

SECTION 15101 - VALVE AND GATE OPERATORS

City of San Diego, CWP Guidelines

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

- A. The WORK of this Section includes providing all shut off and throttling valves with manual and power operators as indicated. The CONTRACTOR shall provide the valve and gate operators, complete and operable, including all controls, motors, gears, enclosures and other necessary appurtenances as indicated.
- B. The WORK also requires that the valve or gate manufacturer accept responsibility for furnishing the WORK in this Section but without altering or modifying the CONTRACTOR'S responsibilities under the Contract Documents.
- C. The WORK additionally requires that the one manufacturer who accepts the indicated responsibilities shall manufacture the valve or gate, as a minimum.
- D. The WORK also includes coordination of design, assembly, testing and installation.

1.2 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.
 - 1. Section 15100 Valves, General
 - 2. Section 16040 Electric Motors
 - 3. Section 16050 Basic Electrical Materials and Methods

1.3 SPECIFICATIONS AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:
 - 1. JIC P-1 Pneumatic Standards for Industrial Equipment and General Purpose Machine Tools
 - 2. NEMA ICS-2 Industrial Control Devices, Controllers and Assemblies

1.4 SHOP DRAWINGS AND SAMPLES

- A. The following shall be submitted in compliance with Section 01300 in addition to the provisions of Section 15100:
 - 1. Electrical wiring and control diagrams.

1.5 SERVICES OF MANUFACTURER

- A. **Inspection, Startup, and Field Adjustment:** An authorized representative of the manufacturer shall visit the site for not less than [] days to furnish the indicated services.

- B. **Instruction of OWNER'S Personnel:** The authorized service representative shall also furnish the indicated services for instruction of OWNER'S personnel for not less than [] days.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. **General:** Unless otherwise indicated, all shut-off and throttling valves, and externally-actuated valves and gates, shall be provided with manual or power operators. The CONTRACTOR shall furnish all operators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All operators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven operators shall be identified by unique numbers.
- B. **Manufacturers:** Where indicated, certain valves and gates may be provided with operators manufactured by the valve or gate Manufacturer. Where operators are furnished by different manufacturers, the CONTRACTOR shall coordinate selection to have the fewest number of manufacturers possible.
- C. **Materials:** All operators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed.
- D. **Mounting:** All operators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or operator with an arrow indicating the direction to open in the counter-clockwise direction. All gear and power operators shall be equipped with position indicators. Where possible, manual operators shall be located between 48 and 60 inches above the floor or a permanent work platform.
- E. **Standard:** Unless otherwise indicated and where applicable, all operators shall be in accordance with ANSI/AWWA C 540 - AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates.
- F. **Functionality:** Electric, pneumatic, and hydraulic operators shall be coordinated with power and instrumentation equipment indicated elsewhere in the Contract Documents.

2.2 MANUAL OPERATORS

- A. **General:** Unless otherwise indicated, all valves and gates shall be furnished with manual operators. Valves in sizes up to and including 3½ inches shall have direct acting lever or handwheel operators of the Manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual operators, with an operating pull of maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 psi, all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear operators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 4 inches to 24 inches in diameter may have traveling-nut operators, or worm-gear operators as indicated.
- B. **Buried Valves:** Unless otherwise indicated, all buried valves shall have extension stems to grade, with wrench nuts located within 6 inches of the valve box cover, position indicators, and cast-iron or steel pipe extensions with heavy valve boxes with stay-put, hot-dip galvanized covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve

boxes with covers of ample size to allow operation of the valve operators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the ENGINEER. Wrench-nuts shall comply with AWWA C 500 -Metal - Seated Gate Valves for Water Supply Service, and a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished.

