
SECTION 230992 – BUILDING AUTOMATION SYSTEM – ENERGY FLOW METERS

Latest Edition 05-18-2023 See Underlined Text for Latest Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all “Underlines”.)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all the other sections of Division 23.

1.2 SUMMARY

- A. This section includes the requirements for energy meters that measure and record energy and fluid flow from HVAC Hydronic Water Systems, Steam Heating Systems, and Building Domestic Water Services and transmit the data to the BAS using the following meter types:
 - 1. Inline energy and/or flow meters.
 - 2. Insertion energy and/or flow meters.
 - 3. Ultrasonic energy and/or flow meters.
 - 4. HVAC fill and drain meters.
 - 5. Building water service meter.

1.3 ACTION SUBMITTALS

- A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

1.4 INFORMATIONAL SUBMITTAL

- A. Manufacturer’s Installation Instructions: Indicate manufacturer’s installation instructions for manufactured components.
- B. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTAL

- A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.
- B. Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in University’s name and registered with manufacturer.

1.6 ELECTRICAL WIRING (BAS)

- A. Electric wiring, wiring connections and interlock wiring required for the installation of energy flow meters, as herein specified, shall be provided as specified in this section, unless specifically shown on the Electrical drawings or called for in the Electrical specifications. Electrical power requirements, including junction boxes, for all BAS energy meters shall be provided by the electrical contractor as indicated on the electrical drawing and in the electrical specifications. Extension of power wiring from junction boxes to the energy meters shall be provided by the BAS contractor.

1.7 WARRANTY/GUARANTEE

- A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 – PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

- A. Equipment Design and Selection: Meters used to measure energy and flow or flow only shall be designed and selected, for the intended use, in accordance with the requirements of this specification. For the purpose of this specification section meters used to measure energy and flow are identified as “energy meters” and meters used to measure flow only are identified as “flow meters”.
- B. Acceptable Manufacturers: Acceptable manufacturers of energy meters and flow meters shall be as follows:
 - 1. Inline and Insertion Energy Meters and Flow Meters: Subject to compliance with requirements, provide energy flow meters by one (1) of the following:
 - a. Onicon.
 - b. Krone.
 - c. Foxboro.
 - 2. Ultrasonic Energy Meters and Flow Meters: Subject to compliance with requirements, provide energy flow meters and flow meters by one (1) of the following:
 - a. Badger Meters.
 - b. Flexum Meters.
 - c. Onicon Meters.
- C. Meter Units of Measurement: Meters used as either Energy Meters or Flow Meters shall include the units of measurement as follows:

1. Energy Meters - Units of Measurement: The energy meter shall provide the following data both locally and remotely, from each system, via direct Ethernet communications capability as follows:
 - a. HVAC Hydronic System - Hot Water Heating Systems:
 - 1) Total Energy: In Btu.
 - 2) Energy Rate/Demand: Btu/h.
 - 3) Total Volume: In Gallons (Gal)
 - 4) Volume Flow Rate: In Gallons per Minute (GPM)
 - 5) Supply Temperature: In °F.
 - 6) Return Temperature: In °F.
 - 7) All readings must have a minimum accuracy of +/- 0.4%.
 - b. HVAC Hydronic Systems: Include Chilled Water, Process Cooling Water, Condenser Water, And Energy Recovery Systems:
 - 1) Total Energy: In Btu, kWh, and ton-hours.
 - 2) Energy Rate/Demand – Btu/hr, kW, and tons.
 - 3) Total Volume: In Gallons (Gal).
 - 4) Volume Flow Rate: In Gallons per Minute (GPM).
 - 5) Supply Temperature: In °F.
 - 6) Return Temperature: In °F.
 - 7) All readings must have a minimum accuracy of +/- 0.4%.
- < Edit Paragraphs a – b above to meet project requirements >**
2. Flow Only Meters - Units of Measurement: The flow only meters shall provide the following data both locally and remotely, from each system, via direct Ethernet communications capability as follows:
 - a. HVAC Hydronic Systems: Include Hot Water Heating, Chilled Water, Process Cooling Water ,Condenser Water, And Energy Recovery Systems:
 - 1) Total Volume: In Gallons (Gal).
 - 2) Volume Flow Rate: In Gallons per Minute (GPM).
 - 3) All readings must have a minimum accuracy of +/- 0.4%.
 - b. HVAC Drain and Fill Systems:
 - 1) Drain Meters – Condenser Water Drain Systems:
 - a) Volume Flow Rate: In Cubic Feet (CF) and Gallons (GAL).
 - b) All readings must have a minimum accuracy of +/- 0.4.
 - 2) HVAC Fill – Make Up Water Systems:
 - a) Volume Flow Rate: In Gallons per Minute (GPM).
 - b) All readings must have a minimum accuracy of +/- 0.4%.
 - c. Domestic Water System – Building Service:

