

## SECTION 23 00 00

### MODEL M-5000

#### Electromagnetic Flow Meter, Liquid, Single-Channel

## PART 1 - GENERAL

### 1.1 SCOPE

- A. This section describes the requirements for a flow sensor.
- B. Under this item, the contractor shall furnish and install the flow measurement equipment and accessories as indicated on the plans and as herein specified.

### 1.2 QUALITY ASSURANCE

- A. Referenced Standards and Guidelines - Complies with applicable portions of ANSI/AWWA Standards and NSF/ANSI Standard 61, Annex G. There are currently no AWWA standards that specifically address electromagnetic metering.
  - 1. Flow measurement function complies with Industry Standards
    - a. ANSI B16.5 Class 150 RF
    - b. AWWA Class B
    - c. NEMA 4X/6P (IP66/IP67)

### 1.3 SUBMITTALS

- A. The following information shall be included in the submittal for this section:
  - 1. Outline dimensions, conduit entry locations and weight
  - 2. Customer connection and power wiring diagrams
  - 3. Data sheets and catalog literature for microprocessor-based transmitter and transducer
  - 4. Interconnection drawings

5. Installation and operations manual
6. List of spare parts
7. Complete technical product description including a complete list of options provided
8. Any portions of this specification not met must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification

#### 1.4 SYSTEM DESCRIPTION

- A. Electromagnetic flow meter is intended for fluid metering in industries including water, wastewater, food and beverage, pharmaceutical and chemical. Measures fluid flow of water or fluids which are highly corrosive, very viscous, contain a moderate amount of solids, or require special handling. No moving parts are in the flow stream. Amplifier can be integrally mounted to the detector or can be remote-mounted. Unit is ideally suited for measuring dynamic, non-continuous flow. In applications where a minimum and/or maximum flow rate must be tracked and monitored, the unit provides pulse signals that can be fed to dedicated batch controllers, PLCs and other more specialized instrumentation.

#### 1.5 DEFINITIONS

- A. Amplifier – Device used for increasing the power of a signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with larger amplitude.
- B. ANSI – (American National Standards Institute) A private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States. The organization also coordinates U.S. standards with international standards so that American products can be used worldwide.
- C. AWWA – (American Water Works Association) An international non-profit professional organization founded to improve water quality and supply.
- D. Detector Coils – Also called an “induction loop”, an electromagnetic communication or detection system which uses a moving magnet to induce an electrical current in a nearby wire.

- E. Electrode – An electrical conductor used to make contact with a nonmetallic part of a circuit (e.g. a semiconductor, an electrolyte or a vacuum).
- F. Modbus RTU – a serial communications protocol published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). This is used in serial communication & makes use of a compact, binary representation of the data for protocol communication.
- G. NEMA – (National Electrical Manufacturers Association) Is the 'Association of Electrical Equipment and Medical Imaging Manufacturers' in the United States. Its approximately 450 member companies manufacture products used in the generation, transmission, distribution, control, and end use of electricity. These products are used in utility, industrial, commercial, institutional, and residential applications.
- H. NSF International – An independent, accredited organization that develops standards, and tests and certifies products and systems. They provide auditing, education and risk management solutions for public health and the environment.
- I. PLCs – (Programmable Logic Controller) A digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines.
- J. PTFE – (Polytetrafluoroethylene) A synthetic fluoropolymer of tetrafluoroethylene that finds numerous applications. The best known brand name of PTFE is Teflon by DuPont Co.
- K. Serial Communications – In telecommunication and computer science, serial communication is the process of sending data one bit at a time, sequentially, over a communication channel or computer bus. This is in contrast to parallel communication, where several bits are sent as a whole, on a link with several parallel channels.

## PART 2 – PRODUCTS

### 1.1 APPROVED MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with specifications, provide flow measurement equipment by one of the following:
  - 1. Badger Meter

## 1.2 OPERATING CONDITIONS

### A. System Components

#### 1. Metering Tube (Detector)

- a. Consists of stainless steel tube lined with a non-conductive material. Energized detector coils around tube create a magnetic field across the diameter of the pipe. As a conductive fluid flows through the magnetic field, a voltage is induced across two electrodes; this voltage is proportional to the average flow velocity of the fluid.