- C. **Chain Operator:** Manually-operated valves with the stem located more than 7 feet 6 inches above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve Manufacturer. The wheel and guide shall be of ductile-iron or cast-iron, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5 feet 6 inches above the operating floor level. The valve stem of chain-operated valves shall be extra strong to allow for the extra weight and chain pull. For plug valves 8 inches and larger, the actuator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.
- D. **Floor Boxes:** Hot-dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.
- E. **Adjustable Shaft Valve Boxes:**

Adjustable shaft valve boxes shall be concrete or cast iron valve extension boxes. Box covers on water lines shall be impressed with the letter "W". Gas line covers shall be impressed with the letter "G".

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NTS: Select from the following two paragraphs which describe a manual worm-gear operator and a traveling-nut operator, respectively, and delete non-applicable items.

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[F. **Manual Worm-Gear Operator:** The operator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The operator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The operator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Operator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the operator. All gearing shall be designed for a 100 percent overload.]

[G. **Traveling-Nut Operator:** The operator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weather-proof cast-iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the operator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of grease nipples. All gearing shall be designed for a 100 percent overload.]

2.3 ELECTRIC MOTOR OPERATORS

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NTS: Paragraphs B, C, and D specify the AC reversing control type, the AC modulating control type, and the DC modulating control type. The Specifier shall edit the text and omit any of the three operators which do not apply to the project. If in doubt, check with the Electrical Division.

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A. General

1. **Equipment Requirements:** Where electric motor operators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adaptor piece.
2. **Gearing:** The motor operator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA [4][7][8] assembly. The operator shall be a single or double reduction unit consisting of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. All gearing shall be accurately cut with hobbing machines. All power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Operator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the electric operator.
3. **Starting Device:** Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The operator motor must attain full speed before stem load is encountered.
4. **Switches and Wiring:** Travel in the opening and closing directions shall be governed by a switch responsive to mechanical torque developed in seating the valve, or by an obstruction met in opening or closing the valve, or by an on-board microprocessor. The torque switch shall be adjustable and shall function without auxiliary relays or devices, or it shall be adjustable in one-percent increments, sensed by a pulse-counter which receives 15 pulses per rotation of the unit. The geared limit switches shall be of the open type and shall be actuated by a rotor cam with 4 contacts to each cam or gear train. The operator shall have a number of gear trains as required to produce the operation indicated. The operator shall be wired in accordance with the schematic diagram. All wiring for external connections shall be connected to marked terminals. One 1-inch and one 1-1/4-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Position limit switches and associated gearing shall be an integral part of the valve operator. To provide the best possible accuracy and repeatability, limit-switch gearing shall be of the "counting" intermittent type, made of stainless steel, grease-lubricated, and enclosed in its own gearcase to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over-travel. Traveling-nuts, cams, or microswitch tripping mechanisms shall not be used. Limit-switches shall be of the heavy-duty open contact type with rotary wiping action.
5. **Handwheel:** A permanently-attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel.

6. **Motor:** The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on [480-volt, 3-phase][240-volt, 1-phase][120-volt, 1-phase], 60-Hz current, and have Class F insulation and a motor frame with all dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. All bearings shall be of the ball type and thrust bearings shall be provided where necessary. All bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require operator disassembly or gearing replacement. The motor shall be furnished with a space heater suitable for operation on 120-volt, single-phase, 60-Hz circuit unless the entire operator is an hermetically-sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.

[B. Electric Motor Operators (AC Reversing Control Type)

1. **General:** Where indicated, electric motor operators shall be the AC reversing type complete with local control station with open/close and local/[auto][remote] selector switches.
2. **Operator Appurtenances:** The operator for each valve shall be supplied with open and close status lights; open, close and lock-out-stop push-buttons, and all other devices indicated.
3. **Starter:** The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 120-volt, 1-phase, 60-Hz current. A control power transformer shall be included to provide a 120-volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120-volt ac, single-phase, 60-Hz space heater to prevent moisture condensation on electrical components.

