

SECTION 13421 - FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Parshall flume.
 2. Ultrasonic open channel flow meter.
 3. Insert flow tube.
 4. Orifice plate.
 5. Differential pressure transmitter (DP/I).
 6. Magnetic flow meter.
 7. Ultrasonic flow meter.
 8. Propeller meter.
 9. Doppler flow meter.
 10. Liquid vortex flow meter.
 11. Rotameter.
 12. Air flow switch.
 13. Liquid flow switch.
 14. Laser doppler
 15. Area velocity meter
 16. Insertion flow meter

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01300 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Parshall Flume:
 - a. BIF Plasti-Fab.
 - b. F.B. Leopold Company, Inc.
 - c. Warminster Fiberglass Company.
 2. Ultrasonic Open Channel Flow Meter:
 - a. Siemens
 - b. Endress-Hauser.
 - c. ADS
 - d. Acusonic.
 3. Insert Flow Tube:
 - a. BIF.
 - b. Badger Meter.
 - c. Fluidic Techniques.

- d. Tech. Tube.
- e. Primary Flow Signal.
- 4. Orifice Plate:
 - a. Badger Meter.
 - b. Daniel.
 - c. Fluidic Techniques.
 - d. Meriam Instrument.
 - e. Tech. Tube.
- 5. Differential Pressure Transmitter:
 - a. Endress-Hauser.
 - b. Siemens.
 - c. ABB.
- 6. Magnetic Flow Meter:
 - a. Siemens.
 - b. Endress-Hauser.
- 7. Ultrasonic Flow Meter:
 - a. Rosemount.
 - b. Endress-Hauser.
- 8. Propeller Meter:
 - a. Water Specialties.
 - b. McCrometer, Division of Ametek.
 - c. Sensus Technologies, Inc.
 - d. Sparling.
- 9. Doppler Flow Meter:
 - a. Flexim.
 - b. Badger Meter.
 - c. Polysonics, Inc.
- 10. Liquid Vortex Flow Meter:
 - a. Endress-Hauser.
 - b. Emerson.
 - c. Badger Meter.
- 11. Rotameter:
 - a. Krohne America, Inc.
 - b. Wallace and Tiernan.
- 12. Air Flow Switch:
 - a. Magnetrol.
 - b. Fluid Components, Inc.
 - c. Revere Electronics Division.
- 13. Liquid Flow Switch:
 - a. Fluid Components, Inc.
 - b. Magnetrol.
 - c. Revere Electronics Division.
- 14. Laser Doppler
 - a. Teledyne Isco LaserFlow
- 15. Area Velocity Meter
 - a. Hach
- 16. Insertion Magnetic Flow Meter
 - a. ABB.
 - b. McCrometer.

2.02 PARSHALL FLUMES

- A. Parshall flumes shall be molded of fiberglass-reinforced polyester resin and shall have minimum wall thickness of 0.25 inch, a glass content not less than 30 percent by weight, and reinforcing ribs to prevent distortion during shipment, installation, and operation. Flumes shall be self-supporting and require no external supporting structure. Outside surface shall include flanges and anchoring ribs for permanent anchorage in concrete. Interior dimensions shall conform to those shown in latest revision of U.S. Department of Agriculture Circular 843.
- B. Flume liners shall be marked every 0.05 foot in vertical lines on inside of liner at locations Ha and Hb. Numerals shall be in ascending order from bottom. Marks and numerals shall be molded into liner during fabrication in fluorescent orange or red color. Numerals shall be at 0.1-foot intervals.
- C. Flume shall be grouted in place. Flumes poured in place will distort during the curing process. Flume shall be measured after installation for internal dimensions from bottom to 2 feet above the bottom at 0.4-foot intervals. Measurements shall be made at inlet, outlet, and middle of throat. Flumes whose internal installed dimensions are in error more than plus or minus 2.0 percent, shall be removed and new flume installed at CONTRACTOR's expense.

