

SECTION 40 27 02

PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Mechanical Engineers (ASME):
    - a. B16.1, Grey Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
    - b. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.
  2. American Society for Testing and Materials (ASTM):
    - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
    - b. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
    - c. A276, Standard Specification for Stainless Steel Bars and Shapes.
    - d. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
    - e. A536, Standard Specification for Ductile Iron Castings.
    - f. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
    - g. B61, Standard Specification for Steam or Valve Bronze Castings.
    - h. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
    - i. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
    - j. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
    - k. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
    - l. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
    - m. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
    - n. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
    - o. D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
    - p. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
  3. American Water Works Association (AWWA):
    - a. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
    - b. C508, Swing-Check Valves for Waterworks Service, 2-in. Through 24-in. (50-mm Through 600-mm) NPS.

- c. C542, Electric Motor Actuators for Valves and Slide Gates.
  - d. C550, Protective Interior Coatings for Valves and Hydrants.
  - e. C606, Grooved and Shouldered Joints.
4. National Electrical Manufacturers Association (NEMA):
- a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

## 1.2 SUBMITTALS

### A. Submittals:

#### 1. Shop Drawings:

- a. Product data sheets for make and model.
- b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction, and cross-sectional details.
- c. Complete valve and actuator schedules.
- d. Submit the following data complete, grouped together, and separated by divider, for each set of valves with the same combination of features and accessories:
  - 1) Dimensional outline drawing showing valve body, trim, actuator, and accessories.
  - 2) Identification of materials of construction, cross-sectional views and details; for valves, components, and accessories.
  - 3) Power and control wiring diagrams, including terminals and numbers.
  - 4) Complete motor nameplate data.
  - 5) Sizing calculations for open-close throttling and modulating.
  - 6) Valve pressure and temperature rating.
  - 7) List of Configuration Parameters: Include the following for each piece of equipment and/ or component which contains adjustable or programmable settings complete with:
    - a) List of switchable settings, or programmable settings complete with:
      - (1) Switch/parameter tag No. or I.D. or address.
      - (2) Range of possible settings.
      - (3) Factory default setting.
      - (4) Blank column for recording final field setting.
      - (5) Description of each adjustable parameter c/w description of each allowable value.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. All valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories, as required, for complete operation.
- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

- C. Valve same size as adjoining pipe.
- D. Valve ends to suit adjoining piping.
- E. Size operator to operate valve for the full range of pressures and velocities.
- F. Size actuators for drip-tight shutoff and breakaway at full valve pressure rating, unless otherwise specified.
- G. Valve to open by turning counterclockwise.
- H. Factory mount and test operator, actuator, and accessories.

## 2.2 MATERIALS

- A. Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
  - 1. Approved alloys are of the following ASTM designations: B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
  - 2. Stainless steel Alloy 18-8 may be substituted for bronze.

## 2.3 FACTORY FINISHING

- A. Epoxy Lining and Coating:
  - 1. Use where specified for individual valves described herein.
  - 2. In accordance with AWWA C550 unless otherwise specified.
  - 3. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
  - 4. Minimum 0.18 mm dry film thickness except where limited by valve operating tolerances.
- B. Exposed Valves:
  - 1. In accordance with Section 09 90 00, Painting and Coatings.
  - 2. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow”.

## 2.4 VALVES

- A. Gate Valves:
  - 1. Type V101 Gate Valve, 75 mm and Smaller:
    - a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, rising stem, Class 125, rated 862 kPa SWP, 1380 kPa WOG/CWP, complies with MSS SP-80 Type 2.
    - b. Manufacturers and Products:
      - 1) NPT Threaded Ends:
        - a) Crane; Fig. 428
        - b) Stockham; Figure B-100

- 2) Soldered Ends:
    - a) Crane; Fig. 1334
    - b) Stockham; Figure B-108
- B. Globe Valves:
1. Type V200 Globe Valve, 75 mm and Smaller:
    - a. All-bronze, union bonnet, packed gland, inside screw, rising stem, PTFE disc, Class 150, rated 1035 kPa SWP, 2070 kPa WOG/CWP, complies with MSS SP-80 Type 2.
    - b. Manufacturers and Products:
      - 1) NPT Threaded Ends:
        - a) Crane; Fig. 7TF
        - b) Stockham; Figure B-22T
      - 2) Soldered Ends:
        - a) Milwaukee; Model 1590T
- C. Ball Valves:
1. Type V300 Ball Valve, 50 mm and Smaller, for General Water and Air Service:
    - a. Two-piece end entry type, standard port, bronze body and end piece, hard chrome-plated bronze or brass ball, PTFE seats and stem packing, blowout-proof stem, zinc-coated steel hand lever operator with vinyl grip, rated 4140 kPa WOG/CWP, 1035 kPa SWP.
    - b. Manufacturers and Products:
      - 1) NPT Threaded Ends:
        - a) Crane; Series 9211
        - b) Watts; Series B6080
        - c) Conbraco Apollo; 70-100
      - 2) Soldered Ends:
        - a) Crane; Series 9212
        - b) Watts; Series B6081
        - c) Conbraco Apollo; 70-200
  2. Type V302 Actuator Ready Ball Valve, 50 mm and Smaller, for General Water and Air Service:
    - a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, actuator ready ISO mounting pad, Type 316 stainless steel ball and stem, vented ball, PTFE seats and seals, adjustable packing gland, blowout-proof stem, rated 4140 kPag WOG/CWP, 1035 kPa SWP, complies with MSS SP-110.
    - b. Manufacturers and Products:
      - 1) Conbraco Apollo; 71-AR
      - 2) Milwaukee; 20BSOR-02
  3. Type V303 Ball Valve, 50 mm and Smaller, for Equipment Air System Shutoff:
    - a. Two-piece, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, PTFE packing, reinforced PTFE seats, blowout-proof stem, adjustable packing gland, rated 4140 kPag WOG/CWP, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel latch-locking handle with vinyl grip, pad-lockable in closed position.