[C. Electric Motor Operators (AC Modulating Control Type)

1. **General:** Where indicated, modulating electric motor operators shall be the ac modulating type complete with a local control station with open/close/auto/hold functions.
2. **Control Module:** The control module shall be of the electronic solid-state ac type with proportional pulse output to control the speed of the motor.
3. **Starter:** The operator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications. Power supply shall be 480-volt, 3-phase, 60-Hz.
4. **Construction:** The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and push-button calibration elements for field-setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal

in 4-20 mA. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate of [200][600] starts per hour at the 50 percent to 85 percent travel range of the valve.

[D. ELECTRIC MOTOR OPERATORS (DC MODULATING CONTROL TYPE)

1. **Equipment Requirements:** Where indicated, electric motor operators shall be of the dc modulating control type and shall be attached to the actuating mechanism housing.
2. **Operator Assembly:** The motor-operator shall include a dc motor, reduction gearing, a control unit, limit-switches, and required accessories in one enclosure.
3. **Control Unit:** The electric motor-operated control unit shall be suited for input power supply of 90 to 140 volts, 60-Hz ac and shall operate satisfactorily when input power is within those limits. Power will be supplied at 120 volts, single-phase, 60-Hz ac.
4. **Input Signal:** The control unit shall be suited to receive an input set-point signal from an external source of 4 to 20 mA-dc with properly selected calibrating resistor.
5. **Control Panel:** Each operator shall be provided with a separate, local control panel for attachment to the valve operator assembly. The panel shall include an open/close/auto/hold selector switch and shall be suitable for indoor or outdoor installation, as required.

2.4 PNEUMATIC OPERATORS

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NTS: There are three basic types of pneumatic valve or gate operators, with many variations in design and control features. The three most-commonly used types are:

1. The pneumatic diaphragm operators: For linear or rotary motion, with spring return and manual override option. These operators are used for torques up to approximately 1500 inch-pounds and they are less-expensive than cylinder operators.
2. The double-piston operators: These operators have two cylinders with rack-and-pinion drive and manual override option. They are used for torques over 1500 inch-pounds.
3. The scotch-yoke piston operators: These are the most-expensive ones of the three types, and they require more space than the other two operators, but they produce the greatest torque. They, too, are available with manual override.

Cylinder operators are available double- or single-acting, with or without spring opening or closing.

The Specifier shall carefully edit the text and delete any non-applicable items. Control features must be individually selected and coordinated with the instrumentation.

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A. **General:**

1. Controls
 - a. Pneumatic cylinder operators shall be provided complete with all necessary pneumatic or electro-pneumatic controls for the intended actuation of the valve or gate.
2. **Lubricators:** Where required by the service and type of operator, oil-lubricators shall be provided in the air supply to the operator, according to the Manufacturer's instructions.
3. Air Supply
 - a. All pneumatic operators shall be sized for the available air pressure as indicated and shall be furnished with isolating valves, adjustable filter-regulators, pressure gauges, and condensate drains. The filter elements shall be replaceable 40 micron units.

[B. Diaphragm Operators

1. **Construction:** The operator shall consist of a ductile-iron, aluminum, or carbon steel diaphragm housing and stainless steel or carbon steel stem; a ductile-iron or cast-iron yoke and spring barrel with carbon steel spring, and Nitrile-covered fabric diaphragm of sufficient strength for the maximum expected torque or force.
2. **Manual Override:** Each operator shall be provided with a manual handwheel override, top-mounted for linear actuation, and worm-gear mounted with declutchable handwheel for rotary actuation. The worm-gear construction shall be as indicated for manual operators.

[C. Double-Piston Operators

1. **Construction:** The operators shall be of the double-acting cylinder type with provision for later field conversion to spring-return action. A rack-and-pinion drive shall provide a 90-degree rotation of the output shaft, which shall be extended to receive a manual override. The operator shall be totally enclosed in a hard-anodized aluminum, ductile-iron, cast-iron, or steel housing. The cylinders and pistons shall be of hard-anodized aluminum or ductile-iron or steel, honed, and nickel or chrome-plated, or coated with a permanent dry-film lubricant and corrosion inhibitor. The rack, pinion, end caps, and tie-rods shall be of hardened carbon steel. The seals and O-rings shall be Buna N.
2. **Manual Override:** Each operator shall be provided with a manual worm-gear override with declutchable handwheel. The worm-gear construction shall be as indicated for manual operators.

