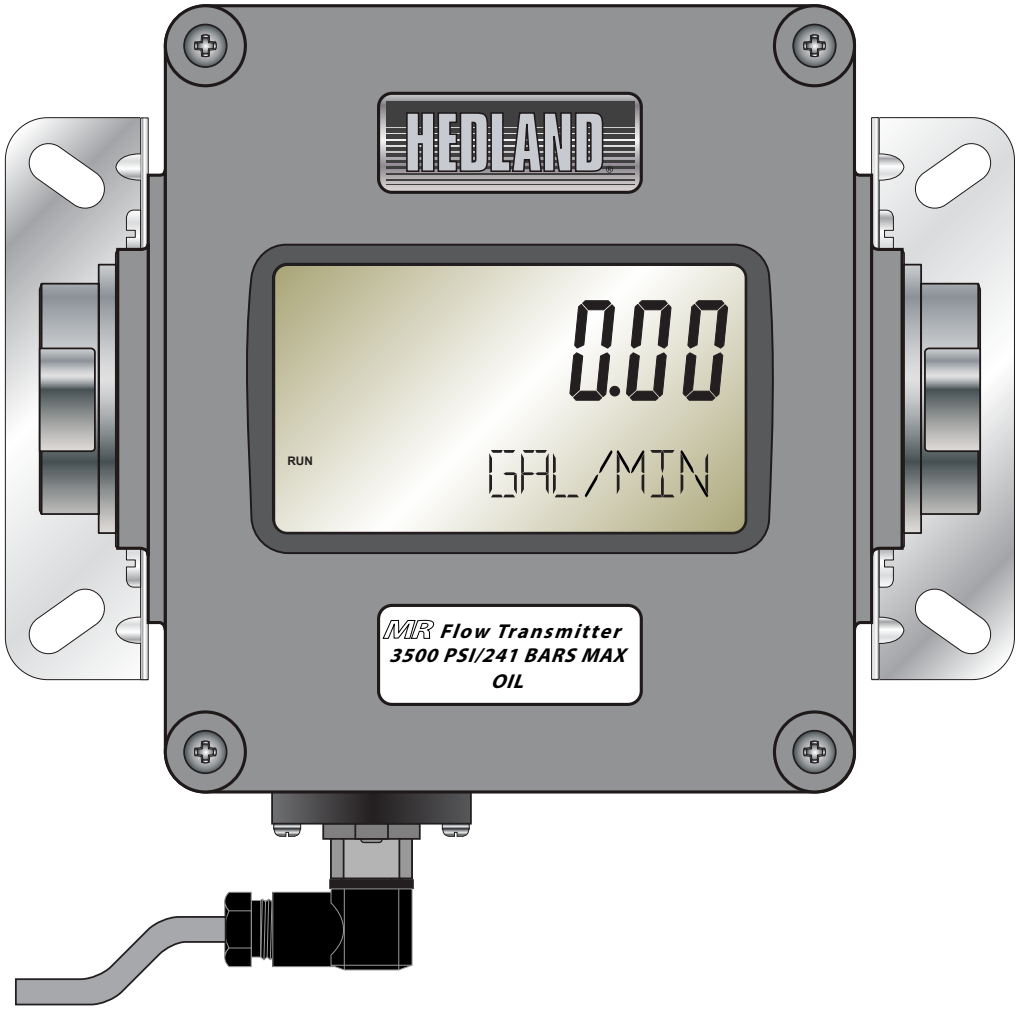
HEDLAND®

MR Flow Transmitter



Badger Meter

XMT-UM-00498-EN-02 (November 2013)

User Manual

CONTENTS

INTRODUCTION

The MR flow transmitter is a state-of-the-art, microprocessor based variable area flow meter. It combines the rugged proven technology of a piston-type, variable area flow meter with solid state circuitry including:

- Non-contact sensor electronics
- Electronic signal conditioning circuit
- Digital flow rate and total indication
- Proportional analog output

The product is sealed against industrial contamination by a NEMA 12 and 13 (IP 52/54) rated enclosure and is available for either liquid or gas service.

The MR flow transmitter is capable of calculating and displaying both flow rate and total accumulated flow. The flow rate and total flow can be displayed in any of the user selectable measurement units. The monitor's large 8 digit numeric liquid crystal display makes extended range viewing practical. The second 8 character alphanumeric display provides for selectable units viewing in *RUN* mode and prompts for variables in *PROGRAM* mode.

All MR flow transmitters come pre-calibrated from the factory. However, the unit may be adjusted by the user to meet specific system requirements. Calibration parameters are included for:

- Specific gravity compensation (all fluids)
- Viscosity compensation (petroleum-based fluids)
- Pressure and temperature compensation (pneumatic applications)

All meters include an analog output that can be configured for 0…5V DC, 0…10V DC, or 4…20 mA current loop. Applications for the MR flow transmitter include:

- Bearing lubrication
- Case drain verification
- Gun drill and machine cooling
- Pump flow outputs

SAFETY INFORMATION

The installation of this flow meter must comply with all applicable federal, state, and local rules, regulations, and codes.

Failure to read and follow these instructions can lead to misapplication or misuse of this product, resulting in personal injury and damage to equipment.

UNPACKING AND INSPECTION

Upon opening the shipping container, visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts, or any other sign of damage that may have occurred during shipment.

NOTE: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carries. A claim for equipment damage in transit is the sole responsibility of the purchaser.

INSTALLATION

⚠CAUTION

THIS PRODUCT SHOULD BE INSTALLED AND SERVICED BY TECHNICALLY QUALIFIED PERSONNEL TRAINED IN MAINTAINING INDUSTRIAL CLASS FLOW INSTRUMENTATION AND PROCESSING EQUIPMENT.

⚠CAUTION

READ INSTRUCTIONS THOROUGHLY BEFORE INSTALLING THE UNIT. IF YOU HAVE ANY QUESTIONS REGARDING PRODUCT INSTALLATION OR MAINTENANCE, CALL YOUR LOCAL SUPPLIER FOR MORE INFORMATION.

⚠WARNING

DISCONNECT ELECTRICAL POWER BEFORE OPENING WIRING ENCLOSURE. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH AND/OR DAMAGE TO THE EQUIPMENT.

⚠WARNING

ALL WIRING SHOULD BE INSTALLED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE® AND MUST CONFORM TO ANY APPLICABLE STATE AND LOCAL CODES. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH AND/OR DAMAGE TO THE EQUIPMENT.

⚠CAUTION

AIR/GAS METERS ARE NOT OXYGEN CLEANED. USE WITH OXYGEN MAY CAUSE HAZARDOUS OR EXPLOSIVE CONDITIONS THAT MAY CAUSE SERIOUS PERSONAL INJURY AND/OR DAMAGE TO THE EQUIPMENT.

⚠CAUTION

THIS METER MAY CONTAIN RESIDUAL AMOUNTS OF TEST FLUID AT THE TIME OF SHIPMENT. THIS FLUID SHOULD BE REMOVED PRIOR TO INSTALLATION AS THE FLUID MAY BE INCOMPATIBLE OR HAZARDOUS WITH SOME LIQUIDS OR GASES. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE EQUIPMENT.

⚠CAUTION

THIS STANDARD METER IS UNIDIRECTIONAL. ATTEMPTS TO FLOW FLUIDS IN THE OPPOSITE DIRECTION OF THE FLOW ARROW WILL RESULT IN THE METER ACTING AS A CHECK VALVE, CREATING A DEADHEADING SITUATION. IF THE DIFFERENTIAL PRESSURE MAGNITUDE IS GREAT ENOUGH, DAMAGE TO THE INTERNAL PARTS OF THE METER WILL RESULT.

Installation Recommendations

The transmitter is a simple device to install. However, the following measures are recommended for reliable, trouble-free operation:

- Align pipe accurately. Piping should be accurately aligned and of correct length. The high pressure body of the transmitter can withstand shock and flow/pressure pulsation. However, the piping should be firmly supported by external mounting brackets, both upstream and downstream of the meter, to avoid any pipe flexing actions that could reduce meter life.
- Use rigid mounting. If the transmitter inlet or outlet are to be rigidly mounted, and the opposing port is to be connected to flexible hose, the end connected with the flexible hose must be rigidly mounted.
- Use Teflon® tape for sealing NPT fitting.
- Install unions. Install a union near the inlet or outlet of the transmitter. This will facilitate quick, easy meter removal and inspection during periodic maintenance procedures.
- Ensure the fluid is traveling in the direction of the flow arrow. See *Figure 4*.

NOTE: The MR flow transmitter display board can be rotated 180° for optimal viewing. Simply remove the MR flow transmitter cover, disconnect the ribbon cable, rotate the display board 180°, reconnect the ribbon cable, and reinstall cover. See Figure 10 for cover screw tightening sequence.

- Use at least a 200 mesh (74 micron) filter. The transmitter will allow particulate to pass that would jam most valves and flow controls. Systems that do not have filtration should be equipped with at least a 200 mesh (74 micron) filter. Most hydraulic systems already have much finer filtration. Dirt, ferrous metal or sealing agents, such as Teflon® tape may lodge and cause malfunction. If the meter is jammed at a fixed position, follow cleaning and maintenance instructions.
- **Do not** use thread locking compounds as thread sealant.
- **Do not** install the transmitter near turbulence producing fittings such as elbows, reducers, or close coupled valves. The transmitter does not require flow straighteners or special lengths of straight inlet/outlet piping to stabilize turbulent flow patterns. However, to assure maximum operational reliability, avoid installation of elbows, valves and/or reducers immediately adjacent to the meter inlet.
- **Do not** install the transmitter near fast-acting valves. Fast-acting valves have the potential to create high magnitude hydraulic pressure spikes. These spikes can damage the internal components of the meter, resulting in inaccuracies or malfunction.
- **Do not** allow unidirectional transmitters to be operated against the direction of the flow arrow. The standard transmitter is a unidirectional flow meter. The piston acts as a check valve to block flow in the reverse direction. This causes an excessive pressure differential, which can result in damage to internal meter components. The transmitter is also available in a modified design, which offers a reverse flow bypass feature to accommodate bidirectional flow.

NOTE: Transmitters with a reverse flow bypass feature are available. Consult factory for details.

Electrical Connections

Cable may be shortened or lengthened as required for proper installation. The cable is soldered directly to the electrical connector at the factory.

Cable replacement requires disassembly of the electrical connector.

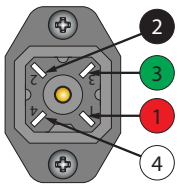


Figure 1: 4-pin cable connection

DC Output Connection	Loop Power Connection
No Connection	(-) 4…20 mA Out
0V DC	No Connection
(+) DC Power	(+) 4…20 mA In
0…5 or 0…10V DC Output	No Connection

⚠CAUTION

THE FLOW TRANSMITTER IS DESIGNED TO OPERATE ONLY ONE OF ITS THREE OUTPUTS AT A TIME (0…5V DC OR 0…10V DC OR 4…20 MA). CONNECTING MULTIPLE OUTPUTS SIMULTANEOUSLY WILL RESULT IN INACCURATE OUTPUT SIGNAL LEVELS.

Schematics

The transmitter can be wired in various configurations to allow interface with many different types of data collection and control instrumentation.

Schematics 1 & 2 (*Figure 3*) represent typical wiring for a target powered by either AC power or DC supply.

Schematics 3 & 4 (*Figure 3*) will be used when the flow transmitter is operated with loop-powered process indicators or data loggers that do not have external sensor excitation available.

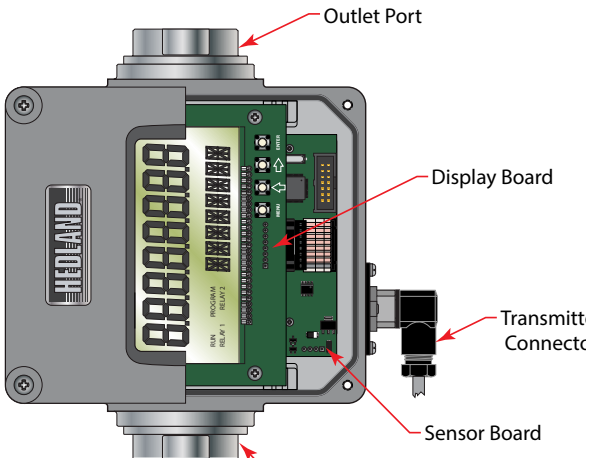
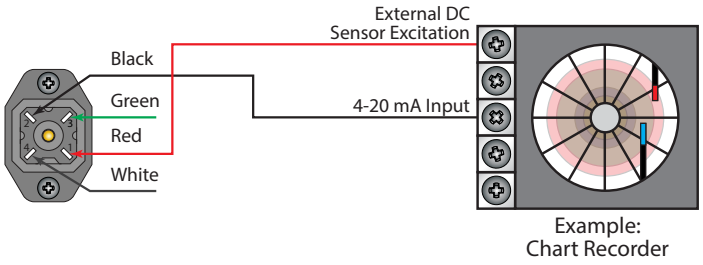
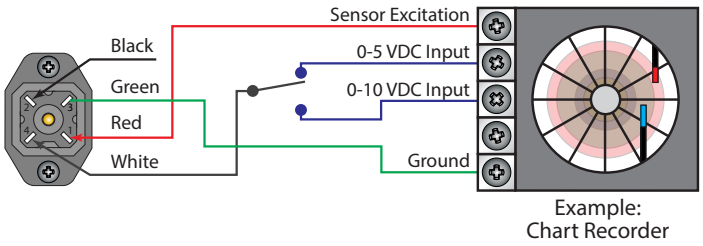


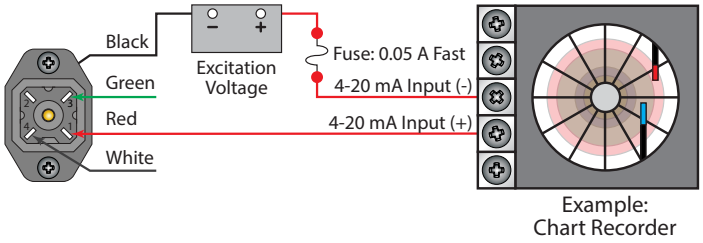
Figure 2: Terminology



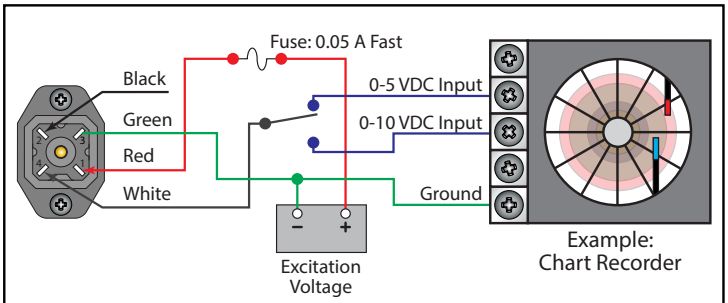
Schematic 1: 4…20 mA connection using targets power supply.



Schematic 2: 0…5 Vdc or 0…10 Vdc connection using targets power supply.



Schematic 3: 4…20 mA connection using targets external power supply.



Schematic 4: 0…5 Vdc or 0…10 Vdc connection using targets external power supply.

Figure 3: Wiring diagrams

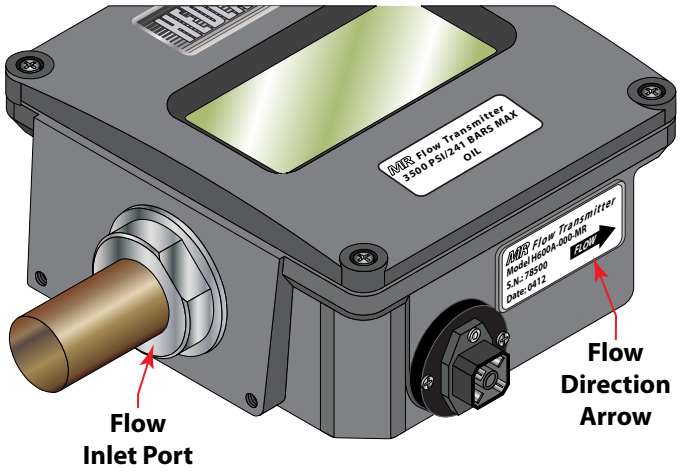
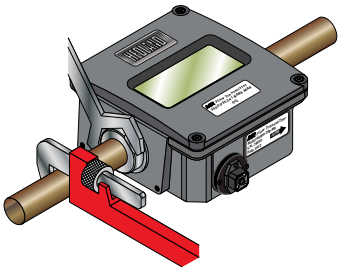


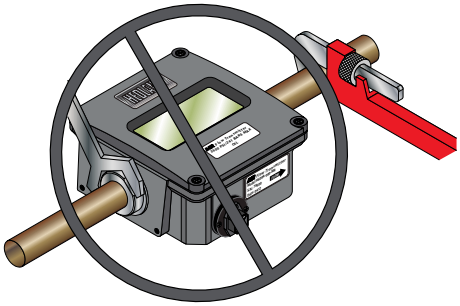
Figure 4: Flow direction arrow

Installing the Transmitter

1. Disconnect the electrical power from the target system before making or changing any transmitter connections.
2. Use 0.05 A fast-acting fuse if non-current limited power sources are used.
3. Terminate cable shield connection at either DC ground or earth ground.
4. Mount the transmitter so fluid is traveling in the direction of the flow arrow. See *Figure 4*.
5. Install unit in desired location. Use wrench on transmitter flats to hold the unit in place during installation. DO NOT TURN the transmitter using the wrench. See *Figure 5*.
6. After installation, rotate the transmitter by hand to view the display. See *Figure 6*.
7. Capture the zero flow position on the meter cone using the ZERO CAPTURE procedure.

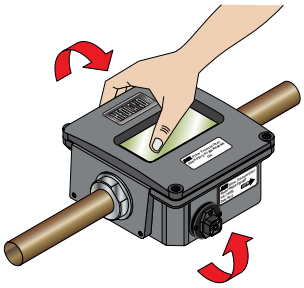


Place wrench on transmitter flats *on the same side* plumbing is being tightened

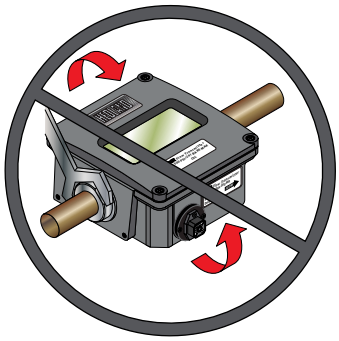


***Never* place wrench on transmitter flats opposite plumbing being tightened**

Figure 5: Installing the meter



Place wrench on transmitter flats *on the same side* plumbing is being tightened



***Never* place wrench on transmitter flats opposite plumbing being tightened**

Figure 6: Rotating meter

OPERATION

Operating the Meter

The monitor has two modes of operation, referred to as *RUN* mode and *PROGRAM* mode as indicated on the display screen readout. Normal operation will be in the run mode. To access the program mode, press **MENU** until the first programming screen *DISPLAY* appears.

NOTE: *PROGRAM* appears on left side of display.

After programming the meter, a password may be entered to prevent unauthorized access to programming.

Normal Operation (RUN) Mode

During normal operation, the transmitter will show *RUN* on the left side of the display. In *RUN* mode the flow rate and total flow will alternate being shown as the default. The meter can also be set to show only flow rate or only flow total.

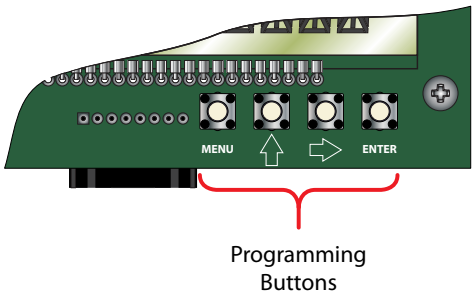


Figure 7: Programming buttons

The four buttons have the following function in RUN mode:

MENU	Selects programming mode.
⇧	No function.
⇨	No function.
ENTER	The current total can be manually stored in the monitor's flash memory. Press and hold **ENTER** for 2 seconds. The display will respond with a flashing *TOTALSVD* and then will return to *RUN* mode.
RESET TOTAL	To reset the monitor's total display, press **MENU** and **ENTER** simultaneously until *TOTALRST* starts to flash. The *TOTALRST* will stop flashing and the display will return to *RUN* mode at the conclusion of the rest procedure.

Programming Operation (PROGRAM) Mode

The programming mode lets you change the configuration and adjust the calibration of the meter. The MR flow transmitter has two types of configuration changes accessible in program mode:

1. To view or change selections from a pre-defined list.
2. To view or change numeric entries.

During programming operation, the following four button functions are provided:

MENU	Enters and exits programming mode. Press **MENU** once to change to programming mode. The mode indicator on the display will change from *RUN* to *PROGRAM*.
⇧	Press ⇧ to scroll through the configuration choices in a bottom-to-top order. For numeric setup, this button increments numeric values.
⇨	Use ⇨ to scroll through the configuration choices in a top-to-bottom order. For numeric setup, this button moves the active digit to the right.
ENTER	Used to enter menus, to change configurations and to save programming information.

NOTE: If any input value exceeds the meter's capabilities, the *LIMIT* indicator will begin to flash indicating an invalid entry. Press **ENTER** once to return to the entry screen to reenter the value.

Cover Removal/Reinstallation

It is necessary to remove the MR flow transmitter cover to access the programming keys. Use a Phillips screwdriver to remove the four screws that hold the cover in place, turning them counterclockwise. When programming is completed, reinstall the cover. To properly seat the built-in cover gasket, tighten the cover screws clockwise in a crisscross pattern as shown in *Figure 8*.