- b. Manufacturers and Products:
    - 1) Watts; Series B6000-LH-SE
    - 2) Conbraco Apollo; 75-100-41
  - 4. Type V306 Stainless Steel Ball Valve, 50 mm and Smaller:
    - a. Two piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body, ball, and end piece, NPT threaded ends, reinforced PTFE seats, PTFE packing, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 6900 kPa WOG/CWP, 1035 kPa SWP.
    - b. Manufacturers and Products:
      - 1) Conbraco Apollo; Series 76F-100-A
      - 2) Watts; S-FBV-1
      - 3) Crane; CSC-9502-2
  - 5. Type V330 PVC Ball Valve, 50 mm and Smaller:
    - a. Rated minimum 1035 kPa at 22.8 degree C, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, PTFE seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
    - b. Manufacturers and Products:
      - 1) Chemline; Type 21
      - 2) Hayward; TB Series
      - 3) ASAHI/America; Type 21.
      - 4) Spears; True Union.
- D. Plug Valves:
- 1. Type V400 Eccentric Plug Valve, 65 mm and Smaller:
    - a. Non-lubricated type rated 1208 kPa CWP, drip-tight shutoff with pressure from either direction, cast iron body, NPT threaded ends, lever operator, cast iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber. Epoxy coated internal and external.
    - b. Manufacturers and Products:
      - 1) Val-Matic; Cam-Centric 5800RTL
      - 2) DeZurik; Style PEC
      - 3) Pratt; Ballcentric.
      - 4) Milliken; Millcentric.
      - 5)
  - 2. Type V405 Eccentric Plug Valve 75 mm to 300 mm:
    - a. Nonlubricated type rated 1208 kPa CWP, drip-tight shutoff with pressure from either direction, cast iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, unless otherwise shown.
    - b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N , seats welded nickel, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on stem.
    - c. Provide external and internal epoxy coating.

- d. Operators:
    - 1) 75 mm Valves: Wrench lever manual.
    - 2) 100 mm-300 mm Valves: Totally enclosed, geared, manual operator with handwheel, 50 mm nut, or chain wheel. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher.
  - e. Manufacturers and Products:
    - 1) Val-Matic; Cam-Centric 5800R
    - 2) DeZurik; Style PEC
    - 3) Pratt; Ballcentric.
    - 4) Milliken; Millcentric Series 600.
    - 5) Butterfly Valves:
3. General:
- a. Valves specified as AWWA C504 to be in full compliance with AWWA C504 and following requirements:
    - 1) Suitable for throttling operations and infrequent operation after periods of inactivity.
    - 2) For valves 600 mm and larger, seats shall be field adjustable and replaceable. Provide one seat adjustment kit per valve model where applicable.
    - 3) Bubble-tight with rated pressure applied from either side in accordance with AWWA C504.
    - 4) Valve shafts to be solid stainless steel, corresponding to design requirements of AWWA C504. The shafts to be fastened to the discs by a means designed to provide vibration proof connection.
    - 5) No travel stops for disc on interior of body.
    - 6) Self-adjusting Buna-N V-type seat and shaft seals.
    - 7) Isolate metal-to-metal thrust bearing surfaces from flowstream.
    - 8) Provide traveling nut or worm gear actuator with handwheel and an externally adjustable closed position stop. Valve actuators to meet the requirements of AWWA C504.
    - 9) The interior and exterior of valves to be coated with a fusion bonded epoxy. Coatings to be applied at the valve manufacturing facility.
    - 10) Two different butterfly valve manufacturers are permitted provided that valves smaller than 600 mm diameter are from the same manufacturer and valves 600 mm and larger are from the same manufacturer.
4. Type V500 Butterfly Valve, 75 mm to 1800 mm:
- a. Flanged end, short body type.
  - b. AWWA C504, Class 150B.
  - c. Cast iron body, ductile iron disc with Type 304 stainless steel shaft, EPDM seat, and stainless steel seating surface. Fusion-bonded epoxy coating internal/external.
  - d. Manufacturers and Products:
    - 1) Pratt; Model 2FII or Triton XR-70
    - 2) DeZurik; BAW
    - 3) Val-Matic; Series 2000

5. Type V514 High Performance Butterfly Valve, 50 mm to 900 mm:
  - a. ASME B16.5 Class 150 lug style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, reinforced PTFE seat, PTFE stem packing, stainless steel with RTFE thrust washer.
  - b. Manufacturers and Products:
    - 1) DeZurik; BHP
    - 2) Watts/Contromatics; Series QF
    - 3) Sure Seal; GTD Series
    - 4) Bray/McCannalok; Series 41
  