- 1) Total Volume: In Gallons (Gal), and Hundred Cubic Feet (CCF).
- 2) Volume Flow Rate: Gallons per Minute (GPM); Gallons per hour (GPH)
- 3) All readings must have a minimum accuracy of +/- 0.4%.

D. Meter Data Outputs and Software: Data outputs and software shall be as follows:

1. Data Outputs: Data outputs shall be as follows:
 - a. Native: 4-20ma; 12-bit resolution, internally powered, can span negative to positive flow/energy rates; test function allows simulated flow output to verify proper installation and span settings on receiving equipment.
 - b. Optional Outputs: Modbus TCP/IP or BACnet®/IP protocols. See Summary Charts for meter and protocol applications.
 - c. Output Data Protocol: Output data protocol shall be based on type of meter service as follows:
 - 1) Energy Meter: Modbus TCP protocol
 - 2) Flow Only Meter: BACnet®/IP protocol (HVAC)
 - 3) Domestic Water Building Service Meter: Modbus TCP protocol
2. PC Software Utility: PC software utility shall be included to configure calibrate, backup and conduct diagnostics on the flow meter. The software shall be compatible with Windows 7 and 10 operating systems.
3. Meter Polarity: For energy meters used to measure data for exporting/importing chilled water to/from the chilled water loop the calculation of date shall be based on the following:
 - a. Exporting Water: Positive flow.
 - b. Importing Water: Negative flow.

2.2 HVAC ENERGY METERS – ONICON, KRONE, FOXBORO

- A. General: Provide energy meters (EM) where indicated on the drawings, details, and diagrams. Each EM shall include one (1) BTU energy measurement meter, and one (1) inline or insertion type flow meter (FM). Each EM shall be capable of communicating with the campus energy system using Ethernet applications. Basis of design is Onicon equipment as specified hereinafter.
- B. Energy Meters – Ethernet Applications: Provide an Onicon System 10 BTU Meter complete with two (2) state of the art temperature sensors, two (2) thermo wells and all required installation hardware. All equipment shall be provided by the same manufacturer and include a certificate of calibration for the energy meters. The energy meter shall include the following features:
 1. Information Data: See paragraph 2.1.C for requirements.