2.03 ULTRASONIC OPEN CHANNEL FLOW METER

- A. Sonic flow device shall be microprocessor-based and include sensing head, control cabinet, and automatic ambient temperature compensation.
- B. CONTRACTOR, equipment supplier, and manufacturer shall examine Drawings for each installation to determine that equipment supplied will work in each application.
- C. Drawings contain a typical installation detail and show locations of sensors.
- D. Equipment supplier must ensure beam angle of sensor shall not have interference from walls or other objects at each location. Shop Drawings shall be specific about model numbers at each location with detailed sketches showing mounting heights, zero dimensions, span dimensions, and beam angle data for each location.
- E. Any device that will not function reliably to Specifications in its application shall be replaced at CONTRACTOR's expense.
- F. Sonic sensor head shall be intrinsically safe for NEMA 7 areas (explosion-proof). Sensor head shall be epoxy-coated metal, encapsulated or mylar for corrosion resistance. Sensor head shall contain a thermostatically controlled heater for outdoor application for manufacturers that require sensor head heater for operation down to -20 degrees F.
- G. Sonic frequency shall be less than 45 kilohertz. Frequencies above this range will not be accepted.
- H. Control cabinet shall be supplied rated NEMA 4 or as shown on Drawings. Control cabinet shall contain a receiver processor, shall be programmable for style and size of flume, shall have full-hinged front door, control cabinet thermostatic controlled heater for -20 degrees F operation, and local indicator.

- I. Connections to controller and sonic sensor shall be with well-marked terminal blocks. Schematics and wiring diagrams shall be furnished for field wiring and documentation.
- J. Field adjustments shall be made through membrane keypad. Units requiring the use of an oscilloscope will not be accepted.
- K. Operational Data:
 - 1. Temperature: Sensor to operate within specifications over -20 degrees F to 150 degrees F. Controller to operate from 32 degrees F to 120 degrees F without heater and -20 degrees F with a heater.
 - 2. Pulse Rate: 1.5 pps minimum sensing rate.
 - 3. Operating Frequency: Less than 45 kilohertz.
 - 4. Reflection Blocking: Adjustable receiver blanking to operate only on first pulse received.
 - 5. Cable Length: Sensor and controller may be separated up to 300 feet.
 - 6. AGC: Automatic gain control to maximize signal to noise ratio.
 - 7. System Accuracy: Plus 2.5 percent of instantaneous value of flow from 10 percent of full scale to full scale over the complete temperature range.
 - 8. Power Supply: 120 volt AC plus 10 percent at 60 hertz with power consumption of 100 watts maximum exclusive of controller heaters.
 - 9. Output: 4-20 mA output linear with flow into 0-700 ohms. Output shall be isolated-floating to prevent system ground loops when used with other control loops that have an established common at a remote location. Output time constant shall be adjustable through keypad from 1-10 seconds.
- L. Units shall be supplied with integral or local digital flow display and shall display the programmed scale of the device. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.

2.04 INSERT FLOW TUBE

- A. Flow tubes shall be insert-type with short laying length suitable for insertion between 125-pound ANSI flanges. Differential pressure connections will be 0.25-inch NPT female. Insert shall be cast iron or outlet cone shall be constructed of polyester plastic-reinforced fiberglass, and throat shall be of bronze. Flange shall be carbon steel with corrosion-resistant paint coating. Head loss at maximum listed flows in all cases shall be no more than 5 percent of design differential.

2.05 ORIFICE PLATE

- A. Orifice plates shall be of size and shall meet the requirements indicated on Drawings. They shall be constructed of 316 stainless steel designed for mounting in aeration lines between screw-on type ANSI flanges. All orifice plates shall be constructed per ASME standards. Plates shall be complete with handles for easy insertion into and removal from pipeline. Unless otherwise indicated, D and 0.5 D orifice taps shall be used; flange taps shall be used on 8-inch units and smaller.
- B. Flange and orifice plate shall be an integrally supplied unit from a single manufacturer for 8-inch units and smaller. In chlorine applications glass plates shall be used.