[D. Scotch-Yoke Piston Operators

1. **Construction:** The operator shall be of the double-acting cylinder type with provision for later field conversion to spring-return action. The operator may be of the single- or double-cylinder design. A scotch-yoke drive shall provide a 90-degree rotation of the output shaft, which shall be extended to receive a manual override. The unit shall be totally enclosed in a hard-anodized aluminum, ductile-iron, cast-iron, or steel housing. The cylinders and pistons shall be of hard-anodized aluminum, cast-iron, ductile-iron, or steel, honed and nickel- or chrome-plated, or coated with a permanent dry-film lubricant and corrosion inhibitor. The piston rod shall be of hard chrome- or nickel-plated steel. The tie-rods shall be of hardened carbon steel, and the seals and O-rings of Buna N.
2. **Manual Override:** Each operator shall be provided with a manual worm-gear operator override with declutchable handwheel. The worm-gear construction shall be as indicated for manual operators.

NTS: The pneumatic cylinder operators specified above are not suited for hydraulic actuation. For Guidelines on fluid power systems for surge control, stop-and-check service, and pump station influent sluice gates, see Chapter D12, paragraphs D12.15 and D12.16 of Design Guidelines, Volume VIII.

2.5 FLUID POWER SYSTEMS

- A. **Equipment Requirements:** The hydraulic gate operator is intended for the hydraulic opening and closing of cast-iron sluice gates and fabricated slide gates. It consists of a linear piston operator over the gate [with extended stem,] with adaption spool, a manual worm-gear override, and all necessary controls.
- B. **Hydraulic Fluid:** The hydraulic cylinder shall meet the requirements of AWWA C504, and be connected to hydraulic power unit furnishing a mineral-based or petroleum-based oil with a viscosity of 90 SUS at 100 degrees F at a working pressure of 1200 psi. The Manufacturer shall certify in writing that all wetted parts of the hydraulic system are suitable for extended operation with the hydraulic fluid, and rated for a maximum working pressure of 3,000 psig..
- C. Hydraulic Cylinder
 - 1. **Construction:** The hydraulic cylinder shall be double-acting, of alloy steel, precision-machined, bored, and honed to a micro-finish and coated against corrosive environment. The cylinder shall be supported on a heavy base plate. The heads and piston shall be of carbon steel with Teflon wear rings for the piston. The piston rod shall be of alloy steel with a micro-finish and hard chrome-plated, running in over-sized bronze bearings. All seals shall be Buna-N or Viton. The adaption spool shall be a one-piece, flanged steel unit with an access door. Adjustable open- and closed-travel stops shall be provided. The cylinder unit shall be fitted with a declutchable worm-gear operated manual override with handwheel, and it shall be capable of holding the gate in any position, without creeping. Position indicator and adjustable speed controls shall be provided.
- D. Power and Control System
 - 1. **General:** The hydraulic operator shall be provided complete with all necessary hydraulic, electric and/or pneumatic controls for the intended actuation of the gate, such as transmitters, controllers, transducers, positioners, limit-switches, solenoid valves, pressure gauges, bi-directional filters, strainers, flexible hose connectors, mounting brackets, and adjustable speed controls.
- E. Fluid Power System
 - 1. Performance Requirements
 - a. Break-loose forces for calculating the thrust required to open the gate shall be calculated on the basis of the full specified water load, acting in either direction, and a guide friction factor of 0.7.
 - b. Downward loading on the yoke, guides, frames, and stem nut pocket shall be calculated on the basis of maximum fluid power system pressure acting on the top of the cylinder piston with the piston unseated.