2. Operator Interface/Display: Menu driven display and membrane keypad make viewing data easy and simplify field re-programming, when necessary. Alphanumeric LCD displays total energy, total flow, energy rate, flow rate, supply temperature and return temperature. Alpha: sixteen (16) character, 0.2 inches high; Numeric: Six (6) digits, 0.4 inch high.
3. Memory - Non-volatile: EEPROM memory retains all program parameters and totalized values in the event of power loss. Minimum memory size shall be adequate to store all metered quantities above at fifteen (15) minute intervals for at least twenty five (25) hours.
4. Programming: Factory programmed for specific application and field programmable via front panel interface.
5. Accuracy: Differential temperature accuracy $\pm 0.15^{\circ}\text{F}$ over calibrated range computing nonlinearity within $\pm 0.05\%$. Flow Meter accuracy to within $\pm 0.5\%$ of rate at the calibrated typical flow rate and within $\pm 2\%$ of rate over an extended 50:1 turndown range (0.4 - 20 feet/second).
6. Control Power: Coordinate with the electrical contractor to provide 120VAC, 20amp electrical branch circuit to Btu meter via #12 awg stranded copper and three quarter (3/4) inch EMT conduit with compression fittings. Btu meter shall include internal 120VAC, minimum 200mA power supply with optional 24 VDC at 200 mA to electronics and flow meter. Provide all necessary field wiring for flow meter and other ancillary electronics to be sub-fed from Btu meter power supply.
7. Enclosure: Provide manufacturer's optional NEMA 4 enclosure to protect internal circuit boards from exposure to dirt, oil and dripping water.
8. Temperature Meters: Solid state meters are custom calibrated using N.I.S.T. traceable temperature standards. Current based signal (mA) is unaffected by wire length. Custom calibrated and matched to accuracy better than $\pm 0.15^{\circ}\text{F}$ from 32°F to 200°F .
9. Temperature Ranges:
 - a. Liquid Temperature Range: 32°F to 200°F .
 - b. Ambient Temperature Range: 40°F to 120°F .
10. Temperature Thermo Wells: For piping up through four (4) inch provide one half (1/2) inch NPT brass thermo wells. For steel piping and/or fiberglass reinforced (FR) piping, six (6) inch and larger provide one half (1/2) inch NPT stainless steel thermo wells.
11. Communications/Remote Interfacing: Provide all necessary components for connecting the Energy Measurement System directly to the existing Ethernet network and for remote interrogation of the above metered quantities via MODBUS TCP/IP protocol. The system will be assigned a network IP address and will be remotely interrogated by the local building automation system as well as other systems in the future. The system must be ready for remote interrogation by multiple, separate remote systems via MODBUS TCP/IP.
12. Commissioning: Coordinate with the Flow Meter manufacturer's sales representative and confirm meter installation is satisfactory and coordinate with

the building automation vendor for performing meter startup, programming and integration with the BAS.

2.3 HVAC FLOW METERS – INLINE & INSERTION TYPE METERS

- A. General: Provide flow only meters (FM) where indicated on the drawings, details, and diagrams. Each FM shall be capable of communicating with the campus energy system and the building automation system (BAS) using Ethernet applications through MODBUS TCP/IP protocol and/or a Siemens P1 FNL protocol. Basis of design is Onicon equipment as specified hereinafter. <Coordinate with UMB and Edit>
- B. HVAC Hydronic System Flow Measurement Meters: Flow Measurement Meters shall be as indicated below: < Coordinate and edit meter types with UMB >
1. Inline Electromagnetic Flow Meter: Provide an Onicon FT-3100 Series Inline Electromagnetic Flow Meter complete with backlit graphic display. All equipment be provided by the same manufacturer and include a certificate of calibration for the energy system. The flow meter shall include the following features:
 - a. Information Data: See paragraph 2.1.C for requirements.
 - b. Connection Type: Provide ANSI Class 150 Flanges. Wafers are not approved. Provide all necessary mating flanges and any required reducer/expanders.
 - c. Flow Tube: The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PTFE for hot water service (302°F maximum).
 - d. Programming: Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter (no special interface device or computer required).
 - e. Transducer/Meter Control Power: Control power shall be 24VDC from the BTU Meter.
 - f. Commissioning: Coordinate with the flow meter manufacturer's sales representative and confirm meter installation is satisfactory and coordinate with the building automation vendor for performing meter startup, programming and integration with the BAS.
 2. Insertion Electromagnetic Flow Measurement Meter: Provide an Onicon F-3500 Series Insertion Electromagnetic Flow Meter complete with all installation hardware. All equipment be provided by the same manufacturer and include a certificate of calibration for the flow meter. The flow meter shall include the following features:
 - a. Information Data: See paragraph 2.1.C for requirements.
 - b. Material:

- 1) Wetted Material: Stainless steel, type 316.
 - 2) Sensor Head: Polypropylene
 - c. Accuracy: Accurate to within +/-1.0% of reading from two (2) to twenty (20) feet/second (ft/sec) and +/-0,02ft/sec below two (2) ft/sec.
 - d. Flow Type: Flow type shall be single direction.
 - e. Temperature Range:
 - 1) Liquid: 15°F to 250°F.
 - 2) Ambient: -5°F to 150°F.
 - f. Output Signals:
 - 1) Analog: Selectable 4-20 mA, 0-10V or 0-5V.
 - 2) Frequency: 0-15 volt peak pulse, 0-500Hz.
 - 3) Scalable Pulse: 0.5, 1, 2, or 6 second duration.
 - g. Electrical Connection: Ten (10) feet of PVC jacketed cable with one half (1/2) NPT conduit connection.
 - h. Connection Type: Provide a standard installation kit for steel pipe and or FR pipe, including a one (1) inch full port ball valve, close nipple, and branch outlet.
3. Insertion Turbine Flow Measurement Meter: Provide an Onicon F-1100 Series, single direction, Insertion Turbine Flow Meter and/or Onicon F-1200 Series, Bidirectional Insertion Turbine Flow Meter complete with all installation hardware. All equipment be provided by the same manufacturer and include a certificate of calibration for the energy system. The flow meter shall include the following features:
- a. Information Data: See paragraph 2.1.C for requirements.
 - b. Material:
 - 1) Wetted Material: Stainless steel, type 316.
 - 2) Sensor Head: Polypropylene
 - c. Accuracy: Accurate to within +/-1.0% of reading from two (2) to twenty (20) feet/second (ft/sec) and +/-0,02ft/sec below two (2) ft/sec.
 - d. Flow Type: Flow type shall be single direction and/or bidirectional.
 - e. Temperature Range:
 - 1) Liquid: 15°F to 250°F.
 - 2) Ambient: -5°F to 150°F.

- f. Output Signals:
 - 1) Analog: Selectable 4-20 mA, 0-10V or 0-5V.
 - 2) Frequency: 0-15 volt peak pulse, 0-500Hz.
 - 3) Scalable Pulse: 0.5, 1, 2, or 6 second duration.
- g. Electrical Connection: Ten (10) feet of PVC jacketed cable with one half (1/2) NPT conduit connection.
- h. Connection Type: Provide a standard installation kit for steel pipe and or FR pipe, including a one (1) inch full port ball valve, close nipple, and branch outlet.

C. HVAC Drain and Fill Meters:

- 1. General: Provide drain meters for Condenser Water and Water Treatment Systems and fill meters for HVAC Make Up Water Systems where indicated on the drawings, details and diagrams. Flow meters shall be Onicon Series FT-3100 In-Line Electromagnetic Meters with a remote D – 100 Totalizing Display Module.
- 2. Flow Meter: See paragraph 2.3.B for meter requirements.
- 3. Display Module: See paragraph 2.2.C for meter requirements.
- 4. Baltimore City Approval: The above referenced water meter has been approved by The Baltimore City Department of Water Management for data reporting by UMB to Baltimore City.

2.4 BUILDING SERVICE – DOMESTIC WATER FLOW METERS

- A. General: Provide a flow meter (FM) for the building water service where indicated on the drawings, details, diagrams. Flow meters shall be Onicon Series [FT-3100] [F-3500] [F-1100] flow meter with a remote D – 100 Totalizing Display Module.
- B. Flow Meter: See paragraph 2.3.B for meter requirements.
- C. Display Module: See paragraph 2.2.C for meter requirements.

2.5 BAS ONICON ENERGY AND FLOW METER SUMMARY CHART

- A. See flow meter summary chart on the next page.

BAS ONICON ENERGY & FLOW MEASUREMENT METERS SUMMARY CHART					
Building System	Meter Type	Function	LAN	Flow Meter	Components
HVAC Hydronic	In Line	Energy & Flow	Ethernet Modbus TCP	FT – 3100 Electro Mag Meter	System 10 BTU Meter
HVAC Hydronic	Insertion	Energy & Flow	Ethernet Modbus TCP	F – 3500 Electro Mag Meter	System 10 BTU Meter
HVAC Hydronic	Insertion	Flow Only	Ethernet Bacnet IP	F – 3500 Electro Mag Meter	Remote Model D-100 Display Module
HVAC Hydronic	Insertion	Flow Only	Ethernet Bacnet IP	F – 1100 Turbine Meter - Single Direction	Remote Model D-100 Display Module
HVAC Hydronic	Insertion	Flow Only	Ethernet Bacnet IP	F – 1200 Turbine Meter - By Direction	Remote Model D-100 Display Module
HVAC Make Up Water	In Line	Flow Only	Ethernet Bacnet IP	FT – 3100 Electro Mag Meter	Remote Model D-100 Display Module
HVAC Drain and Fill	In Line	Flow Only	Ethernet Bacnet IP	FT – 3100 Electro Mag Meter	Remote Model D-100 Display Module
Building Water Service	In Line	Flow Only	<u>Ethernet Modbus TCP</u>	FT – 3100 Electro Mag Meter	Remote Model D-100 Display Module