2.06 DIFFERENTIAL PRESSURE TRANSMITTER

- A. Differential pressure to current signal converters shall be 2-wire, solid-state electronic, temperature compensated, strain gauge or capacitive type. High and low process pressure shall be applied to sealing diaphragms in measuring section. These pressures shall be transmitted to a measuring element connected to the electronics of the transmitter. Transmitter shall output an isolated 4-20 mA signal proportional to differential pressure measurement. Adjustable electronic damping shall be provided .
- B. Positive overage protection shall be provided Diaphragms and wetted parts shall be 316 stainless steel except where other materials are required to prevent corrosion.
- C. Unit shall be capable of square root extraction calculations.
- D. Accuracy shall be within plus 0.1 percent of calibrated span for spans from 1:1 to 10:1 of URL. Stability shall be plus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.
- E. Signal converter shall be supplied with a pre-piped stainless steel 3-valve manifold and pipe with wall flange for mounting. Two sediment traps shall be provided on water systems. Connectors may be either quick disconnect or threaded as required. Materials of construction shall be appropriate to the material being measured.
- F. Units shall be supplied with integral or local digital flow display and shall display the programmed scale of the device. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.

2.07 MAGNETIC FLOW METER

- A. Magnetic flow meters shall be either flanged or flangeless type as indicated. Meters 4 inches or smaller shall be wafer style. Meters 6-inch or larger shall be of flange design.
- B. Meter body shall be Schedule 10, 304 stainless steel or Schedule 40 steel with 150-pound ANSI flange or AWWA Class D flange when ANSI is not an available option. Meters 4 inches or smaller shall be wafer or flangeless style and shall be designed for installation between 150 Class and 300 Class ANSI, DIN, or BS pipe flanges.
 - 1. Wafer or flangeless style meters 4 inches or smaller shall have a ceramic, Teflon, or Tefzel liner and Hastelloy "C" or platinum electrodes as indicated.
 - 2. Meters 6 to 12 inches shall have Teflon or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
 - 3. Meters 14 inches and larger shall have an Elastomer or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
- C. Liner material shall be suitable for the process flow indicated on Drawings.
 - 1. Meters 4 inches or smaller shall be furnished with a Teflon or Tefzel liner. Exception: Ceramic liner shall be furnished for meters 4 inches or smaller used for lime slurry, sludge, and abrasive process flows.
 - 2. Teflon liner shall be furnished for meters 6 to 12 inches.
 - 3. Polyurethane liner shall be furnished for meters 14 inches and larger, or if not indicated otherwise on Drawings or in the Specifications.

- D. Electrodes shall be suitable for the process flow indicated on the drawings and shall be bullet nosed style made of Hastelloy "C." Exception: Platinum electrodes shall be provided for sodium hydroxide or other caustic process applications.
- E. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer. Service personnel of sales representative or of equipment supplier of this Section will not be accepted.
- F. Meter below grade or larger than 10 inches shall be capable of withstanding continuous submergence in up to 30 feet of water without damage. Meters 10 inches or smaller shall be capable of accidental submergence in 30 feet of water for up to 48 hours. Field coil design shall be such that they shall not overheat or otherwise be damaged if flow tube is not totally filled with fluid.
- G. Magmeters shall be provided with 2 grounding rings and be installed per manufactures best practice guidelines.
- H. The sensing element shall be constructed of suitable materials to withstand submergence to 30 feet to IP 68 rating indefinitely. The tube shall be designed so that it may be buried to a depth of 15 feet where applicable. Provide evidence of ability to be buried. Directions for installation of conduit and wiring connections shall be clearly written and graphically shown for Installer's use.
- I. Magnetic flow meter signal converter shall consist of solid-state, feedback-type microprocessor circuitry. Operational parameters shall be user configurable via HART protocol. Appurtenances, including hand-held programmer and/or programming software, shall be provided for local configuration of operational parameters. Converter shall change a low-level flow signal from sensor electrodes into a proportional isolated 4-20 mA DC signal. The converter shall have an extremely high input impedance and not be affected by quadrature noise. The unit shall be capable of accommodating uni-directional or bi-directional flow. Sensing of meter failure shall activate a user-configurable zero or 130 percent output signal and a failure alarm contact closure.
- J. Where indicated on Drawings, a high-frequency digital proportional output shall be provided for use with high-accuracy totalizers. To eliminate errors, the converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure. An automatic empty pipe detector and low-flow cutoff shall be provided as standard.
- K. Magmeter shall be electronically isolated for grounding. Where insulated or nonconductive pipe is used, only orifice plate-type grounding rings will be acceptable. Grounding electrodes which penetrate the liner will not be acceptable.
- L. Unit shall be supplied with remote flow indicator calibrated in engineering units. Indicator shall be tagged showing design range in units being measured and shall be capable of simultaneously displaying flow rate and totalization with an alphanumeric display. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.
- M. Zero stability shall be achieved by pulsing the sensing head magnetic field coils with a regulated direct current, first in one direction and then in opposite direction.

