as required to conform to specified operating requirements. Sequence valves shall be inspected and adjusted as required to obtain the indicated

sequence of operation. Chokes in pilot circuits of plot- operated valves shall be adjusted to obtain smooth, shock-free operation. Hand operated 4-way valves shall be checked and operated.

3.3.3.4 Test Reports

The Contractor shall prepare and complete a test report showing in detail the results of the field tests. The test report shall include a detailed tabulation showing values of pressures, flow rates, and all adjustments recorded during the final tests, and adjustment and calibration of the entire system. During each test run, the following data and observations shall be recorded:

1. Control operation.

2. Voltages.

3. Currents.

4. Pressures.

5. Speeds and times.

6. Three gate operation - variation in gate position.

7. Flow control valve settings.

8. Alignment and operating clearances.

9. Excessive vibration by component.

10. Temperature of motors and hydraulic fluid.

11. Pertinent observations regarding such events as unusual sounds, malfunctions or difficulties encountered, and adjustments required.

3.4 ERECTION ENGINEER(s)

The Contractor shall obtain the services of an experienced erection engineer(s) who is regularly employed by the hydraulic cylinder/power unit manufacturer to supervise the installation, start-up, adjustment and operation, and testing of the equipment provided. The erection engineer(s) shall furnish the Contracting Officer a signed statement stating that the final installation and start-up of the hydraulic power system has been inspected, witnessed, and complies fully with the manufacturer's warranty requirements. The erection engineer(s) shall also instruct the Government's operating staff members in the operation and maintenance features of the equipment. Any errors in the work done or work which does not conform to the manufacturer's instructions shall be corrected at no extra cost to the Government.

-- End of Section --