- c. Once breakloose from the wedges has been achieved, operating forces shall be calculated assuming the full specified differential head, acting in either direction, with a guide friction factor of 0.35.
- d. All directional valves shall be zero leakage (1 drip per minute maximum at 3,000 psig pressure).
- e. Speed control valves shall be pressure-compensated type with locking key.
- f. Fluid power systems shall be designed and furnished by the sluice gate manufacturer as a part of the unit responsibility.
- g. **Operation Capacity:** The fluid power system shall be designed to provide adequate volume and pressure for the operation of all connected equipment in accordance with JIC H-1 - Joint Industrial Council, Hydraulic Standards for Industrial Equipment and General Purpose Machine Tools, as follows:

<u>Equipment Name or Number</u>	<u>Size</u>	<u>Operating Pressure (psi)</u>	<u>Operating Cycle (seconds)</u>	<u>Location of Connected Equipment</u>
[]	[]	[]	[]	[]
[]	[]	[]	[]	[]

- h. **Pressure:** Unless otherwise indicated above, the connected equipment shall be sized for an operating pressure of [1,200] psig, with a pressure of [3,000] psig in the accumulators.
- i. **Operation:** The fluid power system shall operate all connected gates through a complete opening and closing cycle in the time indicated above, with minimum operating oil pressure in the accumulators. All opening and closing times shall be independently adjustable between [30 and 300] seconds. Rigid and secure means of locking these adjustments shall be provided. Interlocks shall be provided to prevent normal (open/close) operation, until the emergency accumulators have been fully charged.

2. Power Systems Construction

- a. **Pumps:** Two positive displacement pumps of the variable-axial piston type with a discharge pressure of [3,000] psig shall be mounted on top of the reservoir, or below the reservoir. Each pump shall be sized to recharge all system accumulators within 15 minutes after they have been fully discharged, and it shall be suitable for continuous operation. Each pump shall be complete with a direct connected, heavy-duty, [TEFC] electric motor suitable for [480 volt, 3-phase, 60 Hz] supply. All necessary unloader valves, check valves, pilot valves, safety valves, air release valves, drain valves, and control valves shall be installed in accessible locations. In addition, a hand-pump, complete with pipe connections and valves, shall be mounted to the reservoir to pressurize the system in case of a power failure.
- b. **Piping:** All necessary piping and valving within the unit and between the unit and the connected valve cylinders and equipment shall be provided. The piping system shall be of seamless steel pipe, conforming to ANSI/ASME B 31.1 - Power Piping, designed for a maximum velocity of 15 feet per second, at a maximum operating pressure of [3,000] psig. The pipe wall thickness shall give a minimum factor of

safety of 4. The fittings shall be 3,000 lb forged steel socket-welded type conforming to ASTM A 105 - Specification for Forgings, Carbon Steel, for Piping Components. The flanges shall be 3,000 lb socket-welded. The suction lines shall be equipped with expansion and vibration isolation joints. All individual lines to connected equipment shall have isolating valves at the power unit.