2.6 BADGER, FLEXUM AND ONICON ULTRASONIC ENERGY AND FLOW METERS – HYDRONIC WATER SYSTEMS

- A. Meter Type: Provide an ultrasonic energy flow meter and accessories where indicated on the drawings and diagram. Energy flow meters shall be clamp on type flow and energy meter for liquids Dynasonics Model TFX Ultra as manufactured by Badger Meters Inc. or Flexum 7407 or 502TE energy meters or approved equal.
- B. Meter Units of Measurement: Meters See paragraph 2.1.C for requirements.
- C. Components: Components shall include the following:
 - 1. Transmitters and Transducers: Unit shall be comprised of two (2) transducers for the transmission and reception of ultrasonic signals, a digital signal processor module to integrate raw measurement data and compute volumetric flow and/or energy rate and total, and an LCD display. Data can be output to a SCADA

- system, PLC or BAS (building automation system) using various analog, digital, serial, and/or IP outputs.
2. Temperature Sensors: Sensors used to measure temperature by correlating the resistance of the RTD element with temperature. Set consists of one to measure liquid in the inlet pipe, and one to measure the liquid in the outlet pipe.
 3. Mounting Hardware: Stainless steel mounting straps and two types of acoustic coupling medium for proper mounting of the transducers in either short term or long term applications.
 4. PC Software Utility: PC software utility shall be included to configure calibrate, backup and conduct diagnostics on the flow meter. The software shall be compatible with Windows 7 and 10 operating systems.
 5. Warranty/Guarantee: See Division 23, Specification Section “HVAC General Requirements.”
 6. Calibration: Flow meter calibration data shall be performed by the factory prior to use. Calibrate to NIST standards to ensure between $\pm 1\%$ accuracy of reading for transit time.

2.7 ULTRASONIC ENERGY AND FLOW METER SUMMARY CHART

- B. See flow meter summary chart on the next page.

ULTRASONIC ENERGY & FLOW MEASUREMENT METERS SUMMARY CHART					
Building System	Meter Type	Function	LAN	Flow Meter	Components
HVAC Hydronic and Make up Water Meters	Strap On	Flow	Ethernet BACNET/IP	Flexum – 7407 or 502TE Dynasonics Model TFX	Flow Sensors Transmitter
<u>HVAC Make up Water Meters, Drain and Fill Meters</u>	Strap On	Flow	Ethernet BACNET/IP	Flexum – 7407 or 502TE Dynasonics Model TFX	Flow Sensors Transmitter
HVAC Hydronic	Strap On	Energy & Flow	Ethernet Modbus TCP	Flexum – 7407 or 502TE Dynasonics Model TFX	Flow Sensors Transmitter Temperature Sensors
<u>Building Water Service Meters</u>	<u>Strap On</u>	<u>Flow</u>	<u>Ethernet Modbus TCP</u>	<u>Flexum – 7407 or 502TE</u> <u>Dynasonics Model TFX</u>	<u>Flow Sensors</u> <u>Transmitter</u>

PART 3 – EXECUTION

3.1 GENERAL

- A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of meters and gauges in the HVAC piping systems. So far as practical, install meters as indicated.
- B. Accessibility: All meters shall be installed in accessible locations for maintenance.

- C. Provide unions and isolation valves for each water meter. See Division 23 Specification Section “Valves for HVAC Piping Systems” for required valves.
- D. Mechanical Requirements: See details on the mechanical and/or plumbing drawings for installation requirements.
- E. Electrical Requirements: See Electrical drawings for power requirements.