- E. Check Valves:
  1. Type V600 Check Valve, 50 mm and Smaller:
    - a. All bronze, threaded cap, threaded or soldered ends, swing type replaceable bronze disc, rated 862 kPa SWP, 1380 kPa WOG/CWP.
    - b. Manufacturers and Products:
      - 1) NPT Threaded Ends:
        - a) Watts; Series CVY
        - b) Crane; Fig. 37
        - c) Stockham; Figure B 319,
        - d) Milwaukee; Figure 509,
      - 2) Soldered Ends:
        - a) Watts; Series CVYS
        - b) Stockham; Figure B 309,
        - c) Milwaukee; Figure 1509,
  2. Type V609 Rubber Flapper Check Valve, 50 mm to 900 mm:
    - a. AWWA C508, cast or ductile iron body and cover, ASME B16.1 Class 125 flanged ends, reinforced Buna-N flapper with raised seating ring, stainless steel bolting, fusion-bonded epoxy coating internal/external, with external backflow device.
    - b. Valves 50 mm through 300 mm rated minimum 1207 kPa CWP and 350 mm through 900 mm rated minimum 1035 kPa CWP.
    - c. Manufacturers and Products:
      - 1) Val-Matic; Series 500 Swing-Flex
      - 2) APCO; Series 100
      - 3) Clow/Kennedy; Style 506
      - 4) Mueller; Flexible Disc Check Valve
      - 5) Milliken; Flex Check
  3. Type V630 PVC Ball Check Valve 100 mm and Smaller:
    - a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 1035 kPa at 22 degrees C, and Viton seat and seal.
    - b. Manufacturers and Products:
      - 1) Chemtrol Tru Union; U45BC
      - 2) Hayward TC Series True Union Ball Check
      - 3) Chemline; Series BT-A-OXX-V-S

- F. Self-Contained Automatic Valves:
1. Type V711 Pressure-Reducing Valve 50 mm and Smaller:
    - a. Direct diaphragm, spring controlled, cast iron body, spring case, seat and diaphragm, stainless steel valve stem.
    - b. Size/Rating: TBD by Contractor.
    - c. Maximum upstream pressure 1035kPa, downstream pressure to be field adjusted.
    - d. Manufacturers and Products:
      - 1) Fisher; Series 95.
  2. Type V730 Pressure-Relief Valve 50 mm and Smaller:
    - a. Direct diaphragm, spring controlled, cast iron body, spring case, nitrile seat, neoprene diaphragm, stainless steel valve stem.
    - b. Capable of opening when upstream pressure reaches a maximum set point.
    - c. Size/Rating: TBD by Contractor.
    - d. Manufacturer and Product:
      - 1) Fisher; Series 98
      - 2) Watts; Series 74
- G. Miscellaneous Valves:
1. Type V940 Solenoid Valve 6 mm to 50 mm:
    - a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120V ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (i.e., open or closed when de-energized)] TBD by Contractor.
    - b. Minimum operating pressure differential no greater than 35 kPag, unless otherwise noted.
    - c. Maximum operating pressure differential not less than 863 kPag.
    - d. Slow closing where noted.
    - e. Provide integral manual override switch.
    - f. Manufacturers and Products:
      - 1) ASCO; Series 8210

## 2.5 OPERATORS AND ACTUATORS

- A. Manual Operators:
1. General:
    - a. Operator force not to exceed 178 N under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 178 N.
    - b. Operator self-locking type or equipped with self-locking device.
    - c. Position indicator on quarter-turn valves.
    - d. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threaded steel reach rods with internally threaded bronze or ductile iron nut.

2. Exposed Operator:
  - a. Galvanized and painted handwheels.
  - b. Lever operators allowed on quarter-turn valves 100 mm and smaller.
  - c. Cranks on gear type operators.
  - d. Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.
  - e. Valve handles to take a padlock, and wheels a chain and padlock.
  
- B. Electric Motor Actuators:
  1. General:
    - a. Comply with AWWA C542.
    - b. Controls integral with the actuator and fully equipped as specified in AWWA 542.
    - c. Stem protection for rising stem valves.
    - d. Suitable for -30 degrees Celsius to 40 degrees Celsius environment.
    - e. For larger valves requiring the addition of an intermediate gearbox, the gearbox shall be of the same manufacturer as the actuator.
    - f. A design that allows the gear case to be opened for inspection or disassembly without releasing the stem thrust or taking the valve out of service.
    - g. Circuitry which ensures the motor turns in the correct direction irrespective of the supply polarity connected to the power terminal; valves and operator to suffer no damage due to incorrect power connection.
    - h. Instantaneous reversal protection whereby an automatic time delay circuit limits the current surges when an actuator is signalled to instantaneously reverse its direction.
    - i. Anti-hammer protection whereby electronic torque limitation switches off the actuator when a preset load is reached due to an obstruction or end of travel.
    - j. Bi-metal thermostat embodied in the motor control transformer windings to prevent overheating due to extensive use.
    - k. Jammed valve motor protection whereby a logic circuit protects the motor from overheating by de-energizing the motor if the valve does not move after developing maximum torque.
    - l. Provide a minimum of four independently configurable Form C latching contacts for remote indication.
      - 1) Contact 1 shall make when valve is fully closed.
      - 2) Contact 2 shall make when valve is fully open.
      - 3) Contact 3 for collective fault (torque fault and other electrical faults)
      - 4) Contact 4 shall indicate when remote is selected.
    - m. Contacts rated for 2A @ 120 VAC and 2A @ 24 VDC.
    - n. Opto isolators incorporated to interface with remote control inputs to protect the logic circuits from high voltage transients appearing at the actuator terminals.
    - o. Actuator shall include a diagnostic module which will store and enable download of historical actuator data to permit analysis of changes in