#### 2. Signal Amplifier

- a. Consists of unit which receives, amplifies, and processes the detector's analog signal. Signal is converted to both analog and digital signals that are used to display rate of flow and totalization. Processor controls zero-flow stability, analog and frequency outputs, serial communications and a variety of other parameters. Integrated LCD display indicates rate of flow, forward and reverse totalizers and diagnostic messages. Display guides user through programmable routines.

### B. Operational Requirements

#### 1. Electromagnetic Flow Meter

- a. The flow meter system shall operate with a pulsed DC excitation frequency, and shall produce a signal output that is directly proportional and linear with the volumetric flow rate of the liquid flowing through the metering tube. The metering system shall include a metering sensor tube (detector), a signal amplifier, and the necessary connecting wiring. The metering system shall have the ability to incorporate a meter mounted or remote mounted amplifier.
- b. Engineering Units:
  - 1) The signal amplifier shall be program selectable to display the following units of measure: U.S. gallons, imperial gallons, million gallons (U.S.), cubic feet, cubic meters, liters, hector-liters, oil barrels, ounces or acre feet.

- c. Operating Principle: Electromagnetic Induction
- d. Metering Tube (Detector)
  - 1) The metering tube (detector) shall be constructed of 316 stainless steel, and rated for a maximum allowable non-shock pressure and temperature for steel pipe flanges, according to ANSI B16.5.
  - 2) The metering tube (detector) shall be available in line size from 1/2" to 24" [12.7 to 600 mm]
  - 3) The metering tube (detector) end connections shall be carbon steel or 316 stainless steel flanged, according to ANSI B16, Class 150 and AWWA Class B standards.
  - 4) The insulating liner material of the metering tube (detector) shall be made of a hard rubber elastomer and NSF-listed for meter sizes 4" and above, in conformance with manufacturer's recommendation for the intended service or an NSF-listed meter option with PTFE liner.
  - 5) The metering tube (detector) shall include two self-cleaning measuring electrodes. The electrode material shall be corrosion resistant and available in Alloy C or 316 stainless steel.
  - 6) The metering tube (detector) shall include a third "empty pipe detection" electrode located in the upper portion of the inside diameter of the flow tube in order to detect an empty pipe condition when the flow tube is running partially empty. Empty pipe detection that is not activated until the pipe is 50% empty is not acceptable.
  - 7) The metering tube (detector) housing shall be constructed of carbon steel, welded at all joints, and rated to meet NEMA 4X/6P (IP66/IP67) ratings.
  - 8) For remote amplifier applications, the metering tube (detector) junction box enclosure shall be constructed of cast aluminum (powder-coated paint) and shall meet NEMA 4X/6P (IP66/IP67) ratings.

- 9) When installed in non-metallic or internally lined piping, the metering tube (detector) shall be provided with a pair of corrosion resistant grounding rings. The grounding ring material shall be 316 stainless steel.

10) Fluid Temperature Range

NOTE TO SPECIFIER: Select the appropriate Fluid Temperature based on liner material and Amplifier type: 302° F for PTFE, PFA, ETFE with Remote Amplifier, 212° F for PTFE, PFA, ETFE with Meter-Mounted Amplifier, or 178° F for Hard Rubber.

- i. For remote amplifier applications, the fluid temperature range shall be 32°F to 178°F [0°C to 80°C] at a maximum ambient temperature of 122°F [50°C] for the hard rubber liner material.
  - ii. For remote amplifier applications, the fluid temperature range shall be -4°F to 302°F [-20°C to 150°C] at a maximum ambient temperature of 122°F [50°C] for the PTFE liner material.
  - iii. For meter-mounted amplifier applications, the fluid temperature range shall be 32°F to 178°F [0°C to 80°C] at a maximum ambient temperature of 122°F [50°C] for the hard rubber liner material.
  - iv. For meter-mounted amplifier applications, the fluid temperature range shall be -4°F to 212°F [-20°C to 100°C] at a maximum ambient temperature of 122°F [50°C] for the PTFE liner material.
- e. Signal Amplifier
- 1) The signal amplifier shall be microprocessor based, and shall energize the detector coils with a digitally controlled pulsed DC. The sampling rate shall be programmable from 1/4, 1 to 99 seconds.
  - 2) Power shall be supplied by internal battery with life of 10 years.
  - 3) The signal amplifier shall have an ambient temperature rating of -4°F to 140°F [-20°C to 60°C].