3.2 INSTALLATION – HVAC ENERGY METERS AND FLOW METERS

- A. Energy Measurement Meter: Installation includes the meter and two (2) temperature sensors. Install the meter in the location indicated on the drawings and/or where directed by UMB. The meter and temperature sensor locations must provide access to the devices for service.
- B. Pipe System Installation: Energy and flow meters supplied by the BAS contractor shall be installed in the piping systems by the mechanical contractor. See Division 23, Specification Section “Meters and Gauges for HVAC Piping” for installation requirements.
- C. BAS Interface Wiring: All BAS interface wiring to the BAS and power wiring from a local junction box shall be provided and installed by the control contractor.
- D. Power Wiring: Power wiring from the electric panel to the local junction box shall be provided by the electrical contractor. All power wiring from a local junction box to the meter shall be provided and installed by the control contractor.

3.3 INSTALLATION – ULTRASONIC ENERGY AND FLOW METERS

- A. Ultrasonic Energy Meter: Install the ultrasonic meter display unit in an accessible location sixty (60) AFF on the nearest wall. Additional installation requirements are as follows:
 - 1. Badger Meter Transducers: Install the remote transducers and temperature sensors on the existing HVAC System piping in a location will promote a clear reading, and provides the minimum straight runs of pipe on both upstream and downstream piping sections of the transducers and temperature sensors. Where the transducers are located on the chilled water piping remove a section of pipe insulation and install the transducers per the manufacturers installation instructions. After the transducers have been secured in place caulk all around the outer edge each transducer body with a non cracking DOW 732 Silicone Sealant. When the sealant has cured insulate the piping up to and between the transducers. Connect the transducer leads to the remote meter.
 - 2. Flexum Meter Transducers: Install the remote transducers and temperature sensors on the existing HVAC System piping in a location will promote a clear

reading, and provides the minimum straight runs of pipe on both upstream and downstream piping sections of the transducers and temperature sensors. Where the transducers are located on the chilled water piping remove a section of pipe insulation and install the transducers per the manufacturers installation instructions. Connect the transducer leads to the remote meter.

3. Temperature Sensors: Mount the temperature sensors onto the supply and return pipes according to the direction provided in the instruction manual. Where the temperature sensors are located on the chilled water piping remove a section of pipe insulation and install the sensors around the pipe per the manufacturers installation instructions. Cover each sensor with insulation and extend the sensor lead through the insulation. Place a bead of caulk around the lead where it passes through the insulation jacket. Connect the sensor leads to the remote meter.
4. Provide supports for the wire leads between the meter and the transducers and sensors.

- B. Installation does not require system shut down and/or cutting into any piping.
- C. Follow manufacturer's recommendation upstream and downstream straight pipe diameters and transducer orientation to achieve optimum performance.
- D. Enter pipe and liquid configuration information into the flow meter. The flow meter will calculate transducer separation from the data entered.

3.4 INSTALLATION – HVAC SYSTEMS – DRAIN AND FILL WATER METERS

- A. Pipe System Installation: Drain and fill meters supplied by the BAS contractor shall be installed in the piping systems by the mechanical contractor. See Division 23, Specification Section “Meters and Gauges for HVAC Piping” for installation requirements.
- B. BAS Interface Wiring: All BAS interface wiring to the BAS and power wiring from a local junction box shall be provided and installed by the control contractor.
- C. Power Wiring: Power wiring from the electric panel to the local junction box shall be provided by the electrical contractor. All power wiring from a local junction box to the meter shall be provided and installed by the control contractor.

3.5 ELECTRICAL WIRING (BAS)

- A. Furnish labor and material to install the necessary wiring to accomplish the successful and complete operation of the new automation system (DDC).
- B. Furnish labor and material to install necessary relays, general purpose enclosures and appurtenances to control designated devices relative to the BAS.

- C. Wiring throughout shall be concealed where possible.
- D. Conduit used shall be EMT, three quarter (3/4) inch minimum size. Conduit sizes shall be large enough to permit the individual conductors to be readily installed or withdrawn without damage to the conductors or their insulation. Splicing of wires will be permitted only in junction boxes or pull boxes.

END OF SECTION 230992