- N. Continuous zero stability shall be obtained by signal sampling during the quiescent coil states. There shall be no zero offset or zero adjustments required. The converter shall not require calibration over its expected life under normal use.
- O. Flow meter shall operate within Specifications on 24 volt DC.
- P. Meter shall be adjustable from zero to full span of meter and range adjustment shall be digital. Converter shall include adjustable damping circuitry. Unit shall not be affected by power line aberrations such as those produced by SCR-type motor controllers or other voltage transients.
- Q. System accuracy, including primary magnetic flow meter, shall be plus 0.25 percent of rate for maximum flow velocities from 1.33 to 33.33 feet per second, and plus 1 percent of rate for maximum flow velocities from 0.7 to 1.32 feet per second. Repeatability shall be plus 0.1 percent of span. Rangeability shall meet or exceed 30:1 turndown.
- R. The signal converter portion of the magnetic flow meter shall include both a magnetic driver to power the magnetic coils and the signal converter electronics. The converter shall be remotely mounted. It shall be housed in a NEMA 4X case. When remotely mounted, the signal cable shall be provided with the proper length. Factory cables shall not be modified. If factory cables are cut, CONTRACTOR will incur recalibration cost at no additional cost to OWNER.
- S. Magmeter manufacturer shall comply with current ISO Standards and the meter shall be FM approved. Signal converters shall be interchangeable without effect of meter accuracy or the need for recalibration for all meter sizes.
- T. CONTRACTOR shall provide spool-pieces as necessary for meters sized 12 inches and smaller.

2.10 ULTRASONIC FLOW METER

- A. Ultrasonic flow meter shall offer no more obstruction to flow than an equivalent length of pipe. Flow tube end connections shall be 150-pound ANSI flange. Interior of flow tube shall be fused epoxy-coated. Exterior shall also be epoxy-coated. Each flow meter shall be flow laboratory wet calibrated.
- B. Start-up and acceptance check for flow tubes shall be performed by a qualified employee of flow meter manufacturer. Service personnel of sales representative or of equipment supplier of this Section will not be accepted.
- C. Calibration data shall be submitted as Shop Drawings for zero flow, 1-foot per second, full-range flow, and one point between full range and 1-foot per second for each flow tube.
- D. A certificate traceable to NIST shall be provided for the flow laboratory to be used for calibration.
- E. Manufacturer shall guarantee each flow meter will operate as specified for fluid to be measured. Solids content or other data may be obtained from ENGINEER at time of Bidding. Piping configurations for each installation shall be examined by manufacturer at Bid time. Any flow meter not performing to Specifications under conditions set forth by Drawings and ENGINEER shall be removed and replaced at CONTRACTOR's expense. Replacement flow meter will be as directed by ENGINEER.