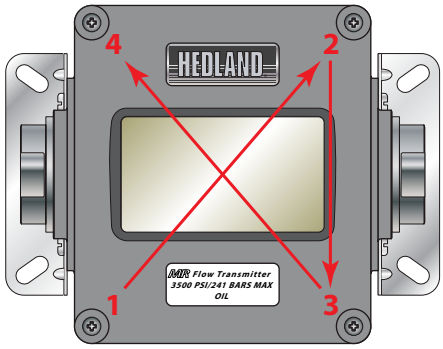


Figure 8: Cover screw tightening sequence

Programming Procedures

The MR flow transmitter has been programmed at the factory according to the specifications that were provided at the time of order. No further programming is required unless a change has occurred in the original specifications.

If programming is required, the MR flow transmitter allows two basic sets of programming procedures:

1. List Item Selection
2. Numeric Value Entry

List Item Selection Procedure

NOTE: If you are already in *PROGRAM* mode and the selection to be viewed or changed is already displayed, proceed to step 3 below. If you are in *PROGRAM* mode and the selection to be viewed or changed is not displayed, press ⇧ or ⇨ and repeat pressing until the desired selection appears. Proceed to step 3.

1. Press **MENU**. *PROGRAM* appears in the lower left-hand corner and *DISPLAY* appears.
2. Press ⇧ or ⇨ to move to the desired selection.
3. Press **ENTER** to view the current selection.
4. If the current selection is desired, press **ENTER** to confirm. The unit will automatically advance.
5. If current selection must change, press ⇧ or ⇨ to scroll through the available choices. Press **ENTER** to confirm your selection. The unit will automatically advance.
6. To exit programming, press **MENU**. The display will change to *RUN* mode.

Numeric Value Entry Procedure

NOTE: If you are already in *PROGRAM* mode and the desired selection is displayed, proceed to step 3 below. If you are in *PROGRAM* mode and the desired selection is not displayed, press ⇧ or ⇨ and repeat pressing until the desired selection appears. Proceed to step 3.

1. Press **MENU**. *PROGRAM* appears in the lower left-hand corner and *DISPLAY* appears.
2. Press ⇧ or ⇨ to move to the desired selection. The current numeric value for this selection appears in the upper section of the display.
3. If the current displayed value is desired, press **ENTER**. The left most programmable number begins to flash. Press **ENTER** again to confirm and keep the current setting. The unit will automatically advance.
4. If the current selection must change, press **ENTER**. The left most programmable number begins to flash. Use ⇧ to scroll through the digits 0-9 and change the flashing digit to the desired value. Use ⇨ to move the active digit to the right. Continue using the ⇧ and ⇨ until all desired digits are selected.
5. Press **ENTER** to confirm your selection. The unit will automatically advance.
6. To exit programming mode, press **MENU**. The display will change to *RUN* mode.

Programming Flow Chart

See the programming flow charts in *"Application Information, Liquid" on page 19* for the menu structure of the MR flow transmitter and the available configuration selections.

Basic Programming Descriptions

Display Mode

The meter can display *RATE* (flow rate) or *TOTAL* (total accumulated flow) or alternate between *BOTH* rate and total. Its displayed name is *DISPLAY* and is viewed or changed using the List Item Selection Procedure.

Rate Units of Measure

The meter allows the selection of many common rate units. Its displayed name is *RATE UNT* and is viewed or changed using the List Item Selection Procedure.

Rate (Time) Interval

The meter allows selection of several intervals based on time. Its displayed name is *RATE INT* and is viewed or changed using the List Item Selection Procedure.

Total Units of Measure

If the total flow is being displayed, the units for the total must first be chosen. The monitor allows the choice of many common totalization units. Its displayed name is *TOTL UNT* and is viewed or changed using the List Item Selection Procedure.

Total Display Multiplier

The meter has the ability to accumulate the flow total in multiples of ten. For example, if the most desirable totalization unit is 1000 gallons, the monitor can easily be set up for this requirement. Once back in *RUN* mode, every time the total display increments by one digit the actual total would be an additional 1000 gallons. At 1000 total gallons the total display would read 1, at 3000 gallons the total display would read 3. This feature allows the unit to accumulate totals that would exceed the 8-digit display capacity. Table 2 lists the available selection choices. Its displayed name is *TOTL EXP* and is viewed or changed using the List Item Selection Procedure.

Exponent	Totalizer Multiplier
E-2	x 0.01 (÷100)
E-1	x 0.1 (÷100)
E0	x 1 (no multiplier)
E1	x 10
E2	x 100
E3	x 1000
E4	x 10,000
E5	x 100,000
E6	x 1,000,000

Table 1: Total flow units

Full Flow Rate

The full flow rate is used to span the meter. Its displayed name is *FULL FLOW* and is viewed or changed using the Numeric Value Entry Procedure.

Zero Capture

The zero position of the meter cone must be set when installing the meter. To capture the zero calibration position, press **ENTER** at the *ZERO CAP* prompt. *NO* will display. Press either arrow key to change to *YES,* then press **ENTER** to capture zero.

Viscosity Units (Displayed for OIL meters only)

The Viscosity Units parameter is used in conjunction with Viscosity to perform viscosity correction for oil applications. The meter allows the selection of the viscosity units, SUS or cSt. Its displayed name is *VIS UNIT* and is viewed or changed using the List Item Selection Procedure.

Viscosity (Displayed for OIL meters only)

Viscosity is used in conjunction with Viscosity Units to perform viscosity correction for oil applications. Enter the viscosity in either SUS or cSt, depending on the viscosity units selected, of the oil that will be used. Its displayed name is *VISCOSTY* and is viewed or changed using the Numeric Value Entry Procedure.

Operating Pressure Unit (Displayed for GAS meters only)

Operating Pressure Units is used in conjunction with Operating Pressure in gas applications to compensate for the actual pressure being measured at the meter. The meter allows the selection of the operating pressure units, Bar or PSI. Its displayed name is *PRESUNIT* and viewed or changed using the List Item Selection Procedure.

Operating Pressure (Displayed for GAS meters only)

Operating Pressure is used in conjunction with Operating Pressure Units in gas applications to compensate for the actual pressure being measured at the meter. Enter the operating pressure in either Bar or PSI units, depending on the Operating Pressure Units selected. Its displayed name is *OP PRES* and is viewed or changed using the Numeric Value Entry Procedure.

Operating Temperature Unit (Displayed for GAS meters only)

Operating Temperature Units is used in conjunction with Operating Temperature in gas applications to compensate for the actual temperature of the gas being measured at the meter. The meter allows the selection of the operating temperature units, °F or °C. Its displayed name is *TMP UNIT* and is viewed or changed using the List Item Selection Procedure.

Operating Temperature (Displayed for GAS meters only)

Operating Temperature is used in conjunction with Operating Temperature Units in gas applications to compensate for the actual temperature of the gas being measured at the meter. Enter the operating temperature in either °F or °C, depending on the Operating Temperature Units selected. Its displayed name is *OP TEMP* and is viewed or changed using the Numeric Value Entry Procedure.

Specific Gravity Correction Factor

Specific Gravity is used to compensate for the specific gravity of the liquid or gas being measured with the meter. Its displayed name is *SP GRAV* and is viewed or changed using the Numeric Value Entry Procedure.

Damping

The Damping factor is increased to enhance the stability of the flow readings. Damping values are decreased to allow the flow meter to react faster to changing values of flow. This parameter can range from 0 to 99; factory default is 0. Its displayed name is *DAMPING* and is viewed or changed using the Numeric Value Entry Procedure.

Output Mode

The MR flow transmitter offers three analog output modes:

- 4…20 mA Output Signal
- 0…5 Volts DC Output Signal
- 0…10 Volts DC Output Signal

The output mode selected is determined by the type of peripheral device being connected to the MR flow transmitter.

The displayed name is *OUT MODE* and is viewed or changed using the List Item Selection Procedure.

NOTE: Setup prompts and descriptors for configuring and calibrating the analog output will correspond to the output mode selected.

Password

Password protection prevents unauthorized users from changing programming information. Initially the password is set to all zeros. Its displayed name is *PASSWORD* and is viewed or changed using the Numeric Value Entry Procedure.

Restore Defaults

This feature allows you to restore factory calibration data. Its displayed name is *RES DFLT*. To restore factory calibration data, select **YES**, then press **ENTER**.

Advanced Programming Descriptions

Advanced programming allows the user access to re-configure the analog output. Calibration of the analog output is preset at the factory, but can be changed to customize calibration for your installation.

To access the Advanced Programming Options, press and hold **MENU** for approximately 3 seconds until *DISPLAY* is viewed on the display panel. The programming menus will begin with display mode *DISPLAY* and continue as described above through output mode *OUT MODE*.

After output mode has been entered, Advanced Programming starts with the following:

Calibration of Analog Output

This selection allows access to the calibration and testing of the analog output signal.

To test or change the analog output calibration, it is first necessary to change the default setting for *CAL OUT?* from *NO* to *YES*.

NOTE: Setup prompts and descriptors for configuring and calibrating the analog output will correspond to the output mode selected. Refer to the Flow Chart.

1. At the *CAL OUT?* prompt press **ENTER**. *NO* will display.
2. To change to *YES*, press either arrow key.
3. The analog output will go to its minimum output level. A numeric value between 0-4000 will display. This is an internal number used to drive the analog output.
4. To increase the analog output signal level, press ⇧. To decrease the analog output signal level, press ⇨.
5. Press **ENTER** to store the setting.
6. The analog output will go to its maximum output level. A numeric value between 0-4000 will display. This is an internal number used to drive the analog output.
7. To increase the analog output signal level, press ⇧. To decrease the analog output signal level, press ⇨.
8. Press **ENTER** to store the setting.
9. The unit will advance to the analog output test mode. The analog output will go to its minimum output level. A numeric value of 0 will display. For test purposes, the analog output signal can be run up or down in increments of 1 milliamp or 1 volt, depending on the *OUT MODE* selected.
10. To increase the analog output signal level, press ⇧. To decrease the analog output signal level, press ⇨.
11. Press **ENTER** to exit the analog calibration mode.
12. The unit automatically advances to the *PASSWORD* feature.

Password

Password protection prevents unauthorized users from changing programming information. Initially the password is set to all zeros. Its displayed name is *PASSWORD* and is viewed or changed using the Numeric Value Entry Procedure f.

Restore Defaults

This feature allows you to restore factory calibration data. Its displayed name is *RES DFLT*. To restore factory calibration data, select **YES**, then press **ENTER**.

MAINTENANCE

⚠WARNING

BEFORE ATTEMPTING TO REMOVE THE TRANSMITTER FROM THE LINE, CHECK THE SYSTEM TO CONFIRM THAT LINE PRESSURE HAS BEEN REDUCED TO ZERO PSI. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH AND/OR DAMAGE TO THE EQUIPMENT.

⚠WARNING

DISCONNECT ELECTRICAL POWER BEFORE REMOVING METER COVER. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH AND/OR DAMAGE TO THE EQUIPMENT.

Cartridge Cleaning

1. Disconnect the transmitter cable.
2. Remove the meter from the line. Remove excess piping from the transmitter. See *Figure 4* and *Figure 5*.

NOTE: It is not necessary to remove the aluminum housing from the transmitter to remove it from the line.

3. Thoroughly wipe off the entire transmitter surface using mild detergent or isopropyl alcohol.

⚠CAUTION

DO NOT USE AROMATIC HYDROCARBONS, HALOGENATED HYDROCARBONS, KETONES OR ESTER BASED FLUIDS ON POLYCARBONATE LENS. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE TRANSMITTER.

4. Remove the inlet port cap, wave spring, retaining ring, and cone assembly from the transmitter body (*Figure 9*).
5. Gently push the body towards the outlet port.
6. The piston, inner magnet and transmitter spring are secured within the transmitter body with a retaining ring. Remove the retaining ring with a small screwdriver, then the internal components can be removed from the body (*Figure 9*).

NOTE: If internal parts do not slide freely from cartridge, use a wooden dowel inserted into the outlet port of the meter to push parts out.

7. Place all parts on a clean work surface. Clean and inspect all parts. Replace any that appear worn or damaged. Check inlet port O-ring for damage and replace if required.

⚠CAUTION

FIELD REPLACEMENT OF THE SPRING, METERING CONE AND/OR PISTON/MAGNET ASSEMBLY MAY RESULT IN CHANGES TO THE CALIBRATION OF THE FLOW METER.

8. Reassemble the transmitter by inserting the transmitter spring into the body, followed by the piston/inner magnet assembly. A slight compression of the piston against the spring is required during installation of the retaining ring.
9. Gently push body assembly into the outlet end of the transmitter enclosure. The flat surface of the body output port should be flush with the transmitter enclosure opening.
10. With the transmitter positioned vertically on a flat surface, inlet port facing up, install the transmitter cone assembly and wave spring into the body and secure with the inlet port end cap.
11. Reinstall transmitter to the line. Reconnect electrical power.

Inspection

1. Frequent inspection should be made. The environment and frequency of use should determine a schedule for maintenance checks. It is recommended that it should be at least once a year.
2. Perform visual, electrical, and mechanical checks on all components on a regular basis.
3. Visually check for undue heating evidence such as discoloration of wires or other components, damaged or worn parts, or leakage evidence such as water or corrosion in the interior.
4. Make sure all electrical connections are clean and tight and that the device is wired properly.

TROUBLESHOOTING

No LCD Display

- For 4…20 mA operation, check for current flow in the loop.
- Check polarity of the current loop connections for proper orientation.
- For 0…5V or 0…10V operation, check for proper voltage being supplied to the unit.
- Check polarity of the supply voltage.

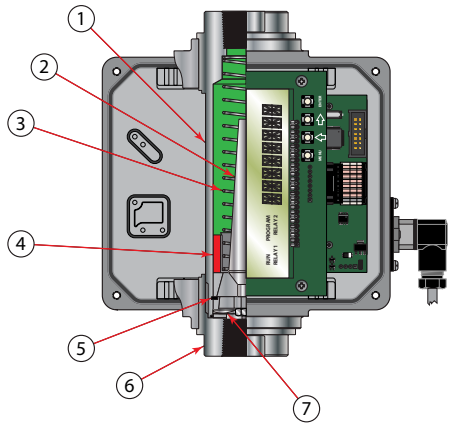


Figure 9: Cartridge components

Number	Name
1	Body
2	Cone Assembly
3	Meter Spring
4	Piston Assembly
5	Retaining Spring
6	Cap
7	Wave Spring

No Rate or Total Displayed

- Check flow meter body and internal components for debris. Piston should move inside the tube freely.
- Check setup programming of flow meter.

Unstable Flow Reading

- This usually indicated pulsing or oscillation in the actual flow. Increase the *DAMPING* parameter to increase the filtering in order to provide a more stable display reading.

APPLICATION INFORMATION, LIQUID

Viscosity Effect (SUS/cSt)

The design uses a precision machined, sharp- edged orifice and biasing calibration spring that assures operating stability and accuracy over the wide viscosity range common to many fluids. Generally, high flow models of each meter size provide good accuracy over a viscosity range of 40…500 SUS (4.2…109 cSt).

Density Effect (specific gravity)

Any fluid density change from stated standards has a proportional effect on meter accuracy. Corrections for more or less dense fluids can be made to standard scales using the following correction factor:

$\sqrt{\frac{1.0}{Specific\ Gravity}}$ For water/water-based meters

$\sqrt{\frac{0.876}{Specific\ Gravity}}$ For petroleum-based meters

Application Information Pneumatic

NOTE: Pressure and temperature readings must be taken at the flow meter inlet to ensure accurate correction factors.

The pneumatic flow meter is calibrated for air in standard cubic feet per minute (scfm) at 1.0 s.g. (70° F @ 100 psi), and liter per second (lps) at 1.0 s.g. (21° C @ 6.9 bar).

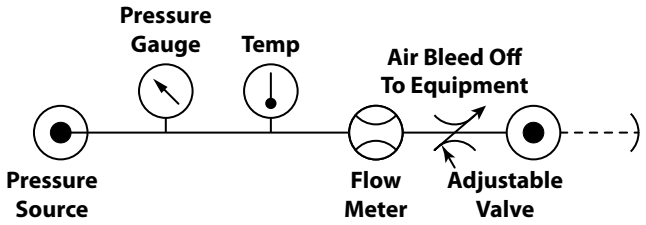


Figure 10: System schematic

DETERMINE FLOW RATES USING DIFFERENT PRESSURES & TEMPERATURES

$$scfm\,(actual) = \frac{scfm\,(indicated)}{f_1 \times f_2 \times f_3}$$

Where f_1 = Conversion Factor for Inlet Pressure
f_2 = Conversion Factor for Inlet Pressure
f_3 = Conversion Factor for Inlet Pressure

Table 1–Temperature Correction Factor (f_1) Operating Pressure

psig	25	50	75	100	125	150	175	200	225	250
BAR	1.7	3.5	5.2	6.9	8.6	10.4	12.1	13.8	15.5	17.2
kPa	172	345	517	689	862	1034	1207	1379	1551	1724
f_1	1.700	1.331	1.131	1.00	0.902	0.835	0.778	0.731	0.692	0.658

$$f_1 = \sqrt{\frac{114.7}{14.7 + psig}} \qquad f_1 = \sqrt{\frac{7.914}{1.014 + BAR}} \qquad f_1 = \sqrt{\frac{790.857}{101.357 + kPa}}$$

Table 2–Temperature Correction Factor (f_2)

°F	10	30	50	70	90	110	130	150	170	190
°C	–12.2	–1.1	9.9	21.0	32.1	43	54	65	76	88
f_2	0.942	0.962	0.981	1.00	1.018	1.037	1.055	1.072	1.090	1.107

$f_2 = \sqrt{\frac{460 + °F}{530}}$	$f_2 = \sqrt{\frac{273 + °C}{293}}$
Table 3–Specific Gravity Correction Factor (f_3)	
$f_3 = \sqrt{Sp.Gr.}$	

Table 2: Conversion factors

NOTE: Table 2 is included to show the correction algorithms include in the program to perform pressure, temperature, and specific gravity corrections. When configuring the MR flow transmitter, enter the actual operating pressure, temperature, and specific gravity values, not the correction factors.

LIQUIDS												
Fluid	Specific Gravity	Correction Factor		Aluminum	Brass	T16 SST	T303 SST	Viton®	EPR	Polycarbonate	Nylon	Pyrex®
		Oil	Water									
Acetic Acid (Air Free)	1.06	0.909	0.971	C	N	R	R	R	R	C	N	R
Acetone	0.79	1.053	1.125	R	R	R	R	N	R	N	R	R
Alcohol Butyl (Butanol)	0.83	1.027	1.098	C	C	R	R	C	R	R	R	R
Alcohol Ethyl (Ethanol)	0.83	1.027	1.098	C	C	R	R	C	R	R	N	R
Ammonia	0.89	0.992	1.060	R	C	R	R	N	R	N	C	R
Benzine	0.69	1.127	1.204	C	R	R	C	R	N	N	R	R
Carbon Disulphide	1.26	0.834	0.891	R	N	R	R	R	N	N	R	R
Castor Oil	0.97	0.950	1.015	C	R	R	C	R	N	C	C	R
Cotton Seed Oil	0.93	0.970	1.037	C	R	R	R	R	N	R	R	R
Ethylene Glycol 50/50	1.12	0.884	0.945	R	R	R	R	R	R	R	C	R
Freon II	1.46	0.774	0.828	R	R	R	R	R	N	R	R	R
Gasoline	0.70	1.119	1.195	R	R	R	R	R	N	C	R	R
Glycerin	1.26	0.834	0.891	R	R	R	R	R	R	R	C	R
Kerosene	0.82	1.033	1.104	R	R	R	R	R	N	R	R	R
Liquid Propane (LPG)	0.51	1.310	1.400	R	R	R	R	R	N	N	R	R
Mineral Oil	0.92	0.976	1.042	R	N	R	R	R	N	R	R	R
Naphtha	0.76	1.074	1.147	R	N	R	R	R	N	C	R	R
Perchloroethylene	1.62	0.735	0.786	C	N	R	R	R	N	N	N	R
Petroleum Oil	0.876	1.000	1.068	R	R	R	R	R	N	R	R	R
Phosphate Ester	1.18	0.862	0.921	R	R	R	R	N	R	N	R	R
Phosphate Ester Base	1.26	0.833	0.891	R	R	R	R	N	R	N	R	R
Phosphoric Acid (Air Free)	1.78	0.701	0.749	N	N	R	N	R	N	R	N	R
Sea Water	1.03	0.922	0.985	N	N	C	C	N	R	R	R	R
Synthetic Petroleum Base	1.00	0.936	1.000	R	C	R	R	R	N	R	R	R
Water	1.00	0.936	1.000	N	R	R	R	N	R	R	R	R
Water Glycol 50/50	1.07	0.905	0.967	R	R	R	R	R	N	R	R	R
Water-in-oil	0.93	0.970	1.037	R	R	R	R	N	R	R	R	R
R–Recommended N–Not Recommended C–Consult Factory												

Table 3: Liquids Fluid selection chart

LIQUIDS											
Fluid	Specific Gravity	Correction Factor	Aluminum	Brass	T16 SST	T303 SST	Viton®	EPR	Polycarbonate	Nylon	Pyrex®
Air	1.0	1.000	R	R	R	R	R	R	R	R	R
Argon (A)	1.38	1.175	R	R	R	R	R	R	R	R	R
Carbon Dioxide (CO_2)	1.53	1.237	R	R	R	R	R	R	R	R	R
Freon 11 (CCl_3F)	4.92	2.218	R	R	R	R	R	R	R	R	R
Freon 12 (CCl_2F)	4.26	2.060	R	R	R	R	R	R	R	R	R
Helium (HE)	0.14	0.374	R	R	R	R	R	R	R	R	R
Hydrogen (H_2)	0.07	0.265	R	R	R	R	R	R	R	R	R
Natural Gas	0.60	0.775	C	C	R	C	R	N	C	R	R
Nitrogen (N_2)	0.97	0.985	C	C	R	R	R	R	C	R	R
Oxygen (O_2)	1.10	1.049	R	R	R	R	R	R	R	R	R
Propane C_3H_8)	1.57	1.253	R	R	R	R	R	N	N	R	R
R–Recommended N–Not Recommended C–Consult Factory											

Table 4: Gaseous fluid selection chart

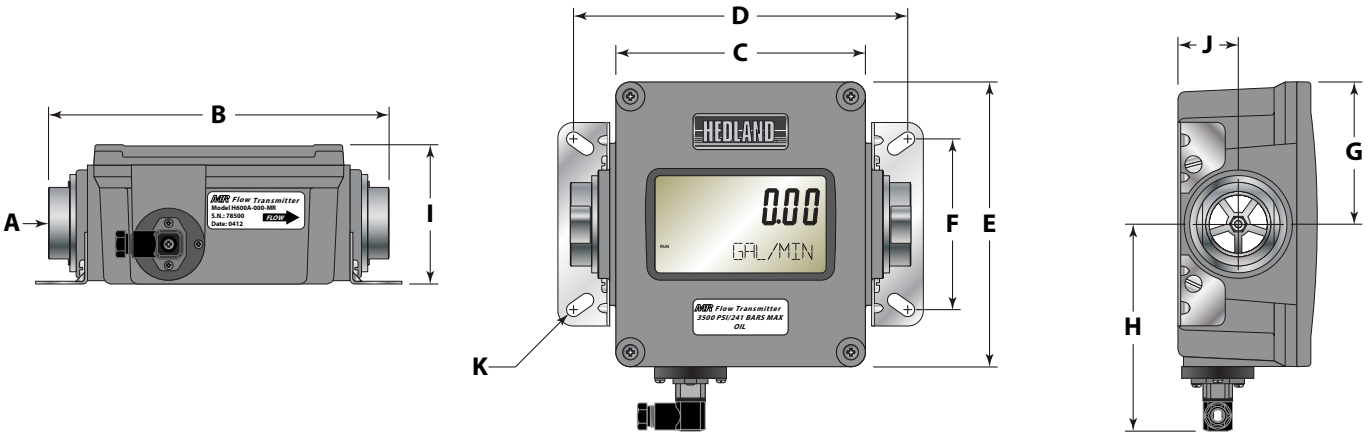


Figure 11: Dimensions

A Nominal Port Size	B Length in. (mm)	C Length in. (mm)	D Length in. (mm)	E Width in. (mm)	F Width in. (mm)	G Width in. (mm)	H Width in. (mm)	I Depth in. (mm)	J Offset in. (mm)	K Hole Dia. in. (mm)
1/4 (SAE 6)	6.60 (168)	5.27 (134)	6.41 (163)	6.00 (152)	3.23 (82)	3.00 (76)	4.20 (107)	2.94 (75)	1.51 (38)	0.31 (8)
1/2 (SAE 10)	6.60 (168)	5.27 (134)	6.41 (163)	6.00 (152)	3.23 (82)	3.00 (76)	4.20 (107)	2.94 (75)	1.51 (38)	0.31 (8)
3/4 (SAE 12)	7.20 (183)	5.27 (134)	7.04 (179)	6.00 (152)	3.60 (91)	3.00 (76)	4.20 (107)	2.94 (75)	1.27 (32)	0.31 (8)
1 (SAE 16)	7.20 (183)	5.27 (134)	7.04 (179)	6.00 (152)	3.60 (91)	3.00 (76)	4.20 (107)	2.94 (75)	1.27 (32)	0.31 (8)
1-1/4 (SAE 20)	12.20 (310)	10.68 (271)	11.65 (296)	7.63 (194)	4.84 (123)	3.82 (97)	5.02 (128)	4.50 (114)	2.20 (56)	0.31 (8)
1-1/2 (SAE 24)	12.20 (310)	10.68 (271)	11.65 (296)	7.63 (194)	4.84 (123)	3.82 (97)	5.02 (128)	4.50 (114)	2.20 (56)	0.31 (8)

SPECIFICATIONS

General

Accuracy	± 2% of full scale
Repeatability	± 1%
Threads	SAE J1926/1, NPTF ANSI B2.2, BSPP IS01179
Temperature Range	–20…240° F (–29…116° C)
Pressure Rating	Aluminum/Brass Operating Liquids: 3500 psi/241 bar maximum (3:1 safety factor) Gases: 1000 psi/69 bar maximum (10:1 safety factor)
	Stainless Steel Operating Liquids (1/4…1/2"): 6000 psi/414 bar maximum (3:1 safety factor) Liquids (3/4…1-1/2"): 5000 psi/345 bar maximum (3:1 safety factor) Gases: 1500 psi/103 bar maximum (10:1 safety factor)

Materials

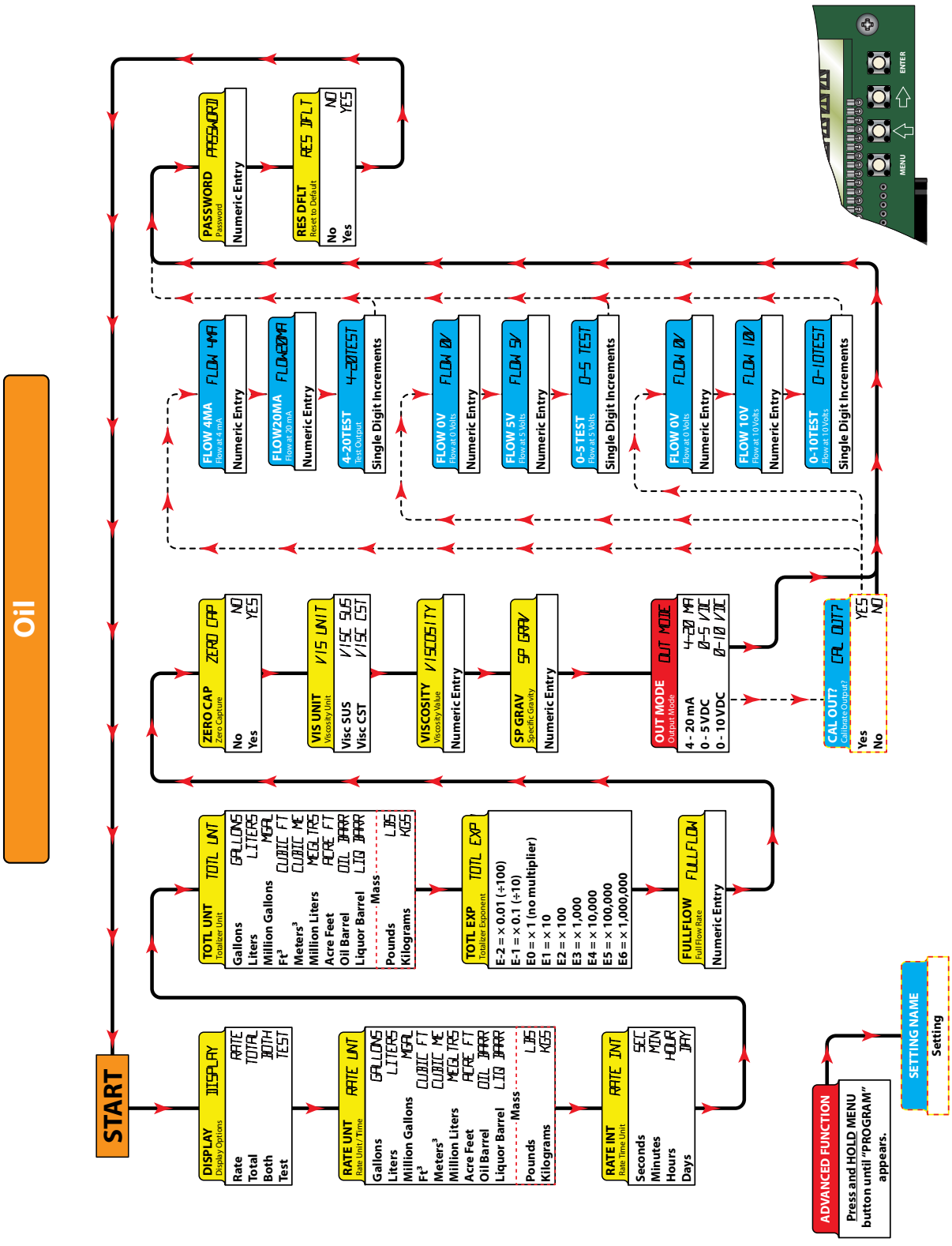
All Meters Common Parts	2024 – T351 Anodized aluminum body, piston and cone C360 Brass body, piston and cone T303 Stainless body, 2024 – T351 Anodized aluminum piston and con (Oil, PE WBF, & Air meters) T303 Stainless body, C360 Brass piston and con (Water meters) T316 Stainless body, piston and cone	
Petroleum (Oil) Common Parts	Spider Plate Retaining Ring Spring Retaining Spring Fasteners Internal Magnet Pressure Seals Enclosure Seal Lens	T316 SS SAE 1070/1090 Carbon Steel 302 SS SAE 1070/1090 Carbon Steel T303 SS Teflon® Coated Alnico 8 Viton® Silicon gasket Polycarbonate
Phosphate Ester (PE) Common Parts	Spider Plate Retaining Ring Spring Retaining Spring Fasteners Internal Magnet Pressure Seals Enclosure Seal Lens	T316 SS SAE 1070/1090 Carbon Steel 302 SS SAE 1070/1090 Carbon Steel T303 SS Teflon Coated Alnico 8 EPR Silicon gasket Polycarbonate
Water-Based (WBF), Water, Air Common Parts	Spider Plate Retaining Ring Spring Retaining Spring Fasteners Internal Magnet Pressure Seals Enclosure Seal Lens	T316 SS T316 SS T302 SS T316 SS T303 SS Teflon Coated Alnico 8 Viton Silicone gasket Polycarbonate
API Oil/Air/Caustic/ Corrosive Liquids and Gases Common Parts	Spider Plate Retaining Ring Spring Retaining Spring Fasteners Internal Magnet Pressure Seals Enclosure Seal Lens	T316 SS T316 SS T316 SS T316 SS T316 SS Teflon Coated Alnico 8 Viton Silicone gasket Polycarbonate

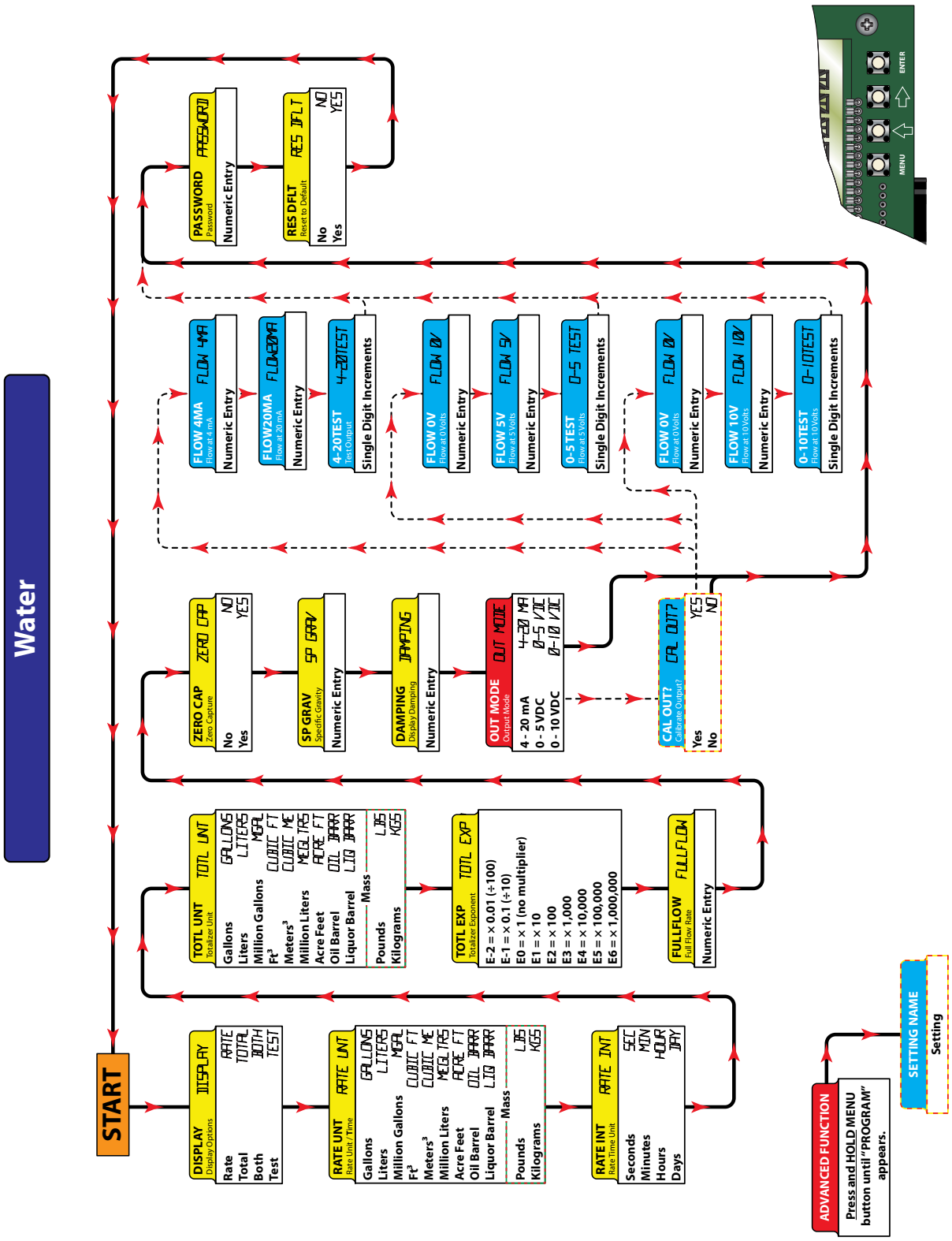
High Cycle Applications: Pressure Fatigue Rating

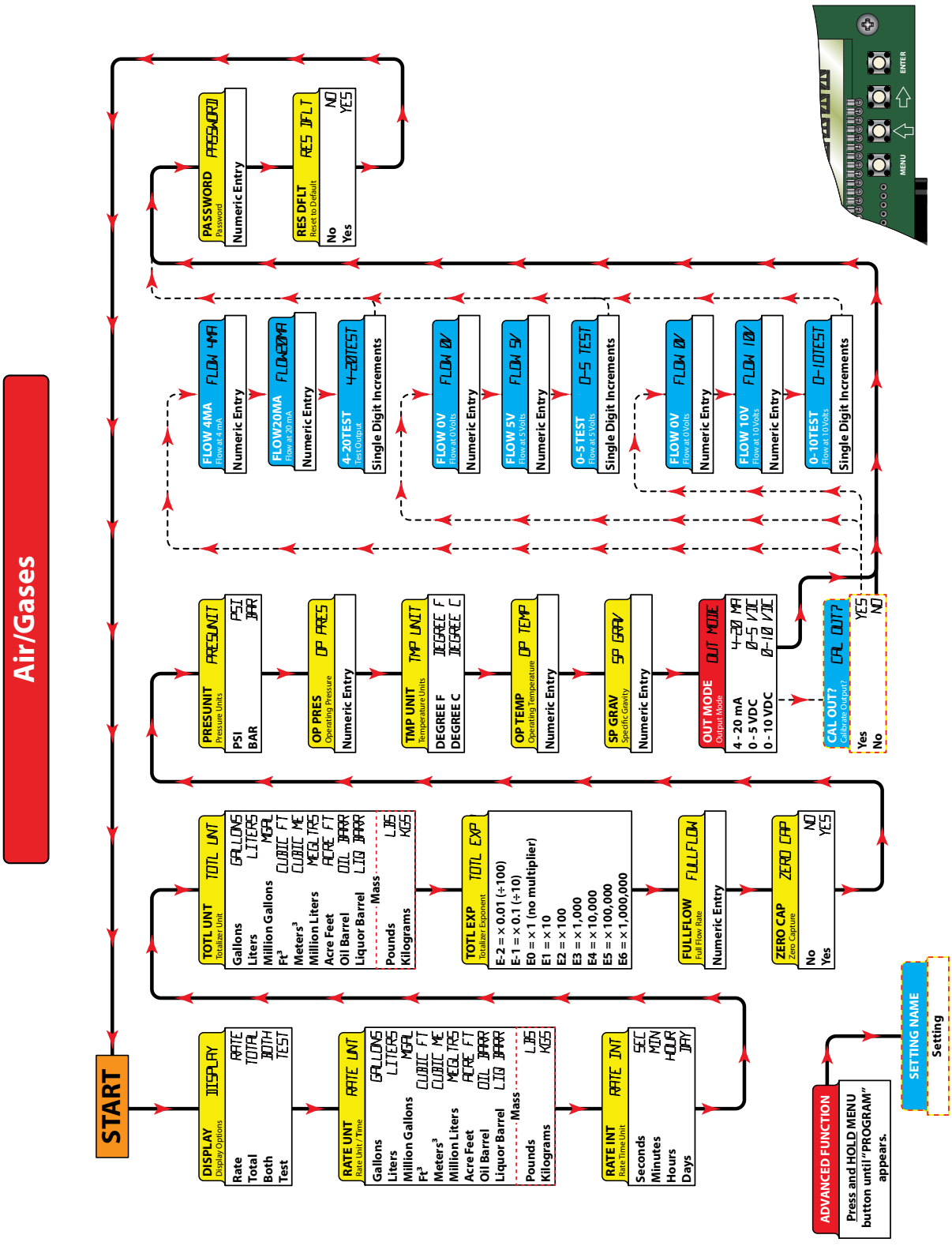
Per NFPA/T2.6.1 R1 - 1991, C/90, the method of verifying rated fatigue pressure (or establishing the rated burst pressure, or both) of the pressure containing envelope conforms to NFPA/T2.6.1 R1, Fluid power systems and products – Method for verifying the fatigue and establishing the burst pressure ratings of the pressure containing envelope of a metal fluid power component.

Meter Size	Aluminum		Brass		Stainless Steel	
	RFP*	Cycles	RFP*	Cycles	RFP*	Cycles
1/4	2000	1×10^6	**		3000	1×10^6
1/2	2000	1×10^6	**		3000	1×10^6
3/4	1500	1×10^6	**		3000	1×10^6
1	1500	1×10^6	**		3000	1×10^6
1-1/4	1000	1×10^6	**		3000	1×10^6
	1500	70×10^3	**		3000	1×10^6
1-1/2	1000	1×10^6	**		3000	1×10^6
	1500	70×10^3	**		3000	1×10^6

*RFP = Rated Fatigue Pressure
**Consult Factory

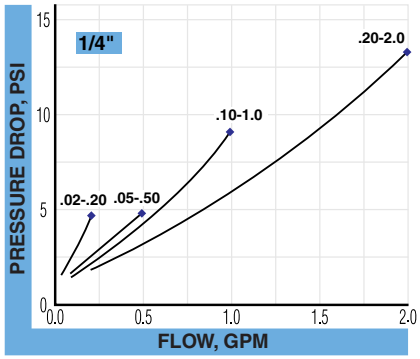


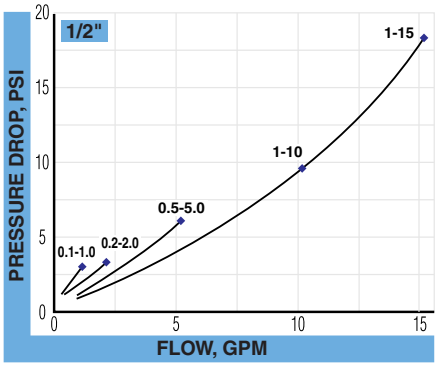


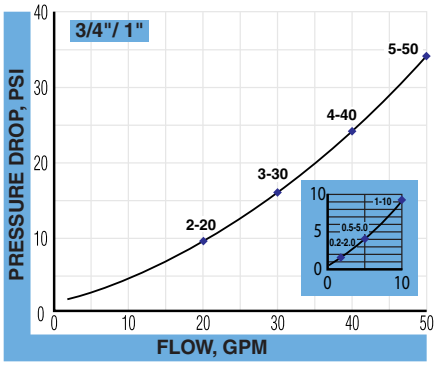


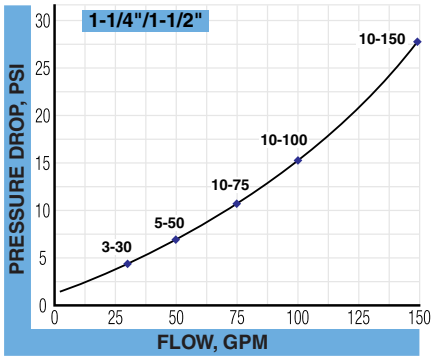
FLOW VS PRESSURE DROP

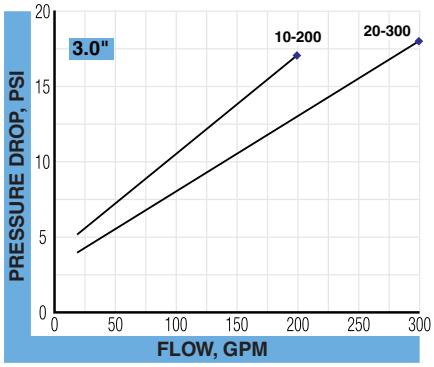
Petroleum Fluids

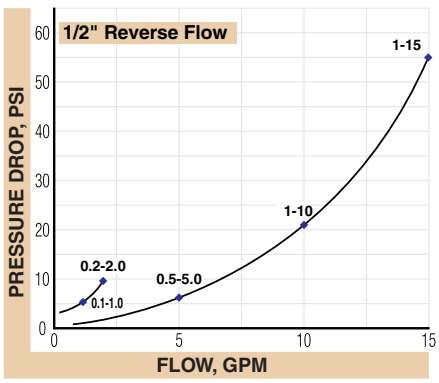


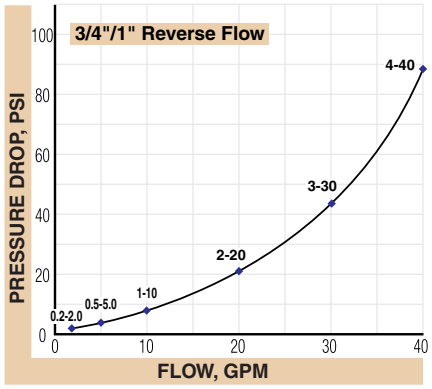


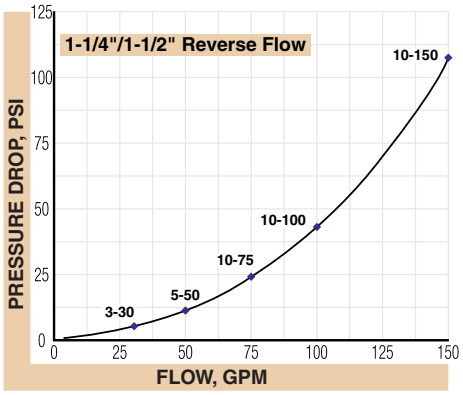








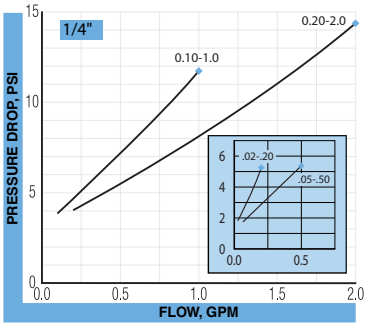


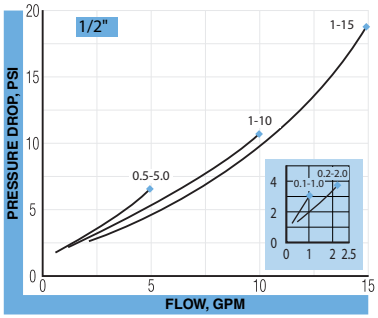


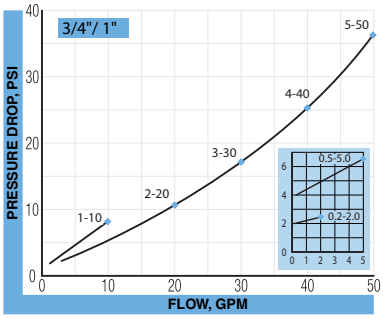
The pressure drop curves are valid for fluids with density and viscosity similar to factory test fluids. Fluids, especially with higher viscosity than theses test fluids, will yield a higher pressure drop through the flow meter and piping system per a given flow volume.

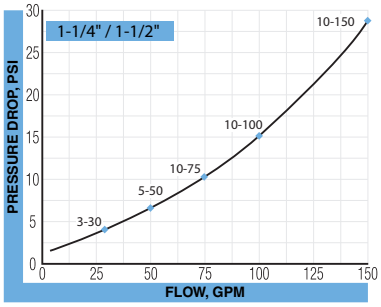
A system must have adequate fluidic horsepower available to move the system fluid at a prescribed rate at a pressure adequate to overcome all pressure reducing devices, including the flow meter.

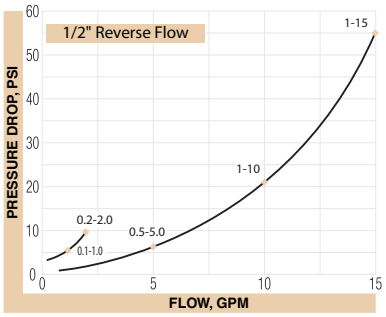
Phosphate Ester

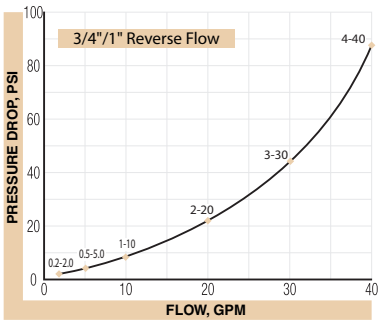


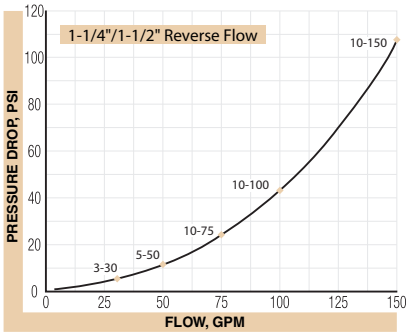




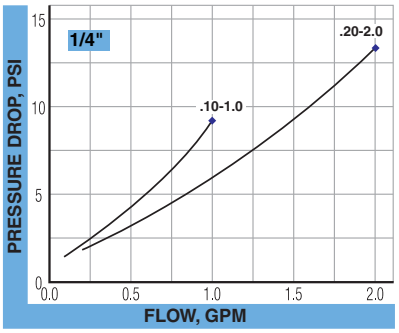


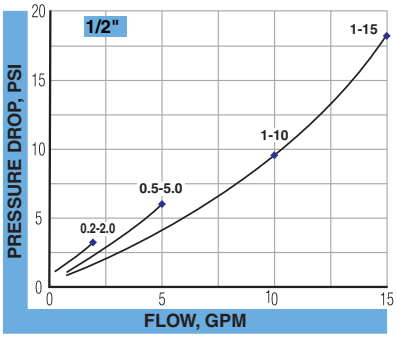


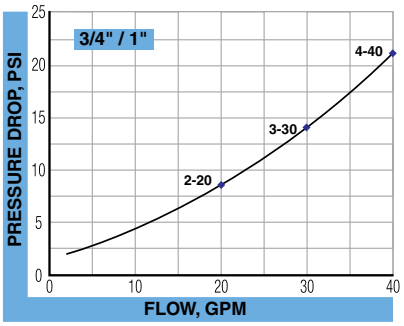


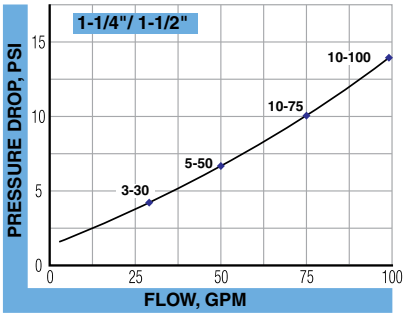


API Oil

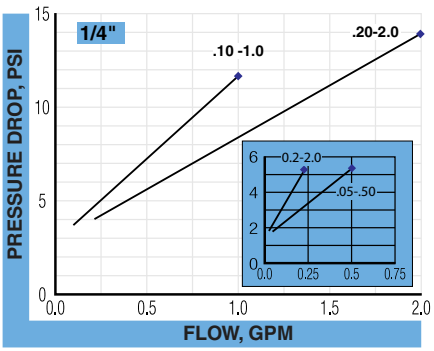


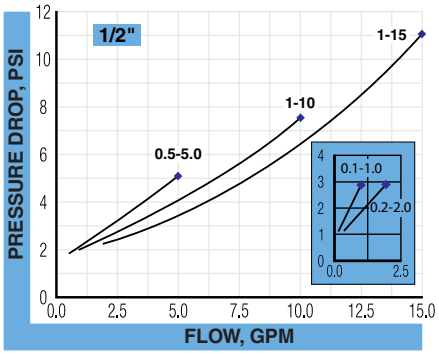


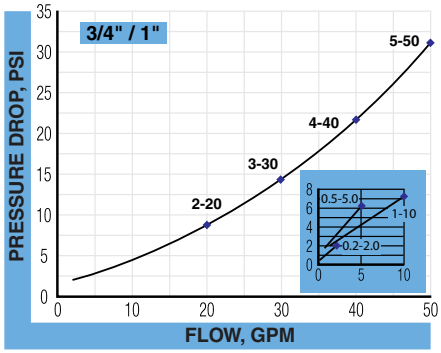


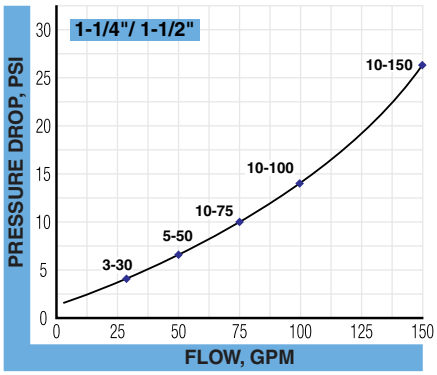


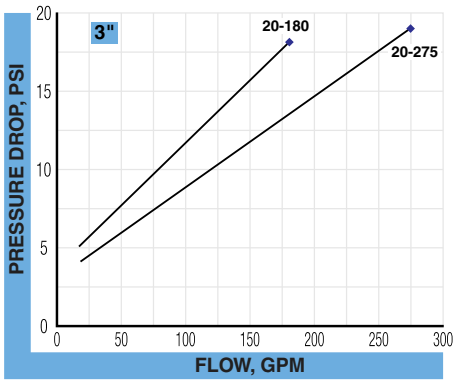
Water-Based Fluids

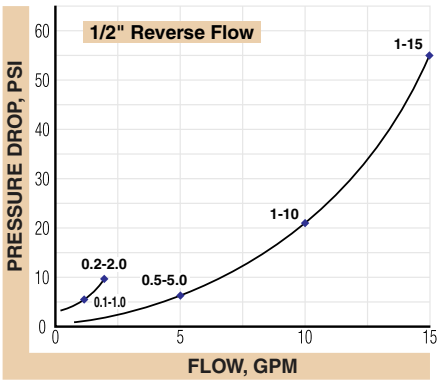


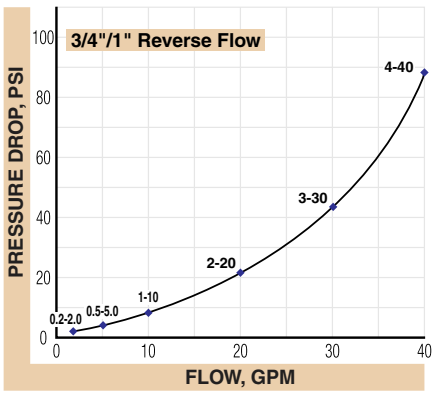


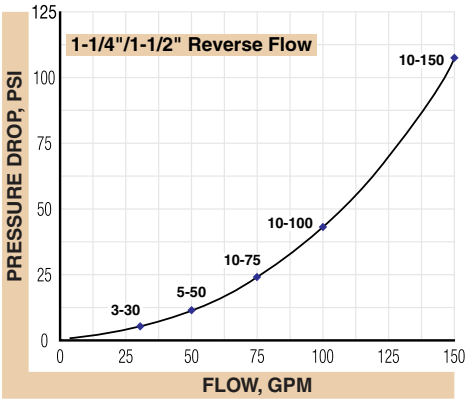












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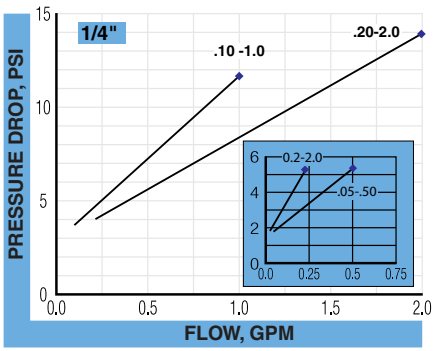
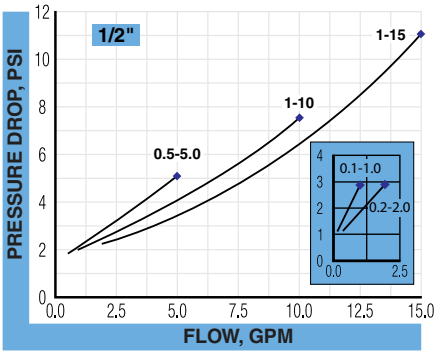
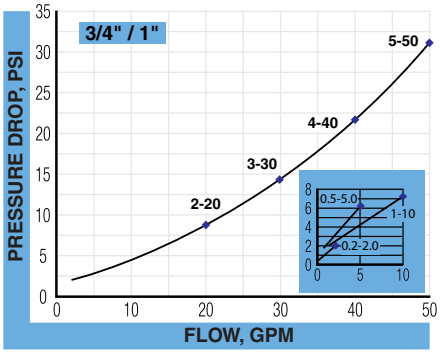
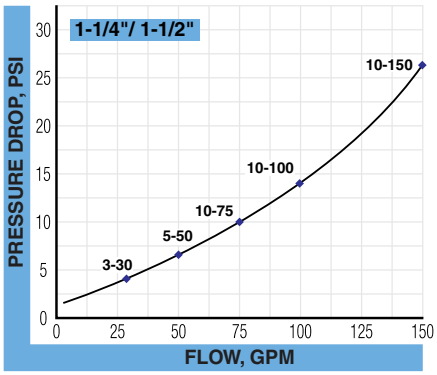
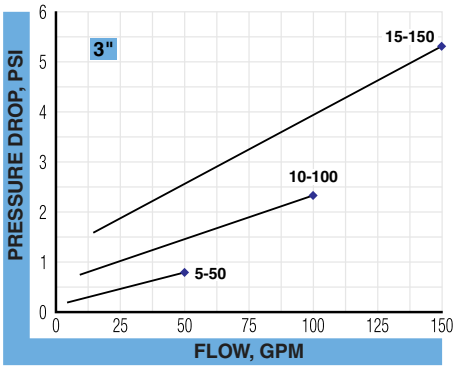


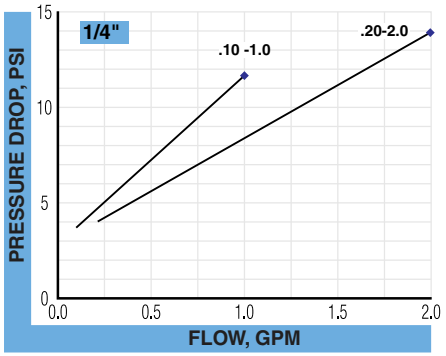


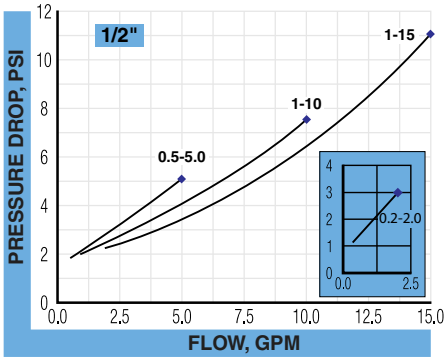


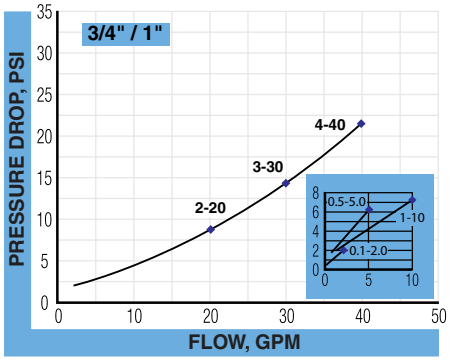


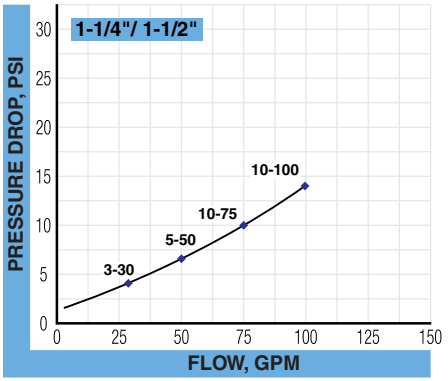


Caustic and Corrosive Liquids

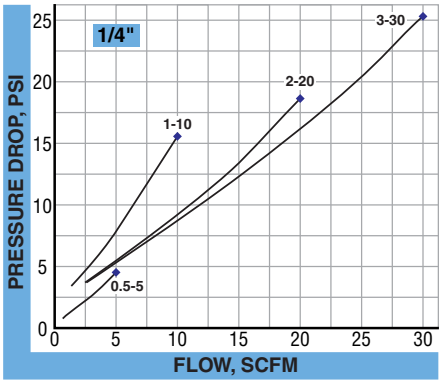


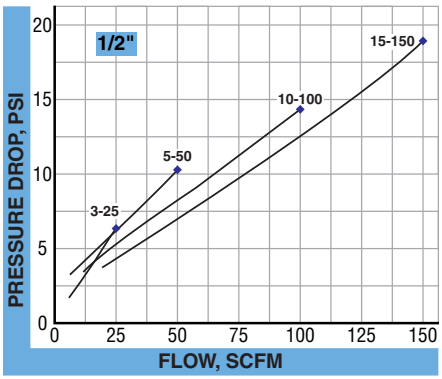


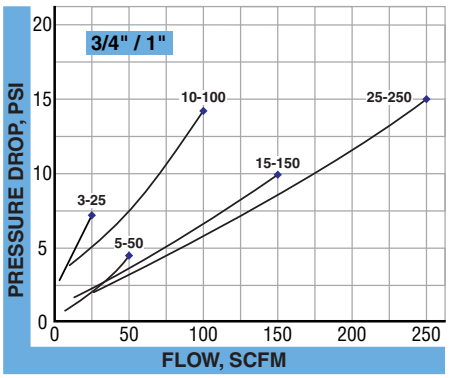


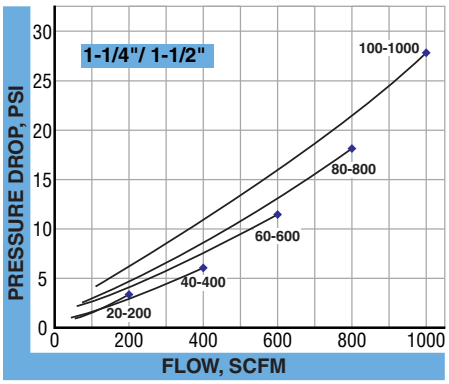


Air/Compressed Gases

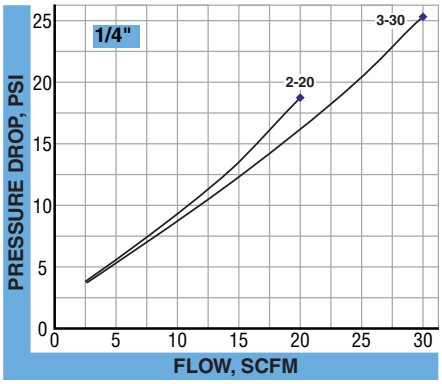


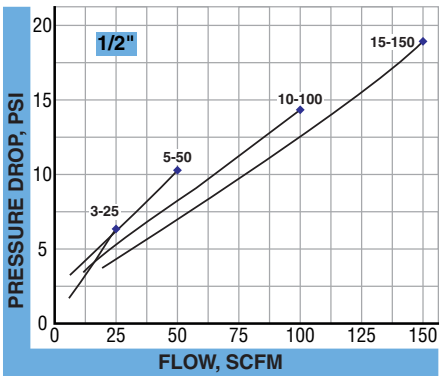


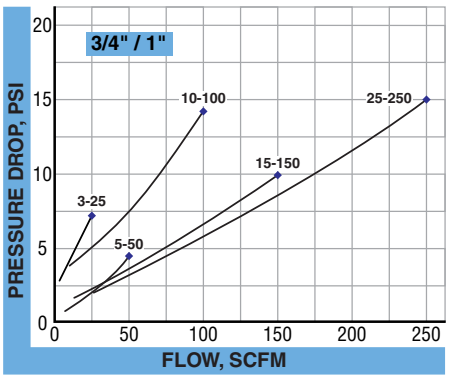


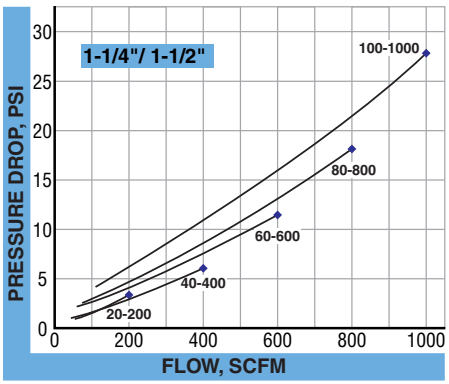


Air/Caustic and Corrosive Gases









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