- actuator or valve performance. Retrieval of this information must be demonstrated in the field
2. Actuator Operation- General:
    - a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multi-turn valves.
    - b. Manually override handwheel.
    - c. Valve position indication.
    - d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in a minimum of 60 seconds.
    - e. Nonintrusive Electronics: Local controls, diagnostics, and calibration, including limit and torque switch settings, shall be accomplished non-intrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two minimum.
  3. Open-Close/Throttling Service:
    - a. Capable of minimum 60 starts per hour.
    - b. Size for 1.5 times required operating torque. The safety factor shall be demonstrated and documented in the shop drawings submittals and at time of commissioning under real service conditions using the actuator software and torque display on actuator. Motor stall torque not to exceed capacity of valve.
    - c. Actuator suitable for throttling operation of valve at intermediate positions.
    - d. LOCAL-OFF-REMOTE selector switch, padlockable in each position:
      - 1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
      - 2) Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; valve travel stops when remote STOP contact opens.
      - 3) Auxiliary contact that closes in REMOTE position.
    - e. OPEN and CLOSED indicating lights.
    - f. Integral reversing motor starter with built-in overload protection. Control transformer for 120V ac or 24V dc control voltage.
    - g. Valve shall remain in last position on loss of operator power.
  4. Modulating Service:
    - a. Capable of minimum 1200 starts per hour. All components including the gearbox, contactor, motor, etc. shall be rated accordingly.
    - b. Size motors for continuous duty and specified starts per hour.
    - c. Actuators to be sized with a minimum 2.0 safety factor based on the maximum unseating and seating torque of the valve. The safety factor shall be demonstrated and documented at time of commissioning under real service conditions using actuator software. Motor stall torque not to exceed torque capacity of valve.
    - d. Feedback potentiometer and integral electronic positioner/comparator circuit to maintain valve position.
    - e. LOCAL-OFF-REMOTE selector switch:
      - 1) Padlockable in each position.

- 2) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in REMOTE position.
  - 3) 4 to 20 mA dc input signal to control valve in REMOTE position.
  - 4) Auxiliary contact that closes in REMOTE position.
  - f. Valves shall close upon loss of signal unless otherwise indicated.
  - g. OPEN and CLOSED indicating lights.
  - h. Ac motor with solid state reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Non solid state compliant equipment will not be acceptable.
  - i. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
  - j. Valve position output converter that generates an isolated 4 to 20 mA dc signal in proportion to valve position, and is capable of driving into loads up to 500 ohm at 24 volts dc.
  - k. Remote Position Indication: Integral position transmitter producing a 4 to 20 mA dc output in direct proportion to valve position for connection to an external instrument loop. Fully CLOSED position shall correspond to 4 mA dc. The transmitter shall be capable of driving an external load impedance of 350 ohms minimum
5. Actuator Power Supply:
    - a. 600-volt, three-phase unless otherwise indicated.
    - b. Control power transformer, 120-volt secondary.
  6. Enclosure:
    - a. Unless otherwise indicated, provide enclosure as defined in NEMA 250, Type 6P.
    - b. Contain 120-volt space heaters Or electrical compartment shall be non-breathing to prevent condensation
  7. Limit Switches:
    - a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 2 amps at 120 V ac.
    - b. Each valve actuator to have a minimum of two transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
    - c. Housed in actuator control enclosure.
  8. Control Features: Electric actuators with features noted above, and as modified/supplemented in the Electric Motor Actuator Schedule.
  9. Manufacturers and Products:
    - a. Rotork; IQ Pro Range
    - b. EIM Series 2000 with TEC2000

## 2.6 ACCESSORIES

- A. Tagging: 38 mm diameter stainless steel tag attached with No. 16 stainless steel jack chain for each valve, bearing the valve tag number.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Field installation by Installation Contractor. Clauses below apply to any factory installation.
- B. Flanged Ends:
  - 1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
  - 2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
- C. Screwed Ends:
  - 1. Clean threads by wire brushing or swabbing.
  - 2. Apply joint compound.
- D. PVC Valves: Install using solvents approved for valve service conditions.
- E. Valve Orientation:
  - 1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 1476 mm or less above finished floor, unless otherwise shown.
  - 2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 1476 mm and 2057 mm above finish floor, unless otherwise shown.
  - 3. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.
  - 4. If no plug valve seat position is shown, locate as follows:
    - a. Horizontal Flow: The flow shall produce an “unseating” pressure, and the plug shall open into the top half of valve.
    - b. Vertical Flow: Install seat in the highest portion of the valve.
- F. Orientation of valve position Indication: Install valve operators whether manual, pneumatic or electric, to clearly indicate whether the valve is open, closed or partially open from a point no less than 3 m away and visible from a position compatible with normal plant operation.
- G. Orientation of Electric Actuators: Orient electric actuators to satisfy the following:
  - 1. Direct viewing and access of actuator controls and monitoring devices such as handwheels, pilot lights, and pushbuttons, when:
    - a. Valve is installed in horizontal runs of pipe having centerline elevations 1476 mm or less above the finished floor, or
    - b. When valve is installed in vertical runs of pipe with centre of valve body at elevations 1476 mm or less above the finished floor,
    - c. Unless otherwise shown.
  - 2. Limit interference with structures and with any other equipment or piping.
  - 3. Show valve position indicator from operating position.