- F. Flow-sensing transducers shall be mounted integral to flow meter and shall be field replaceable without shutting down process. Transducers mounted on outside of flow meter requiring acoustic energy to penetrate a metal pipe wall will not be accepted. Doppler-type acoustic flow meters will not be accepted. Flow meter shall be capable of steam cleaning up to maximum process temperature limit. Electronic converter package shall be field replaceable and interchangeable with other units without aid of test equipment. Sensor package shall be explosion-proof or intrinsically safe for hazardous explosive areas. General-purpose use shall be NEMA 4.
- G. Unit shall be supplied with an integral or local conduit-mounted flow indicator calibrated to display programmed scale of device. Indicator shall be accurate and readable (markings) to plus 2 percent of full scale. Indicator shall be tagged showing the design range in units being measured.
- H. Digital readouts shall be calibrated in units of flow in accordance with the design drawings and application.
- I. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.
- J. Electrical connections shall be with NPT type conduit connectors.
- K. Electronics shall be microprocessor-based. Only field adjustments required shall be zero and full-scale span. These shall be accomplished without the aid of external test equipment. Span and zero adjustments shall be noninteracting to less than plus 0.5 percent of full adjustment range.
- L. Span adjustment shall be field changeable with internal calibrated switches or dials.
- M. Printed circuits shall be coated for moisture and fungus protection.
- N. Flow meter operation shall not be degraded or interrupted by the build-up of grease or other electrically conductive or nonconductive materials on inside wall of flow meter up to thicknesses of 0.75-inch. External or auxiliary cleaning devices designed to purge or otherwise remove pipe wall coatings cannot be used to meet the intent of Specification.
 - 1. Operational Data:
 - a. Temperature: Sensor and controller transmitter to operate within Specifications over ambient temperature range of -20 degrees F to 130 degrees F. Indoor-mounted units shall operate from plus 15 degrees F to 130 degrees F. Provide thermostatic controlled heaters when required for application.
 - b. Power: 120 volt AC plus 10 percent of 60 hertz plus 10 percent with a power consumption not to exceed 50 watts. Unit shall be unaffected by line transients and both power supply and output circuits shall have lightning spike protection.
 - c. Sample Rate: 100 complete samples per second minimum.
 - d. Noise and Reflection Blocking: Circuitry shall be provided to reject all electrical and mechanical noise and to reject false or reflected samples.
 - e. Loss of Signal: Electronics shall be capable of operating on as few as 2 percent of attempted samples without exceeding accuracy of Specification. Unit shall indicate loss of signal locally and on sustained loss of signal drive output to zero or full scale by switch selection. Output shall remain at zero for empty pipe conditions.
 - f. System Accuracy (Reynolds number above 100,000): Plus 1 percent of instantaneous value of flow from 1-25 fps and plus 0.02 fps from 0.1 to 1.0 fps of flow for installations having 10 diameters upstream of straight pipe, and 5 diameters downstream of straight

pipe minimum. Accuracy of flow calibration facility shall be traceable to National Bureau of Standards. Accuracy shall not be affected by changes in fluid density or viscosity. Air bubbles shall not affect accuracy to a greater extent than fluid volume represented by bubbles.

- g. Vibration: Flow tube and integral transmitter shall be capable of withstanding pipeline vibration of 1.5 G from 5 to 2,000 hertz.
- h. Zero Stability: Plus 0.015 fps over entire operating and ambient temperature range.
- i. Outputs: 4-20 mA linear with flow into 0-600 ohm. Output is to be isolated and floating to prevent ground loops when used with other control loops that have an established common.
- j. A pulsed output shall be available when called for on Drawings.

2.11 PROPELLER METER

- A. Propeller meters shall be either flanged tube or saddle type as shown. Both types shall be provided with straightening vanes directly upstream of meterhead assembly. Meterheads shall be furnished with a conical-shaped bladed plastic propeller with propeller and shaft-mounted on bearings manufactured from corrosion-resistant material. Meterheads shall be connected to tube or saddle by means of a flanged connection faced and drilled to conform to AWWA flange standards. Saddle type meters shall be complete with a welding type saddle suitable for welding to steel or steel cylinder concrete pipe and have a meter drop pipe of required length to ensure propeller will be mounted transversely in center of pipe same diameter as with tube type.
- B. Readout shall be a 6-digit reading totalizer with flow rate dial indicator. Register dial shall be protected by a suitable hinged cover complete with locking hasp. Meter to register within 2 percent of true flow of water at all flows above minimum for that meter.
- C. Meter shall be capable of remote readout for both totalizer and rate indicator when required. Remote readout may be self-powered or operated from 120 volt AC in a NEMA 4 enclosure.
- D. Meter shall be capable of transmitting a 4-20mA signal proportional to flow. When 4-20 mA flow signal is required, unit shall be supplied with a local conduit-mounted flow indicator calibrated 0-100 percent. Indicator shall be accurate and readable (markings) to plus 2 percent of full scale. Indicator shall be tagged showing the design range in units being measured.
- E. At manufacturer's option, transmitter may be integral with meter or wall mounted.