- 4) The signal amplifier shall include non-volatile memory capable of storing all programmable data and accumulated totalizer values in the event of a power interruption.
- 5) Automatic zero stability, low flow cut-off, empty pipe detection and bi-directional flow measurement shall be inherent capabilities of the signal amplifier.
- 6) All signal amplifier outputs shall be galvanically isolated to 50 volts.
- 7) The signal amplifier and remote junction enclosures shall be constructed of cast aluminum (powder-coated paint) and shall meet NEMA 4X/6P (IP66/IP67) ratings.
- 8) Inputs/Outputs:

The signal amplifier shall provide a total of four digital outputs and one digital input.

- i. Up to four open collector digital outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, high/low flow alarm, empty pipe alarm, flow direction, and error alarm.
- ii. One digital input: ADE
- iii. Advanced protocol support using Modbus/RTU.

f. Control and Programming

- 1) The signal amplifier shall be programmed via three function buttons. The programming functions shall be available in a user-friendly, menu driven software through the two-line LCD interface. The signal amplifier shall accommodate the following languages: English, German, Czech, French, Italian or Spanish.
- 2) Programmable parameters of the amplifier include, but are not limited to: calibration factors, totalizer resets, unit of measure, pulse output scaling and ADE, flow-alarm functions, language selection, low-flow cutoff, noise dampening factor and sampling frequency selection.
- 3) The signal amplifier shall have a programming option allowing entry of a selected numeric password value for tamper protection.

g. System Performance

- 1) The metering system shall operate over a flow range of 0.10 to 32.8 ft/s [0.03 to 10 m/s].
- 2) The metering system shall perform to an accuracy  $\pm 0.4$  percent of rate  $\pm 0.0065$  ft/s [ $\pm 2$  mm/s].  
The accuracy for zero straight run with a single elbow up and/or a single elbow down stream shall be 1% or better in the flow range 1.2 ft/s (0.35 m/s) and up.
- 3) The metering system shall be capable of measuring the volumetric flow rate of liquids having an electrical conductivity as low as 20 micromhos per centimeter.
- 4) The system measuring repeatability shall be  $< 0.10\%$  of full scale.

h. Indication

- 1) The signal amplifier shall include a two-line, 15-character, LCD interface to display the following values:
  - i. Flow rate in selectable rate units
  - ii. Forward totalizer in selectable volume units
  - iii. Reverse totalizer in selectable volume units
  - iv. Net totalizer in selectable volume units
  - v. Error or alarm messages
  - vi. Software revision level
  - vii. Flow velocity
  - viii. % of full scale flow

## PART 3 - EXECUTION

### 1.1 INSTALLATION

- A. Follow manufacturer's recommendation for installation. Installation will conform to the guidelines provided by the Installation & Operation Manual.
- B. Straight pipe requirement shall be an equivalent of three diameters on the inlet (upstream) side, and two diameters on the outlet (downstream) side.

- C. For best performance, place meter vertically, with liquid flowing upward and meter electrodes in a closed, full pipe.

## 1.2 CALIBRATION

- A. Each meter shall be hydraulically calibrated in an ISO 9000-certified testing facility, which utilizes a computerized gravimetric testing method with a measuring uncertainty of 0.1%.
- B. Each meter shall be provided with a calibration certificate indicating the measured error (percent deviation) at three different flows, respectively equivalent to 25%, 50% and 75% of the nominal flow rate for each size.

## 1.3 MANUFACTURER'S WARRANTY

- A. Terms
  - 1. The manufacturer of the above specified equipment warrants the Product to be free from defects in materials and workmanship appearing within the earlier of either: One (1) year after installation; or one (1) year and six (6) months after shipment from manufacturer.

END OF SECTION