- H. Limit Switches:
  - 1. Set limit switches to indicate valve positions or equipment status as required and indicated on Drawings.
  - 2. Provide stem-mounted stainless steel devices and hardware to actuate limit switches.
  - 3. Arrange limit switch contacts to close when valve is fully open, unless otherwise noted.
- I. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.
- J. Locate valves to provide accessibility for control and maintenance.

### 3.2 TESTS AND INSPECTION

- A. Field installed valves tested and inspected by Installation Contractor. The clauses below apply to factory installed valves.
- B. Valve may be either tested while testing pipelines, or as a separate step.
- C. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
- D. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- E. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.
- F. Set, verify, and record set pressures for all relief and regulating valves.
- G. Automatic valves to be tested in conjunction with control system testing. Set all opening and closing speeds, limit switches, as required or recommended by the Contract Administrator.

### 3.3 MANUFACTURER'S SERVICES

- A. See Section 01 43 33, Contractor's Field Services and Section 46 43 80, High Rate Clarification System.

END OF SECTION

SECTION 40 90 00

PROCESS INSTRUMENTATION AND CONTROL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

- A. Comply with latest edition of the codes and standards referenced in contract documents and following statutes and codes and all amendments thereto.
- B. The following is a list of standards which may be referenced in this section:
  - 1. The Instrument, Systems, and Automation Society (ISA):
    - a. 5.1, Instrumentation Symbols and Identification.

1.2 SUMMARY

- A. This section gives general requirements for the Process Instrumentation and Control System (PICS). The following sections expand on requirements of this section.
  - 1. Section 40 90 01, Instrumentation & Control Components.
- B. Comply with Division 1, General Requirements.

1.3 DESIGN REQUIREMENTS

- A. The Specifications have been developed on a conceptual basis. Provide a complete design of the instrumentation and control components required for the fully functional operation of the high rate clarification system.
- B. Provide a comprehensive set of Process and Instrumentation Drawings (P&IDs), together with all recommended instrumentation and control components including those supplied by Others. The P&ID drawings and all equipment identification shall be based on the City's Identification Standard and ISA 5.1.
- C. Provide instrumentation location drawings:
  - 1. Plan and/or elevation drawings as required for clear understanding of all recommended instrument locations.
- D. Provide typical instrument installation details.
- E. Provide a detailed instrument list for all recommended instruments including the following information:
  - 1. Instrument tag,
  - 2. Instrument make/model where known,
  - 3. Instrument description,
  - 4. Instrument type (e.g. discrete, analog, other)
  - 5. Principle means of measurement (e.g. ultrasonic),
  - 6. Required measurement range,

7. Expected nominal value of measurement,
  8. Minimum operating requirements, where required (e.g. slew rate, accuracy, repeatability, etc.)
  9. Environmental exposure (e.g. submerged),
  10. Indication whether instrument is supplied as part of the high rate clarification system, or if instrument is to be supplied by Others.
- F. Provide a comprehensive control narrative document
1. The control narrative shall be an English language functional description of the detailed operation of the high-rate clarification control system. Describe in general and in detail all aspects of the devices controlled, the operations or actions performed by the controlled devices, the devices monitored, the sensors, and the logic performed. Include any assumptions made in developing the program.
  2. The control narrative shall be comprehensive of all equipment and instrumentation required for the operation of the HRC system, regardless of whether the equipment or instrumentation is supplied under this Contract.
  3. The control narrative shall be written with a target audience of:
    - a. Operations and maintenance personnel,
    - b. Process engineers,
    - c. Automation engineers.
    - d. Automation programmers
  4. Minimum Content, Topics, Headings:
    - a. Overview of the process,
    - b. Outline of the process equipment,
    - c. Operator controls,
    - d. Control mode definition,
    - e. Local controls (functions),
    - f. Remote manual (functions),
    - g. Remote auto (functions),
    - h. Control mode transfer,
    - i. Fail to Operate actions,
    - j. Alarms,
    - k. Hardware interlocks,
    - l. Software interlocks,
    - m. Permissives,
    - n. Calculations.
  5. The document includes at minimum:
    - a. Narrative style,
    - b. Control issues and features,
    - c. Control strategies,
    - d. Remote system capabilities,
    - e. Identifies instruments deployed and their general location,
    - f. Operator adjustments and controls at the equipment,
    - g. Operator adjustments and controls via the HMI,
    - h. Standard mode options and options specific or unique to the machine/system,
    - i. Indicators at the equipment,

- j. Indicators at the HMI,
  - k. Sequences and steps,
  - l. Continuous control modes deployed such as feed forward, cascade, remote setpoint, ratio, PID, etc.,
  - m. Identifies standard and additional location(s) of field control stations and panels where applicable,
  - n. Description of operation under normal and adverse operating conditions,
  - o. Description of operation under all potential failure modes (equipment failure, control loss, power loss, etc.). Illustrate how system responds to failures to ensure that safety requirements are met, process equipment is protected from damage, and process performance is maintained to the degree possible.
  - p. Startup requirements for initial placement into service and any subsequent return to service,
  - q. Shutdown requirements.
- G. Provide an I/O list of the recommended I/O including the following fields for each input/output point:
- 1. I/O type (DO, DI, AI, AO)
  - 2. A description of the I/O point (e.g. Recirculation Pump 1 Running).
- H. Provide a Functional Requirements Details document for the high-rate clarifier equipment, indicating at minimum for each component:
- 1. Control details,
    - a. For all process control loops, indicate setpoint variable, process variable, and control variable.
    - b. Provide detailed description of control system operation.
    - c. Clearly identify all operating states. For each state detail:
      - 1) Conditions for the state transitions.
      - 2) Specific control requirements of each state.
  - 2. Equipment and process operating setpoints and setpoint ranges.
  - 3. Control interlocks.
  - 4. Listing of all alarms, including:
    - a. Alarm setpoints and delays.
    - b. Alarm priorities.
- I. Recommended calibration procedures:
- 1. Provide calibration procedures for all instrumentation supplied under the Contract. Include sketches as applicable.

#### 1.4 WORK BY OTHERS

- A. Work by others will be as follows:
- 1. All installation work.
  - 2. Design and supply of the PLC control panel.
  - 3. Supply of instruments not within the scope of Section 40 91 01.
  - 4. Design of instrument wiring diagrams.
  - 5. Design of cable routing.

6. Implementation of the software logic, as prescribed by the Contractor's Control Narratives and Functional Requirements Details.

## 1.5 SUBMITTALS

- A. Submittals (Submit updated versions as they occur):
  1. P&IDs.
  2. Instrumentation Location Drawings.
  3. Instrument Installation Details.
  4. Instrument List.
  5. Control Narrative.
  6. I/O List.
  7. Functional Requirements Details.
  8. Recommended Calibration Procedures.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. Furnish instrumentation items as specified in 40 91 01.

## PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 40 91 00

INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.1 REFERENCES

- A. Comply with latest edition of the codes and standards referenced in contract documents and following statutes and codes and all amendments thereto.
- B. The following is a list of standards which may be referenced in this section:
  - 1. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41,
  - 2. The Instrument, Systems, and Automation Society (ISA):
    - a. 5.1, Instrumentation Symbols and Identification.
    - b. 20, Specification Forms for Process Measurement and Control Instruments
    - c. 50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
  - 3. Canadian Standards Association (CSA):
    - a. C22.2 Electrical Safety Code
  - 4. National Electrical Manufacturers Association (NEMA).
  - 5. National Fire Code, National Fire Protection Association (NFPA): 820, Fire Protection in Wastewater Treatment Plants.
  - 6. Underwriters Laboratory, Inc. (UL): 508, Standards for Safety, Industrial Control Equipment.

1.2 DESIGN REQUIREMENTS

- A. The Specifications have been developed on a conceptual basis. Provide a complete design of the instrumentation and control components required for proper operation of the high-rate clarification system.
- B. Supply the following instrumentation for the high-rate clarification system:
  - 1. Influent turbidity.
  - 2. Influent pH
  - 3. Effluent turbidity (one per HRC train)
  - 4. Effluent pH (one per HRC train)
  - 5. Sludge blanket depth (one per HRC train), if required for proper system control
- C. Provide a detailed instrument datasheet for all instrumentation required for proper HRC system operation and control, whether included in the supply scope or not.
  - 1. Complete in accordance with ISA 20.
  - 2. Indicate the location or service.
  - 3. Provide recommended process design scale range, setpoints, materials of construction, etc.
  - 4. Provide recommended type of instrument.

### 1.3 SUBMITTALS

#### A. Submittals:

1. Manufacturer data sheets and shop drawings.
2. Component Data Sheets:
  - a. Format and Level of Detail: In accordance with ISA-S20.
  - b. Specific features and configuration data for each component:
    - 1) Location or service.
    - 2) Manufacturer and complete model number.
    - 3) Size and scale range.
    - 4) Set points.
    - 5) Materials of construction.
    - 6) Options included.
  - c. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
3. Sizing and Selection Calculations:
  - a. Primary Elements: Complete calculations plus process data used.  
Example for flow elements: Minimum and maximum values, permanent head loss, and assumptions made.

### PART 2 PRODUCTS

#### 2.1 COMPONENT SPECIFICATIONS

##### A. pH Element and Transmitter:

1. General:
  - a. Function: Measure, indicate, and transmit pH of process fluid.
  - b. Type: Electrometrically measure pH without requiring electrolyte flow.
  - c. Parts: Element, transmitter, interconnecting cable, and expendables.
2. Performance:
  - a. Range: 0.00 to 14.00 pH units (or -2.00 to 14.00 pH units).
  - b. Accuracy: 0.01 pH.
  - c. Sensitivity: 0.01 pH.
  - d. Stability: +/-0.035 pH per 24 hours, noncumulative.
  - e. Maximum Flow Rate: as required by the application, but not less than 0.9 meter per second.
3. Features: Automatic compensation for process liquid temperatures minus 10 to 110 degrees C (14 to 230 degrees F).
4. Element:
  - a. Type: three electrode, unless otherwise noted.
  - b. Process Electrode: Glass, unless otherwise noted.
  - c. Body Material: Liquid crystal polymer or PEEK, unless otherwise noted.
  - d. Liquid Junction (if applicable): Wood/Kynar, unless otherwise noted.
  - e. Features: Integral preamplifier.
  - f. Sensitivity: 0.01 pH.
  - g. Stability: 0.03 pH units for 24 hours, non-cumulative.
  - h. Operating Conditions: Capable of withstanding up to 690 kPa at 60 degrees C.

- i. Mounting/Process Connection: As required by equipment, from among the following:
  - 1) Immersion:
    - a) CPVC pipe (25 mm diameter by 1200-1400 mm long).
    - b) Coupling.
    - c) Sensor protector, if required.
    - d) PVC pipe-mount junction box, if required.
    - e) Interconnecting cable, if required.
  - 2) Flow-Through Mounting:
    - a) CPVC 25/38 mm tee.
    - b) Rated for 690kPa at 65 degrees C.
    - c) Interconnecting cable, if required.
  - 3) Union mounting:
    - a) CPVC 38/50 mm union pipe adapter, sealing hub, and lock ring..
    - b) Rated for 690kPa at 60 degrees C.
    - c) Interconnecting cable, if required.
- 5. Transmitter:
  - a. Features:
    - 1) Indicator: LCD with LED backlighting.
      - a) Display: pH, temperature, sensor diagnostics, etc.
    - 2) Scale Range: 0.0/-2.0 to 14.0 pH units, 0.00/-2.00 to 14.00 pH units, field selectable.
  - b. Signal Interface:
    - 1) Analog Output:
      - a) Two isolated 4 to 20 mA dc for load impedance 0 to 500 ohms, unless otherwise noted.
      - b) Output proportional to pH and process temperature, unless otherwise noted.
    - 2) Discrete Contacts:
      - a) Minimum two SPDT plus one SPST rated 5 amp continuous at 120V ac, or as required by the application.
      - b) Each contact setpoint: Fully adjustable for pH or temperature, or as required by the application.
  - c. Enclosure:
    - 1) Type: NEMA 4X.
    - 2) Mounting: Wall, unless otherwise noted.
  - d. Power: 120 VAC, 60 Hz.
- 6. Cable: 3 meters standard; Length as required to accommodate device location.
- 7. Expendables (for Each Unit Provided):
  - a. Chemicals: 500 mL each of buffer solution for pH 4, pH 7, and pH 10.
  - b. Salt Bridge: One double junction salt bridge, containing ceramic inner junction, binary fill solution, and O-ring.
  - c. Standard Cell Replacement Solution: One container, 500 milliliters pH.
- 8. Manufacturers:
  - a. Hach.
  - b. Rosemount Analytical.

- B. Turbidity Element and Transmitter (HRC Influent):
1. General:
    - a. Function: Measure, indicate, and transmit the turbidity of a process stream.
    - b. Type: Flow-through 90-degree surface scatter using photocell sensed, nephelometric measurement.
    - c. Parts: Turbidity element, transmitter, interconnecting cable, and accessories.
  2. Performance:
    - a. Range:
      - 1) As per equipment manufacturer recommendations.
      - 2) Within 0 to 9999 Nephelometric Turbidity Units (NTU).
    - b. Accuracy: Plus or minus 5 percent from 0 to 2,000 NTU and plus or minus 10 percent from 2,000 to 9,999 NTU.
    - c. Repeatability: Plus or minus 1.0 percent or 0.04 NTU, whichever is greater.
    - d. Resolution: 0.01 NTU below 1000 NTU; 0.1 NTU between 1000 and 9999.9 NTU.
    - e. Initial Response Time: 45 seconds.
    - f. Ambient Temperature Range: 0 to 50 degrees C (32 to 122 degrees F).
    - g. Ambient Humidity Range: 0 to 95 percent noncondensing.
  3. Element:
    - a. Type: Photocell sensed, nephelometric sensor used for continuous flow, continuous reading.
    - b. Sample Flow: 1 to 2 liters per minute (0.25 to 0.5 gpm).
    - c. Sample Temperature Range: 0 to 50 degrees C (32 – 122 F).
    - d. Materials: Corrosion-resistant materials for all wetted parts.
    - e. Process Connections:
      - 1) Sample Inlet: 19mm (3/4 inch) NPTF.
      - 2) Overflow: 25mm (1 inch) NPTF.
      - 3) Drain: 19 mm (3/4 inch) NPTF with ball type shutoff valve.
    - f. Mounting: Wall.
    - g. Enclosure: NEMA 12.
  4. Transmitter:
    - a. Features:
      - 1) Type: Microprocessor based.
      - 2) Indicator: Graphic, dot matrix LCD with LED backlighting, which continuously displays turbidity in the range from 0.01 to 9,999 NTU, with automatic decimal point positioning.
        - a) Display: Turbidity, diagnostics, alarms, etc. user programmable.
      - 3) Diagnostics: Self-test diagnostics to automatically indicate possible instrument malfunction. System warning and system shutdown alarms, each activating an SPDT contact on a system fault.
      - 4) User interface: menu driven program, password protection available.

- b. Enclosure:
    - 1) Type: NEMA 4X.
    - 2) Mounting: Wall.
  - c. Signal Interface:
    - 1) Analog Output:
      - a) Isolated 4 to 20 mA dc signal for load impedance 0 to 500 ohms.
      - b) Programmable to span any portion of the 0 to 9999 NTU range.
    - 2) Contacts: Four electromechanical SPDT (Form C) contact, rated 5A, 250VAC.
      - a) Configurable to operate on Primary turbidity measurement, timer, alarm, feeder control, PWM control, or system alarm.
  - d. Power: 120V ac, 60 Hz.
  - 5. Cable: Vendor supplied, 2 meter length, with plug and play connector.
  - 6. Accessories (for Each Unit Provided):
    - a. Bubble Trap or Internal Bubble Removing Baffles: Required, unless otherwise noted.
    - b. Calibration Kit: One calibration cup and one bottle of 4,000 NTU Formazin standard solution.
    - c. All required mounting and installation hardware.
    - d. Power cord.
    - e. Flowmeter (100 to 1,600 mL/min), unless otherwise noted.
    - f. Standardization plates.
  - 7. Manufacturers:
    - a. Hach.
- C. Turbidity Element and Transmitter (HRC Effluent):
- 1. General:
    - a. Function: Continuously measure, indicate and transmit a signal proportional to turbidity of a sample stream of process fluid.
    - b. Type: Light scatter detection measurement using a 90-degree scatter photocell detector.
    - c. Parts: Element, transmitter, interconnecting cable, mounting hardware and expendables.
  - 2. Performance:
    - a. Range: 0-100 NTU.
    - b. Resolution: .0001 NTU.
    - c. Repeatability: Plus or minus 2.0 percent or plus or minus 0.015 NTU From 0 to 40 NTU.
    - d. Response Time: Initial response time in 1 minute, 15 seconds for a full scale step change.
    - e. Required Flow: 200-750 ml/min.
    - f. Sample Fluid Temperature: 0-50 degrees C.
    - g. Operating Temperature: 0-40 degrees C.

3. Element:
    - a. General: Flow-through body using focused light and a photodetector cell to measure 90-degree scattered light within the fluid.
    - b. Internal bubble trap and vent.
  4. Transmitter:
    - a. Features:
      - 1) Type: Microprocessor based.
      - 2) Indicator: Graphic, dot matrix LCD with LED backlighting, which continuously displays turbidity in the range from 0.01 to 9,999 NTU, with automatic decimal point positioning.
        - a) Display: Turbidity, diagnostics, alarms, etc. user programmable.
      - 3) Diagnostics: Self-test diagnostics to automatically indicate possible instrument malfunction. System warning and system shutdown alarms, each activating an SPDT contact on a system fault.
      - 4) User interface: menu driven program, password protection available.
    - b. Enclosure:
      - 1) Type: NEMA 4X.
      - 2) Mounting: Wall.
    - c. Signal Interface:
      - 1) Analog Output:
        - a) Isolated 4 to 20 mA dc signal for load impedance 0 to 500 ohms.
        - b) Programmable to span any portion of the 0 to 9999 NTU range.
      - 2) Contacts: Four electromechanical SPDT (Form C) contact, rated 5A, 250VAC.
        - a) Configurable to operate on Primary turbidity measurement, timer, alarm, feeder control, PWM control, or system alarm.
    - d. Power: 120V ac, 60 Hz.
  5. Cable: Vendor supplied, 2 meter length, with plug and play connector.
  6. Expendables:
    - a. Lamp Units: One for each unit provided.
    - b. Formazin Calibration Kit: One for each unit provided.
  7. Manufacturers:
    - a. Hach Company.
    - b. HF Scientific.
- D. Sludge Blanket Level Probe, Ultrasonic:
1. General:
    - a. Function: Measure, indicate, and transmit the sludge level.
    - b. Type:
      - 1) Standard of acceptance to be ultrasonic based.
      - 2) Alternate technologies will be considered based upon the recommendations of the high-rate clarification vendor.

2. Performance:
    - a. Range:
      - 1) 0.2 to 12 m (0.6 to 40 ft.)
    - b. Resolution: 0.03 m (0.09 ft.)
    - c. Accuracy: +/- 0.1 m (+/0 0.33 ft.)
    - d. Ambient Temperature Range: 2 to 50 degrees C (35.6 to 122 degrees F).
  3. Element:
    - a. Type: Ultrasonic
    - b. Wiper: Magnetic coupled for cleaning the probe.
    - c. Indicator: visual performance LED indicator.
    - d. Integral temperature sensor for temperature compensation.
    - e. Construction:
      - 1) Wiper: silicon
      - 2) Body: stainless steel
      - 3) Face: polyoxymethylene
  4. Transmitter:
    - a. Features:
      - 1) Type: Microprocessor based.
      - 2) Indicator: Graphic, dot matrix LCD with LED backlighting.
      - 3) Operation: Physical buttons.
      - 4) User interface: menu driven program, password protection available.
    - b. Signal Interface:
      - 1) Analog Output:
        - a) Isolated 4 to 20 mA dc for each connected probe.
      - 2) Contacts: Four electromechanical SPDT (Form C) contact, rated 5A, 250VAC.
        - a) Configurable to operate on level measurement, timer, alarm, feeder control, PWM control, or system alarm.
    - c. Power Supply: 120 VAC 60 Hz / 24 VDC.
    - d. Enclosure: NEMA 4X.
    - e. Mounting: Wall.
    - f. Ambient Temperature Range: -20 to 60 degrees C.
    - g. Ambient Humidity Range: 0 to 95 percent noncondensing.
  5. Cable: 10 meters standard; Length as required to accommodate device location.
  6. Manufacturers:
    - a. Hach.
- E. Flow Element and Transmitter, Electromagnetic:
  1. To be supplied by Others as required. See Clause 1.2.
- F. Level Element and Transmitter, Ultrasonic:
  1. To be supplied by Others as required. See Clause 1.2.
- G. Pressure Differential Transmitter, Electronic:
  1. To be supplied by Others as required. See Clause 1.2.
- H. Pressure Transmitter, Electronic:
  1. To be supplied by Others as required. See Clause 1.2.

- I. Temperature Element and Transmitter, Resistance:
  - 1. To be supplied by Others as required. See Clause 1.2.

### PART 3 EXECUTION

#### 3.1 QUALITY CONTROL

- A. Test and inspect all materials and workmanship in accordance with this specification and all applicable codes and regulations.
- B. Furnish certified test documentation.

END OF SECTION