2.12 DOPPLER FLOW METER

- A. Flow meter shall be designed to operate over a 15:1 range with meter accuracy of plus 1 percent full scale or 2 percent of instantaneous rate.
- B. Flow meter shall respond to changes in flow when flow stream is relatively clean (as in secondary effluent) or a sludge (as in primary or return sludge). Manufacturer shall be responsible for assuming meter will function properly on flow stream to be monitored. Manufacturer shall provide a written performance guarantee with Shop Drawing submittal.
- C. Flow sensing element(s) shall be mounted on outside of pipe and shall be capable of being installed and removed without interrupting flow within pipe. Sensor(s) shall respond to and shall accurately

measure flows with velocities from 1 to 40 feet per second. Flow meters utilizing more than 1 flow sensor mounted on pipe shall not require precise alignment of these sensors for proper operation.

- D. Electroacoustic sensors shall consist of 2 piezoelectric crystals cast in an epoxy resin. Sensors shall be designed to operate continuously with pipe temperatures up to 150 degrees C. Sensor shall be clamped to pipe wall with a suitable acoustic coupling agent and shall be suitable for use with pipes 1-inch O.D. and larger. A sensor mounting kit shall be furnished with each sensor. Each sensor shall be furnished with a minimum of 20 feet of interconnecting cable unless otherwise noted.
- E. Transmitter shall be housed in a NEMA 4X enclosure and shall be powered with 24-volts DC. Field connections to transmitter shall be via screw-type terminal blocks. Transmitter shall have an integral flow indicator and shall be capable of transmitting a 4-20 mA isolated signal proportional to flow into a 0-600 ohm load. Integral indicator shall be digital type. Indicator shall be tagged showing design range in units being measured. Digital indicators shall be calibrated in units of flow being measured.
- F. Transmitter electronics shall be all solid-state with all circuit boards coated with an anti-fungus compound. Electronics shall reject external electrical and self-generated noise. Sensitivity shall be field adjustable for specific liquid and background noise conditions. Electronics shall have built-in protection against power line transients and lightning spikes. Transmitter electronics shall be designed to operate at temperatures between -20 and 60 degrees C.
- G. Transmitter shall indicate loss of signal locally and on sustained loss of signal shall drive 4-20 mA output to zero or full scale by switch selection. Transmitter output shall remain at zero for empty pipe conditions.
- H. Transmitter shall include adjustments for range calibration, sensitivity, output zero, and span. Output span adjustment shall allow spans up to 40 feet per second flow velocity. Span adjustment shall be by keypad. Span calibration shall have a resolution to 0.01 foot per second. Flow meter shall be linear to within plus 0.5 percent, repeatable to within plus 0.1 percent, and accurate to plus 2.0 percent of full scale calibrated span.
- I. When noted on Drawings, flow meter shall be portable type furnished with a carrying case for transmitter, sensor, and cable. Portable unit shall be capable of operating from 24 volt DC AND a self-contained rechargeable battery. Portable unit shall meet all of above Specifications. For acceptance testing, portable unit shall be placed in operation on a pipe chosen by ENGINEER and shall function properly and continuously for a duration of not less than 72 hours.

2.13 LIQUID VORTEX FLOW METER

- A. Liquid vortex flow meter shall consist of a cylindrical housing that contains a 2-part Vortex shedding body with no moving parts. It shall be constructed of Type 304 or 316 stainless steel with sensing element having no wetted contact with liquid flow that it measures.
- B. Flow meter shall be suitable for Class 1, Division 1, Group D environments as defined in NEC.
- C. Signal conditioner shall provide a 4-20 mA DC signal and operate from 25 volt DC plus 10 percent or 120 volt AC plus 10 percent as required. Signal conditioner may be mounted on the flow meter body or may be remote located using a furnished manufacturer's cable where required.

- D. Indicator may be local mounted or remote mounted on the wall as shown.
- E. Flow meter shall be designed to operate over a 15:1 range with meter accuracy of plus 1 percent full scale or 2 percent of instantaneous rate.
- F. Flow meter shall operate within a temperature range of -20 degrees F to 150 degrees F.
- G. Flow meter size shall be as indicated on Drawings.
- H. Units shall be supplied with integral or local digital flow display and shall display the programmed scale of the device. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.