- c. **Accumulators:** The power system shall be provided with an accumulator which shall be sized to provide sufficient volume and pressure to operate all connected equipment under maximum conditions through 2 complete operating cycles with the pumps not operating. In addition, not less than 3 emergency operation accumulators shall be provided which will not be drained by the normal operation. The accumulators shall conform to the requirements of ANSI/ASME Boiler and Pressure Vessel Code, Section VIII, and all local regulations. A pre-charge kit shall be furnished, including all required fittings, hoses, connections, gauge, regulators, and nitrogen bottles sufficient for one year's operation. The accumulators shall be suitable for an operating pressure of [3,000] psig, with a pressure regulator set to supply hydraulic fluid at [1,200] psig to the system.
 - d. **Oil Reservoir:** The reservoir shall serve as the mounting base for the other equipment as far as practicable. It shall be of ample capacity to contain all the oil in the system. Internal baffles or other design features shall allow time for air bubbles to separate from the discharged oil before reaching the pump suction. The reservoir shall be of heavy, welded-steel construction, with welded supports, pipe connections, manhole, level gauge with cast aluminum or steel armor, drain valve, vent, and welded pads for the support of the auxiliary equipment and pumps. The capacity of the reservoir shall be not less than [] gallons.
 - e. **Oil Cooler:** The fluid power system shall be equipped with a readily accessible heat exchanger to cool the hydraulic fluid at high ambient temperatures of up to 110 degrees F. The heat exchanger shall be of the shell and tube type, with thermostat control and all necessary controls, solenoid valves, temperature gauges, valves, and fittings, connected to the available cooling water supply. The equipment shall be sized for the quality and temperature of the available cooling water, to maintain the oil temperature at maximum 130 degrees F. The heat exchanger shall be mounted in such a way as to facilitate withdrawal and cleaning of the tubes.
 - f. **Oil Heater:** Where fluid power systems are located in areas subject to ambient temperatures below 50 degrees F, the oil reservoir shall be equipped with an electric immersion heater with thermostat control, sized for the Manufacturer's recommended temperatures.
3. Power and Controls
- a. **Electrical Equipment:** The system shall be provided complete, with all required electrical components, including pump starters, branch circuit protection, magnetic circuit breakers, control transformers, elapsed time meter, pressure gauges, and switches.
 - b. **Automatic Controls:** Automatic controls shall be provided to:
 - (1) Start the first pump when pressure in the accumulator drops to a pre-determined lower limit.
 - (2) Start the second pump when required to maintain adequate operating pressure.

- (3) Stop the pump(s) when the pressure in the accumulator rises to a pre-determined upper limit.
 - (4) Start the second pump and initiate an alarm should the first pump fail.
 - (5) Alternate operation between the two pumps.
 - (6) If variable-displacement, pressure-compensating pumps are provided, only items 2, 4, and 5 above shall apply. In addition, however, under item 2, the second pump shall automatically stop when the first pump can adequately maintain the pressure in the accumulator.
- c. **Control Cabinet:** All electrical control devices and wiring termination shall be located in an enclosed cabinet with NEMA rating in accordance with the designations of Section 16050 - Basic Electrical Materials and Methods. The cabinet shall be mounted on the power unit, or wall-mounted as indicated. Terminal blocks shall be provided for interconnection to any other control devices indicated. All controls shall be suitable for 120 volt power supply.
 - d. **Protection Devices:** Protection devices shall be provided to perform the following functions:
 - (1) Low oil pressure - alarm
 - (2) Low-low oil pressure - shutdown
 - (3) High oil pressure - alarm
 - (4) Low reservoir oil level - alarm
 - (5) Low-low reservoir oil level - alarm and pump shutdown
 - e. **Emergency Controls:** The system shall include all emergency operation controls with a 24 volts DC battery storage system served by a dual-rate rectifier, to activate the emergency accumulators. The system may be required to close the gate(s) in case of a power failure or high level in the wet well.
4. **Accessories:** The fluid power system shall be provided with all necessary accessories, such as pressure gauges, relief valves, oil level sight glass, pressure and level switches, filters, pressure reducing valves, operating and isolating valves, nameplates, electrical and control wiring, and all other appurtenances for a complete and operable installation. 110-mesh (149 micron) stainless steel strainers shall be installed in the pump suction line. The return lines to the reservoir shall have 10 micron filters at the reservoir. Both filters shall have an internal bypass and visual clogging indicators.
 5. **Spare Parts and Supplies**
 - a. **Spare Parts:** The CONTRACTOR shall furnish the following;
 - (1) 2 sets of all packings, gaskets, O-rings, and seals
 - (2) 3 sets of oil filter cartridges
 - (3) 2 sets of all fuses
 - (4) 1 set of all motor and pump bearings
 - (5) Spare parts shall be stored in tool boxes and be identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
 - b. **Supplies:** Oil to test, flush, and initially fill the hydraulic system shall be provided. A supply of oil equal to the total volume of the system shall also be furnished for future

use. The oil shall be a mineral-based or petroleum-based oil to the Manufacturer's specifications.

2.6 MANUFACTURERS

A. Products shall be from the following manufacturers, or equal.

1. Valve Boxes

Brooks 3RT
Christie G5
Empire 7½

2. AC Reversing Control Type Operators

EIM
Keystone
Limitorque
Rotork

3. AC Modulating Control Type Operators

EIM
Limitorque Corporation
Rotork

4. DC Modulating Control Type Operators

EIM "Futronic - III"
Limitorque Corporation, "Modutronic - 10"

5. Pneumatic Cylinder Controls

G.H. Bettis
Fisher Controls
Keystone Controls, Inc.
Miller Fluid Power
Neles-Jamesbury, Inc.

Rexroth Corporation

6. Air Supply Lubricators

Fisher Controls, Series 67

7. Diaphragm Operators

Fisher Corporation
ITT Engineered Valves
Neles-Jamesbury, Inc.

8. Manual Worm-Gear Override

G.H. Bettis
Keystone Controls, Inc.
Neles-Jamesbury, Inc.

9. Scotch-Yoke Piston Operators

G.H. Bettis
Keystone Controls, Inc.
Neles-Jamesbury, Inc.
Rotork Controls, Inc.

10. Hydraulic Cylinder Operators

G.H. Bettis
Miller Fluid Power
Rexroth Corporation

11. Power and Control Systems

G.H. Bettis
Miller Fluid Power
Rexroth Corporation

12. Fluid Power Systems

R.W. Atkinson Co., Inc.
Miller Fluid Power
Parker Hannifin Corporation
Rexroth Corporation

PART 3 -- EXECUTION

3.1 Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.2 SERVICES OF MANUFACTURER

A. Field Adjustments

1. Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric operators shall adjust operator controls and limit-switches in the field for the required function.

3.3 INSTALLATION

A All valve and gate operators and accessories shall be installed in accordance with Section 15100 - Valves, General.

NTS: The following paragraphs of clause 3.4 apply to fluid power system operated gate operators only. For all other operators, clause 3.4 must be omitted.

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[3.4 FLUID POWER SYSTEM INSTALLATION

- A. **Pickling:** Before installation, all piping components must be shipped to a pickling plant to undergo the following cleaning process. Remove all extraneous materials, remove all oils or grease in an alkaline bath, rinse with water, coat all vulnerable surfaces of valves, flanges, etc., acid-pickle, dry, and inspect piping before closing cleaned pipes.
- B. **Cleaning:** After installation, the piping shall be thoroughly inspected and cleaned, to remove all foreign materials, including mill scale, dirt, rust, oil, grease, weld spatter, and cutting chips. Cleaning may be accomplished by hot oil flush or other approved method. All cleaning shall be done in strict accordance with the Manufacturer's written instructions.
- C. **Field-Testing:** After installation, the fluid power system and piping shall be hydraulically tested to 150 percent of the maximum working pressure. The reservoir shall be tested for leakage by hot oil or other approved method, prior to painting. Operational tests shall be performed on all equipment and devices to demonstrate proper function. Adjustable devices shall be checked for range of adjustment and given final adjustment.
- D. **Inspection, Startup, and Field Adjustment:** An authorized representative of the Manufacturer shall visit the site and witness the following:
 - 1. Installation of the equipment for not less than [2] days.
 - 2. Inspection, checking, and adjusting the equipment for not less than [1] day.
 - 3. Startup and field-testing for proper operation for not less than [1] day.
- E. **Instruction of OWNER'S Personnel:** The authorized service representative shall visit the site for not less than [2] days to instruct the OWNER'S personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.]

- END OF SECTION -