2.14 ROTAMETER

- A. Rotameters shall be equal to Fischer and Porter Co. Model 10A2152 with Model 50KF1001 indicators, or Wallace and Tiernan Model 520.205 with Model 521.061 indicators. When designated as transmitting, furnish a Fischer and Porter 50KF1005 or Wallace and Tiernan 521.062 transmitter for 3-15 psi service or a Fischer and Porter 50EL1021 or Wallace and Tiernan 521.065 transmitter for 4-20 mA DC service. Rotameters shall employ an armored, flow-through design. Indicator shall be direct reading. Materials of construction for various chemicals shall be as follows:

<u>Chemical</u>	<u>Materials</u>
Sulfuric Acid (H ₂ SO ₄)	End fittings: Vitreous Enamel Other parts: Hastelloy "B"
Ferrous Sulfate (Fe ₂ SO ₄)	Float: Hastelloy "C" Other parts: 316 stainless steel
Sodium Hydroxide (NaOH) 50%	All parts: Monel
Sulfur Dioxide (SO ₂)	All parts: Hastelloy "C"
Ferric Chloride (FeCl ₃)	All parts: Tantalum
Polymer	All parts: 316 stainless steel
Water (H ₂ O)	All parts: 316 stainless steel
Chlorine Solution	End Fittings: Vitreous enamel Other parts: Tantalum

2.15 AIR FLOW SWITCH

- A. Air flow switch shall be a velocity-actuated switch. Switch will operate in vertical-up air stream or horizontal air stream. Adjustable switch-actuating point at standard temperature and pressure shall be at an air velocity of 200 feet per minute plus 50 feet per minute decreasing velocity and a maximum of 400 feet per minute on increasing velocity. Switch shall be SPDT with contacts rated for 120 volt AC at 1 amp. Wire connections shall be screw terminal type for No. 14 wire. Sensor

head shall be mounted in a 1.25-inch NPT female port with no moving parts, and shall operate on 120 volt AC with a power consumption not to exceed 5 watts.

2.16 LIQUID FLOW SWITCH

- A. Liquid flow switch shall be a velocity-activated switch. Switch will operate in a vertically or horizontally flowing liquid. Sensor shall have no moving parts. Switch activating point shall be at a velocity of 4.5 plus 0.5 feet per minute with field adjustment from 3 to 6 feet per minute Relay contact shall be SPDT, with contacts rated 1 amp at 120 volt AC. Sensor head shall be mounted in a 1.25-inch NPT female port. Liquid flow sensor shall operate in -40 to 150 degrees F ambient air temperature and with sensor operating pressures up to 300 psi. Sensor shall operate on 120 volt AC with power consumption not to exceed 5 watts.

2.17 LASER DOPPLER

- A. Laser doppler shall provide non-contacting velocity and level measurement.
- B. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer or authorized representative of manufacture.
- C. CONTRACTOR, equipment supplier, and manufacturer shall examine Drawings for each installation to determine that equipment supplied will work in each application.
- D. Units shall be supplied with integral or local digital flow display and shall display the programmed scale of the device. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.

2.18 AREA VELOCITY METER

- A. Unit shall include AV9000 analyzer module and area velocity sensor (FL900AV).
- B. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer or authorized representative of manufacture.
- C. CONTRACTOR, equipment supplier, and manufacturer shall examine Drawings for each installation to determine that equipment supplied will work in each application.
- D. Units shall be supplied with integral or local digital flow display and shall display the programmed scale of the device. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.

2.19 INSERTION FLOW METER

- A. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer or authorized representative of manufacture.
- B. CONTRACTOR, equipment supplier, and manufacturer shall examine Drawings for each installation to determine that equipment supplied will work in each application.
- C. Operational Data:
 - 1. Temperature: Sensor to operate within specifications over -20 degrees F to 150 degrees F. Controller to operate from 32 degrees F to 120 degrees F without heater and -20 degrees F with a heater.
 - 2. System Accuracy: Plus 2.0 percent of instantaneous value of flow from 10 percent of full scale to full scale over the complete temperature range.
- D. Output: 4-20 mA output linear with flow into 0-700 ohms.

- E. Units shall be supplied with integral or local digital flow display and shall display the programmed scale of the device. Units shall be HART protocol capable and supplied with HART hand-held configurator (per project). See specification section 16050 2.01.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION