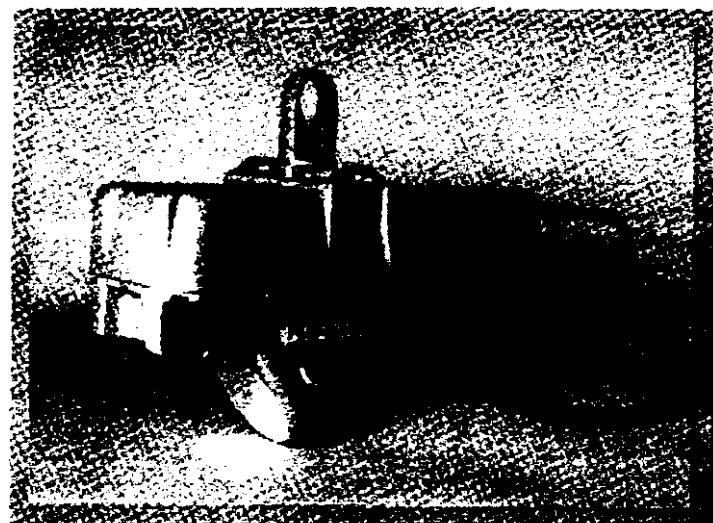
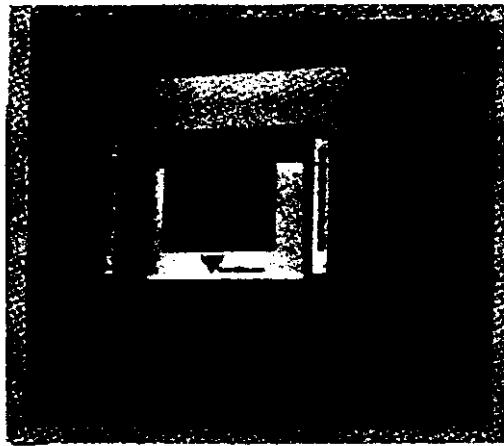

APPENDIX B:

USER'S MANUAL

Installation & Operation



MARSH-McBIRNEY, INC.



FLO-DAR SYSTEM™
Open Channel Non-Contact
Radar Flowmeter
Model 450

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Patent Notice

This equipment is manufactured in the U.S.A. under one or more of the following U.S. patents: 4015471, 4083246, 4459848, 4549434, 4688432, 4455870, 4669308, 4821580, 5313842, 5385056, 5315880 and 5811688. Other Patents pending.



WARRANTY STATEMENT

Manufacturer warrants all products of its manufacture to be free from defects in workmanship and material under normal use and service. This warranty extends for a period of twelve (12) months after date of shipment, unless altered by mutual agreement between the purchaser and manufacturer prior to the shipment of the product. If this product is believed to be defective, purchaser shall notify manufacturer and will return the product to the manufacturer, postage paid, within twelve (12) months after date of shipment by the manufacturer. If the purchaser believes the return of the product to be impractical, manufacturer shall have the option, but will not be required, to inspect the product wherever located. In any event, if the purchaser requests the manufacturer visit their location, the purchaser agrees to pay the non-warranty expenses of travel, lodging and subsistence for the field service response. If the product is found by the manufacturer's inspection to be defective in workmanship or material, the defective part or parts will either be repaired or replaced, at manufacturer's election, free of charge, and if necessary the product will be returned to purchaser, transportation prepaid to any point in the United States. If inspection by the manufacturer of such product does not disclose any defect of workmanship or material, manufacturer's regular service repair charges will apply. Computing devices sold but not manufactured by Marsh-McBirney, Inc. are covered only by the original manufacturer's written warranty. Hence, this warranty statement does not apply.

THE FOREGOING WARRANTY IS MANUFACTURER'S SOLE WARRANTY, AND ALL OTHER WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE NEGATED AND EXCLUDED. THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, GUARANTEES, REPRESENTATIONS, OBLIGATIONS OR LIABILITIES ON THE PART OF THE MANUFACTURER. Purchaser's sole remedy and manufacturer's sole obligation for alleged product failure, whether under warranty claim or otherwise, shall be the aforesated obligation of manufacturer to repair or replace products returned within twelve months after date of original shipment. The manufacturer shall not be liable for, and the purchaser assumes and agrees to indemnify and save harmless the manufacturer in respect to, any loss or damage that may arise through the use by the purchaser of any of the manufacturer's products.

Safety warnings

When installing, operating, and maintaining Marsh-McBirney equipment where hazards may be present, you must protect yourself by wearing Personal Protective Equipment (PPE) and be trained to enter confined spaces. Examples of confined spaces are manholes, pumping stations, pipelines, pits, septic tanks, sewage digesters, vaults, degreasers, storage tanks, boilers, and furnaces.

You must follow all state and local laws, as well as Occupational Health and Safety Administration (OSHA) regulations concerning Personal Protective Equipment, confined-space entry, and exposure to bloodborne pathogens. Specific requirements can be found in the OSHA section of the Code of Federal Regulations: *29 CFR, 1910.132 - 1910.140, Personal Protective Equipment; CFR Title 29, Part 1910.146, Permit-Required Confined-Spaces; and 29 CFR, 1910.1030, Bloodborne Pathogens.*

WARNING!

Never enter a confined space without first testing the air at the top, middle, and bottom of the space. The air may be toxic, oxygen deficient, or explosive. Do not trust your senses to determine if the air is safe. You cannot see or smell many toxic gases.

WARNING!

Never enter a confined space without the proper safety equipment. You may need a respirator, gas detector, tripod, lifeline, and other safety equipment.

WARNING!

Never enter a confined space without standby/rescue personnel within earshot. Standby/rescue personnel must know what action to take in case of an emergency.

WARNING!

Always protect yourself when handling equipment that has been exposed to biological hazards: wear disposable latex examination gloves, goggles, aprons, waders, and other required Personal Protection Equipment.

Regulatory Compliance

This device complies with Part 15 of the FCC Rules and Industry Canada RSS210. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that causes undesired operation.

No additional user license is required.

CAUTION

Any changes or modifications not expressly approved by Marsh-McBirney, Inc. could void the user's authority to operate the equipment.

Flo-Dar Model 450

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Chapter 1

Before You Start

In this chapter you will find out about this manual, how to register your equipment, what you must know about safety, where to go for further information, and the typing conventions used in developing procedural data.

About this manual

This manual shows you where and how best to install, operate and maintain the Flo-Dar equipment.

Chapter 1 covers what you must know before starting. Chapter 2 gives an overview of the Flo-Dar System. In Chapters 3 through 8, you'll find out about:

- selecting the site
- installing the Flo-Dar system
- Flo-Dar system operations
- external devices
- Flo-Dar system maintenance

Registering your equipment

Take a moment to register your equipment using the registration card that came with your documentation. As a registered user, you will receive notices of new and upgraded Marsh-McBirney products.

What you must know about safety

Before installing certain Marsh-McBirney equipment, you must be trained to enter confined spaces. If you haven't already, please read "Safety warnings" on page v.

Conventions

This manual uses the following conventions:

- Text that you type is shown in bold, small capital letters. For example:

Type **MAPLE STREET**

- Keys that you press are shown in bold, large capital letters. For example:

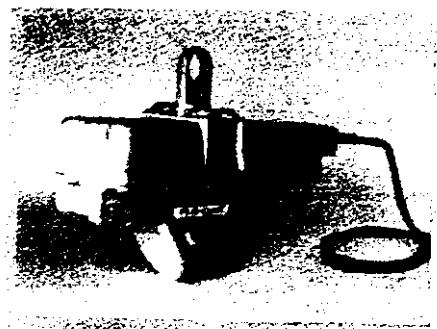
Accept key **ACCEPT**

- Terms defined in the glossary are shown in *italics* the first time they are used.

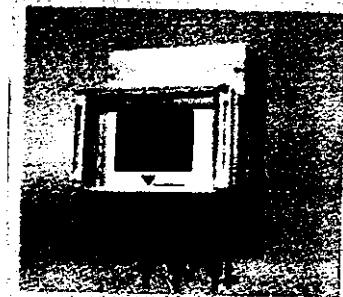
Chapter 2

About the Flo-Dar System Model 450

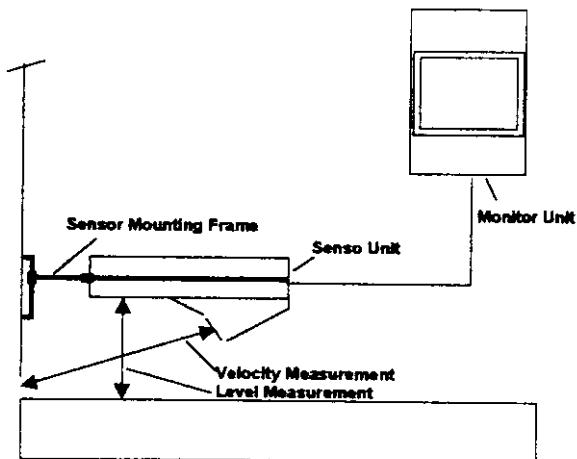
Flo-Dar flowmeters provide a revolutionary approach to open channel flow monitoring. The Model 450 Flo-Dar Flowmeter combines advanced radar velocity sensing technology with ultrasonic pulse echo level sensing to remotely measure open channel flow.



Model 450 Sensor



Model 450 Monitor



The Sensor Unit measures surface velocity using Doppler radar, the level of the fluid in the pipe using an ultrasonic look-down level sensor and level under surcharge conditions using a pressure transducer.

The level and velocity data is transferred to the monitor, processed, combined with site characteristic data to calculate the flow rate. The resulting information is shown on the Monitor display.

The Model 450 Flowmeter consists of the Sensor Unit, the Sensor Mounting Frame Assembly and the Monitor Unit.

The sensor mounting frame assembly is installed on the wall of the manhole above the flow. One-time manhole entry is required only during installation. A sensor installation/retrieval tool is available for retrieval or reinstallation without confined space entry. The sensor may

be pointed either upstream or downstream to take advantage of the best flow conditions.

The monitor unit provides the display of the flow data, 4-20 mA outputs, proportional contact closure and an external pulsed input. Site specific characteristics are entered into the monitor unit via a menu-driven touch screen. The monitor is connected to the sensor via a cable which is disconnectable at both the sensor and the monitor.

How does the Flo-Dar system work?

Velocity measurement

The velocity of the liquid surface is sensed by microwave Doppler much the same way a police speed gun operates. The sensor, installed over the flowing conduit, produces a microwave beam footprint just inside the sewer pipe cross section. It is very important to center the beam over the stream to ensure maximum beam coverage of the stream. The sensor measures the surface velocity of the moving liquid by determining the shift in frequencies between the transmitted frequency and the frequency of the signal reflected from the surface.. This difference is called the Doppler Shift. The measured surface velocity is then converted to mean flow velocity using empirical equations.

During installation many adjustments are available to accurately center the beam over the flow. The sensor frame can be adjusted vertically, horizontally, and in three degrees of movement (pitch, roll, and yaw). All of these adjustments are designed to accommodate all types of non-vertical walls above the flow inlet. Flo-Tractor and Laser Alignment accessories are recommended to assist in properly aligning the sensor mounting frame.

Level measurement

The liquid level is sensed by the pulse echo ultrasonic (acoustic) method with the beam directed vertically down from the sensor enclosure. The time it takes the beam to reach the top of the moving liquid and back to the transducer is referred to as a time interval. It is recorded many times a second at a constant speed. Since the speed of the pulse and time interval are known, the sensor computes the distance traveled to track the liquid level as it falls and rises.

During the one-time installation of the sensor assembly, a number of physical measurements are taken. The primary measurements are pipe inside diameter (ID) and sensor distance to the crown of the pipe. If there is sediment present then that thickness will need to be noted as well.

There are two ways to determine the liquid level:

- Intrusive - measure from the bottom of the pipe to the sensor, or
- Non-Intrusive - measure from the crown of the pipe to the sensor.

The intrusive method will be sufficient for low flow in large pipes and all flows in small pipes. This can be accomplished by inserting a straight edge into the stream to the bottom of the pipe and noting the height to the crown and to the bottom of the sensor level transducer.

The Non-Intrusive method will work in all cases (especially for large pipes with fast flows). Measure the distance from the bottom of the sensor transducer to the crown of the pipe (sensor level offset).

Measure the inside diameter of the pipe. The sensor then adds the two distances to get a known distance from the bottom of the pipe to the bottom of the sensor level transducer.

In each case, the distance to the bottom of the pipe must be known in order for the sensor to determine the subsequent distances for the changing liquid levels. Provisions in the setup procedure allow for a sediment offset measurement to be subtracted from the total distance.

Level Measurement During Surcharge Conditions

A stainless steel, diaphragm isolated, absolute pressure transducer is located at the lower portion of the sensor enclosure. Under surcharge conditions, the level measurement is derived from this pressure transducer. Correction for local atmospheric variations is made by using the output of the barometer in the monitor.

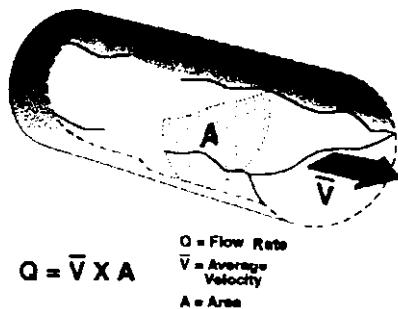
Flow Rate Calculation

The velocity and level measurements provided by the open channel sensor are used to calculate the *flow rate*. Flow rate (also known as Q , as the *flow*, or as *throughput*) is the amount of fluid moving through a channel or pipe in a period of time. For example, if 200 gallons of water move past the sensor in one minute, the flow rate is *100 gallons per minute (GPM)*.

To calculate the flow rate, two things are needed:

The *cross-sectional area* of the channel and the *average velocity*.

Cross-sectional area is determined using the dimensions of channel and the measured level.



Average velocity is determined using the surface velocity (measured by the sensor) and empirical equations.

Flow rate is calculated by using the *Continuity Equation*:

Flow Rate = Average Velocity x Area

Other system functions

The monitor provides connections for a personal computer (RS-232), chart recorder (current loops), external flow metering device (contact closure), rain gauge (pulse in), AC power, and DC power. See Chapter 7 for further details.

Flo-Dar system features

- One-time manhole entry installation
- No Profiling Required
- Personnel do not come in contact with the flow during installation.
- Field Replaceable/Interchangeable Sensors and Monitors
-

Solution for Difficult Flow Conditions

- Flows with High Solids Content
- High Temperature Flows
- Caustic Flows
- Large Man-Made Channels
- High Velocities ± 20 ft/s
- Shallow Flows

Flo-Dar System Uses

- Billing Purposes
- EPA Permitting Requirements
- Inflow/Infiltration Studies
- Combined Sewer Overflow Monitoring
- Process Control
- Sampler Pacing
- Modeling/Sewer System Evaluations
- Wastewater Treatment Plant Balancing
-

Chapter 3

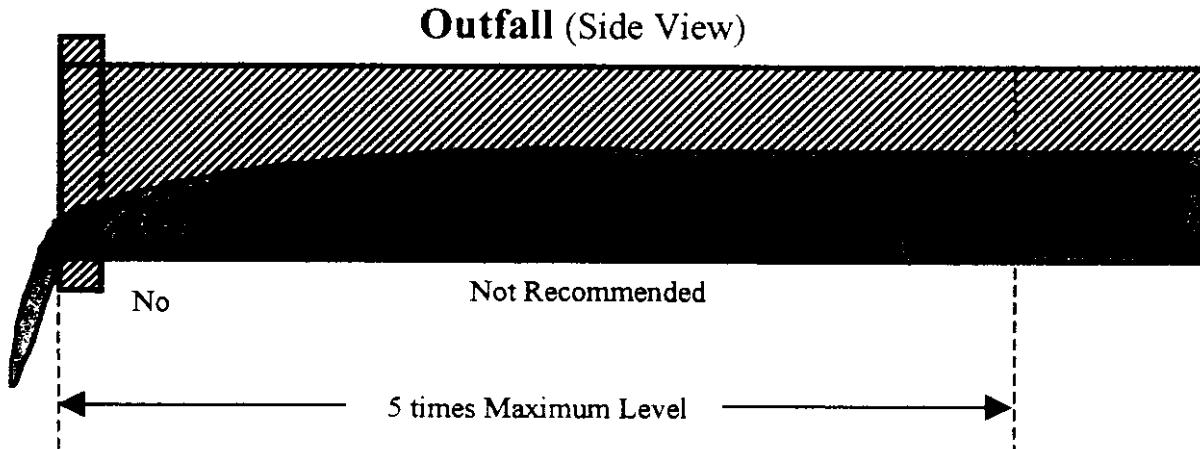
Selecting the Site

This chapter describes various site conditions to consider prior to manhole installation. Site conditions described include outfalls, vertical drops, baffles, elbows, gradual curves, and pipe junctions.

Choose an installation site that gives the best measurements. Locating the sensor above areas of low turbulence will result in the highest accuracy. The best choice for an installation site is a manhole just downstream from a long, straight channel or pipe. Pipe bends, obstructions, or other sources of turbulence (both upstream and downstream from the sensor) can cause problems.

Outfalls

Locate the sensor in a manhole at least five times the pipe diameter (or maximum level) from the outfall. The velocity profile becomes distorted closer to the outfall, making it difficult to obtain accurate measurements



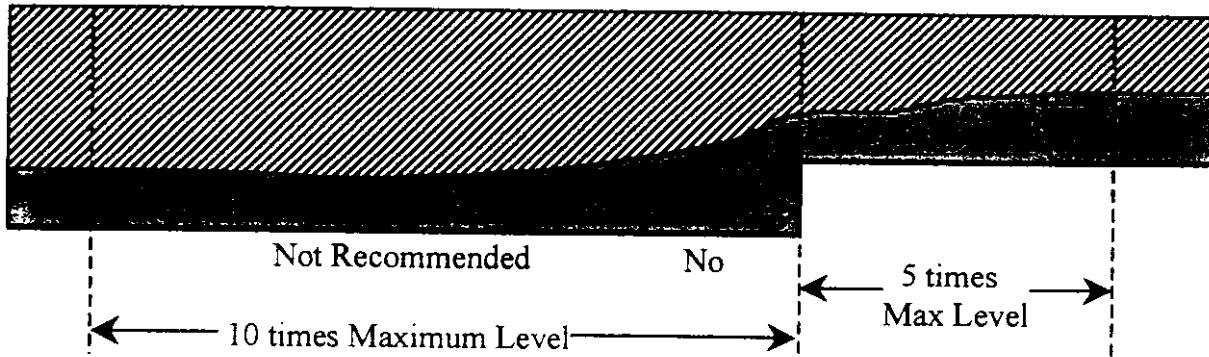
Vertical drops

The sensor should not be placed in a manhole near a vertical drop in the channel. The manhole must be at least five times the pipe diameter (or maximum level) upstream from the vertical drop, or ten times the pipe diameter downstream.

Downstream
installation

Vertical Drop (Side View)

Upstream
installation



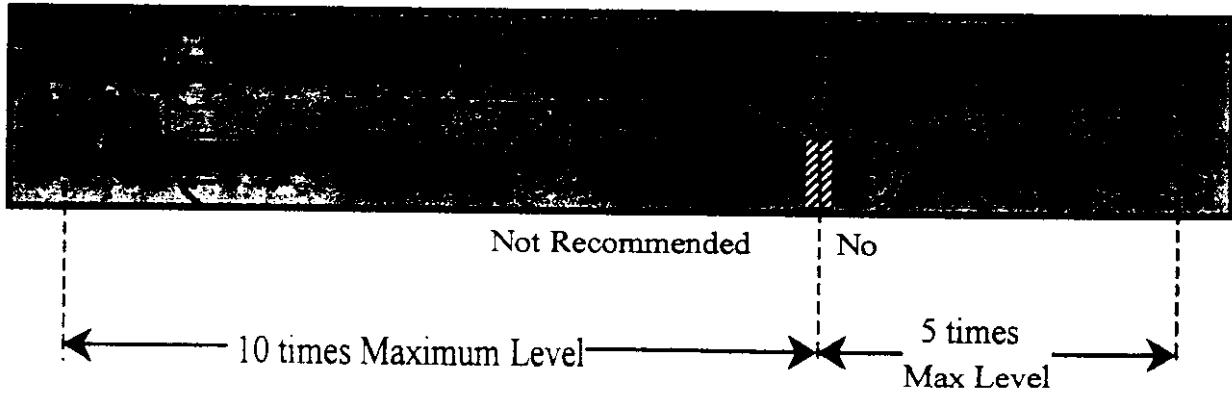
Baffles

The sensor should not be placed in a manhole near a baffle (or other obstruction) in the channel. The manhole must be at least five times the pipe diameter (or maximum level) upstream from the obstruction, or ten times the pipe diameter downstream.

Downstream
installation

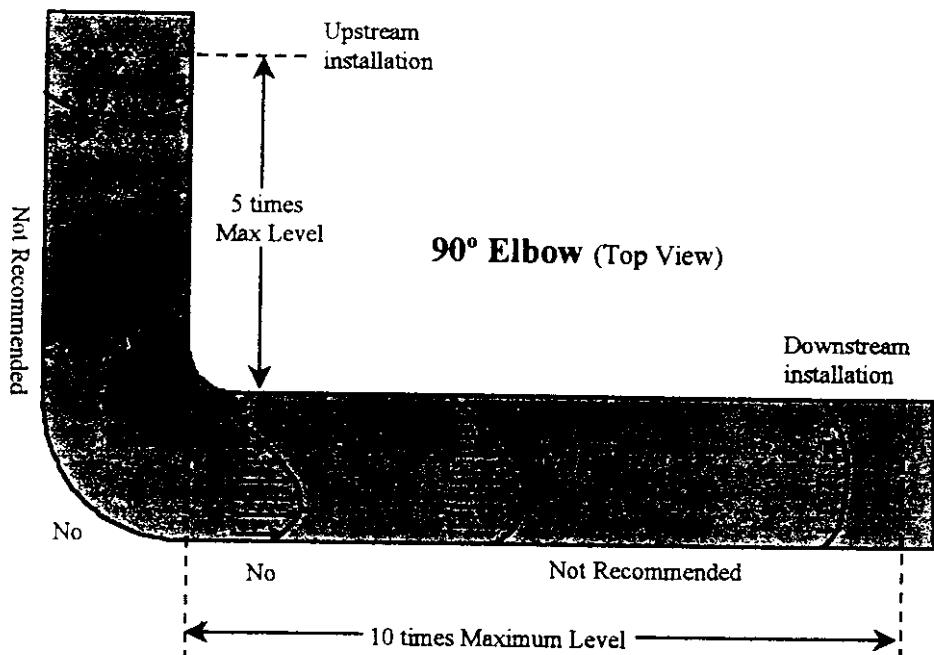
Baffle (Top View)

Upstream
installation



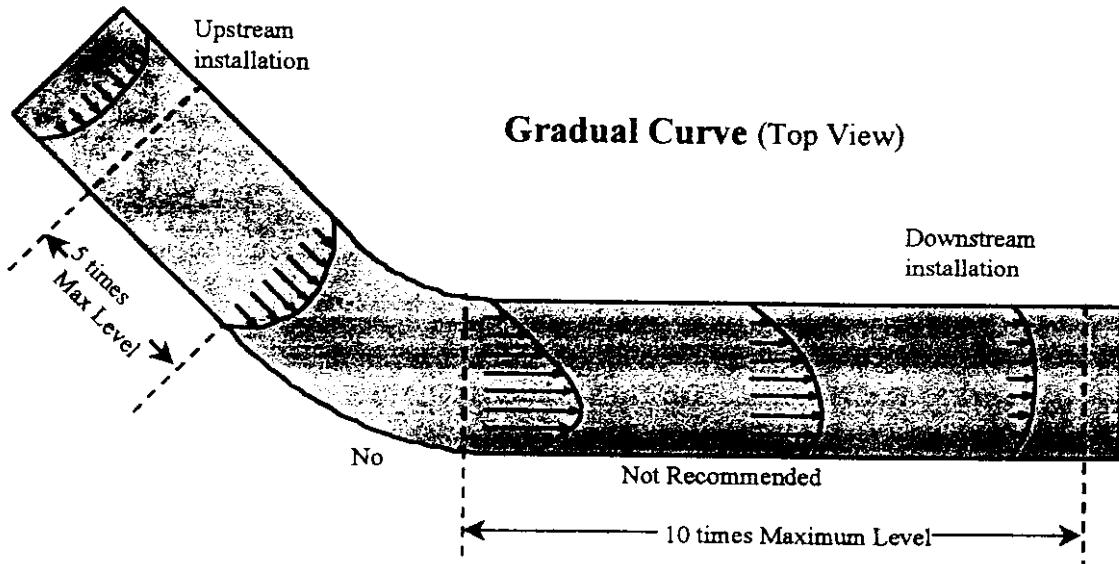
Elbows

If the sensor needs to be installed in a manhole near a curve or elbow, it should be at least five times the pipe diameter (or maximum level) upstream, or ten times the pipe diameter downstream of the bend.



Gradual curves

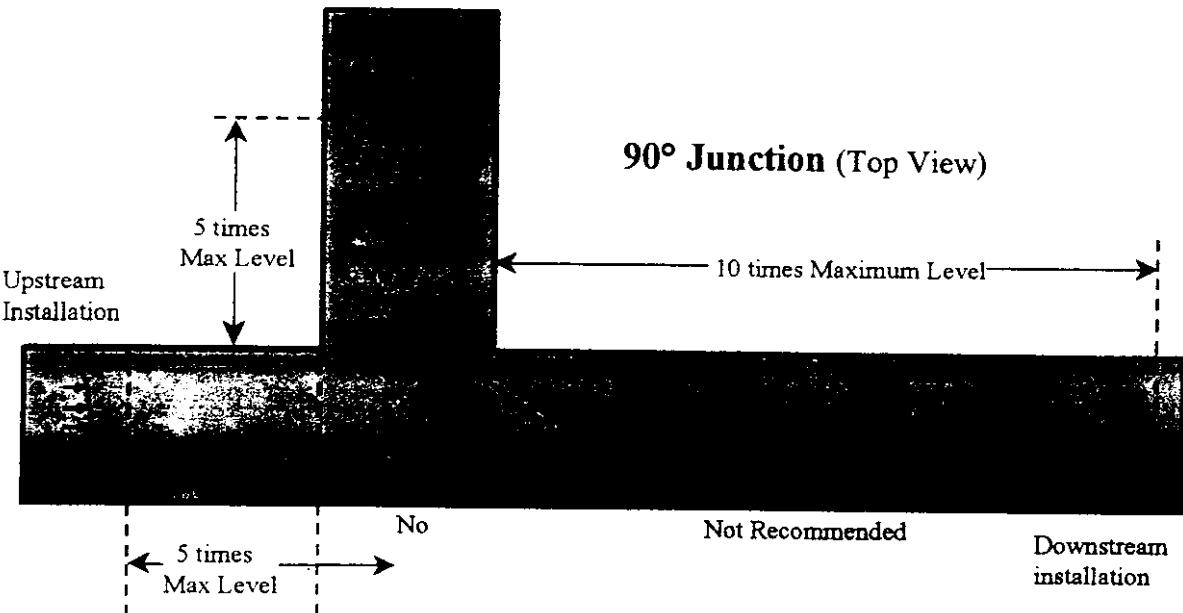
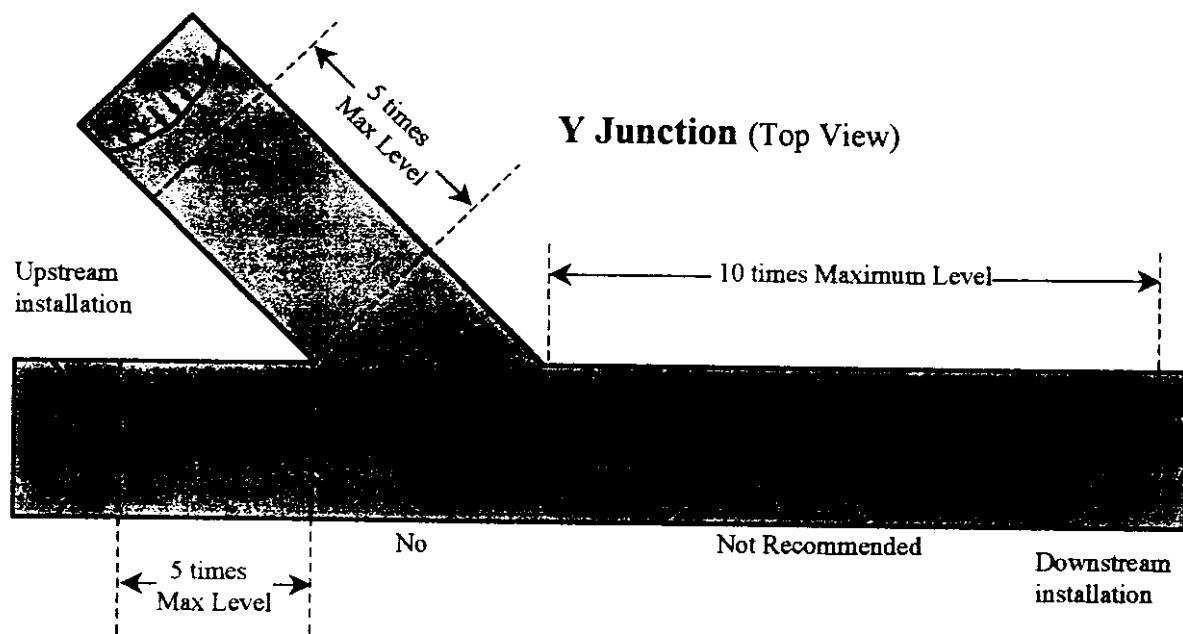
If the sensor needs to be installed in a manhole near a curve or elbow, it should be at least five times the pipe diameter (or maximum level) upstream, or ten times the pipe diameter downstream of the bend.



Pipe junctions

Locate the sensor in a manhole away from any pipe junctions. If the flow in both pipes coming in to the junction is approximately equal, make sure the manhole is at least five times the pipe diameter (or maximum level) upstream, or ten times the pipe diameter downstream from the junction.

Use the pipe diameter (or maximum level) of the pipe below which the sensor is installed. If the flow in one pipe or channel is significantly higher than in the other, install the sensor on the wall closest to the low flow channel.



Chapter 4

Installing the Flo-Dar System

This chapter describes the materials required for installation, how to locate the installation points, installing the sensor frame, installing the sensor, installing the monitor, and attaching the cables.

Installation instructions

The frame is mounted by drilling two holes in the wall of the manhole above the flow, installing two concrete anchors and attaching and aligning the frame. The objective is to level the frame assembly over the center of the flow for optimum location. The sensor is then locked into the frame and connected to a remotely located monitor.

What you need to get started

Before going into the field check that all parts are present (see figure). Also, determine what tools are needed for the complete installation. It is suggested that the frame and mounting hardware be assembled before arriving at the installation site. Loosening the clamps will then allow a normal installation once in the manhole.

Part Number	Quantity	Description
XXX	1	Installation and Operation Manual
880002902	1	Monitor Assembly - Consisting of:
XXX	1	• Monitor Box
XXX	2	• Monitor Box Side Rails
XXX	8	• Philips Head Screws
880002901	1	Sensor Assembly
XXX	1	Cable Assembly
XXX	1	Flo-Tractor Tool
XXX	1	Locking Assembly
XXX	1	Hook Assembly
XXX	1	Alignment Plate
XXX	1	Laser Pointer
800011701	1	Frame Assembly - Consisting of:
422005401	1	• Sensor Mount Frame
422005301	1	• Wall Mount Frame
510011001	1	• Wall Mount Bracket
510011701	1	• Spacer Bar - 2"
510011601	1	• Spacer Bar - 12"
510011501	4	• Clamps
93803	8	• 1/4" Hex-Head Bolt
93047	2	• 3/8 Flat Washer
920003701	2	• 3/8 x 2 1/4" Anchor Wedge
93007	2	• 3/8-15 Hex Nut

Tools required

The following tools will ensure a smooth installation. The hammer drill will be used to drill into the concrete (or brick). The flashlight and mirror will be used to observe upstream or downstream obstructions. The tape measure will be used as an alternate means of measuring (Flo-Tractor recommended).

- Hammer drill
- 1/4" concrete bit
- 3/8" concrete bit
- 7/16" Socket
- 9/16" Socket
- 1/4" Ratchet
- Rubber Mallet
- Marker
- Flashlight
- Mirror
- Tape measure
- Power screwdriver
- Philips screwdriver
- Straight-edge

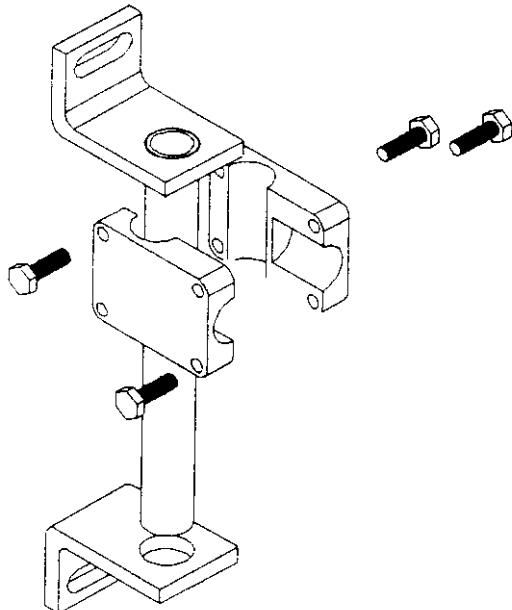
Assembling the wall mount clamp

NOTE

Check anchor bolt threads for obstructions.

- 1 Assemble two clamp halves over wall mount using four 1/4-20 bolts (see figure).
- 2 Insert two bolts in diagonally opposite, non-threaded corners.
- 3 Hand tighten bolts until they are finger-tight.
- 4 Position clamp to just under top bracket.
- 5 Insert and hand tighten the remaining two bolts.

- 6** With a 7/16" socket, tighten bolts just enough to keep clamp in place.

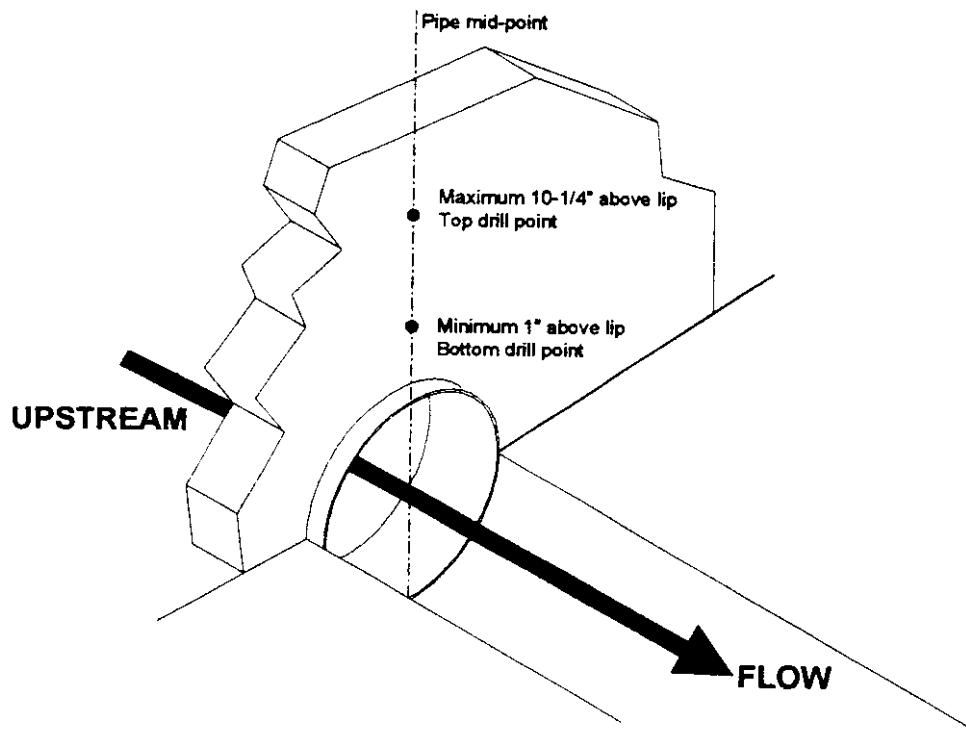


Assembling the frame clamp

- 1** Determine the front end of the frame (see figure). The front end has a knurled area for better gripping action of the clamp.
- 2** Assemble clamp halves over front end of frame using four 1/4-20 bolts.
- 3** Insert two bolts in diagonally opposite, non-threaded corners.
- 4** Hand tighten bolts until they are finger-tight.
- 5** Insert the 2 1/4" spacer in frame clamp. The 10" spacer is provided for a spare 2 1/4" section and a 7 3/4" spacer for pipe lips greater than 5 1/2".
- 6** Insert and hand tighten the remaining two bolts.
- 7** With a 7/16" socket, tighten frame clamp bolts just enough to keep it in place.

Where to install the sensor

Determining the ideal position for the sensor fame by inspecting the upstream and downstream flow characteristics is crucial for proper installation. Use the flashlight and mirror. Flow should be free of any standing waves, pools, undesirable materials, and foreign objects that might disrupt the flow contour.



Locating the sensor above areas of low turbulence will result in the highest accuracy. In general, the best choice for an installation site is a manhole just downstream from a long, straight channel or pipe. It is also important to locate the sensor so that it is accessible for ease of installation and maintenance.

If possible, the bottom of the frame clamp should not be located any closer than 1" from the top of the pipe. This ensures that the sensor is above the flow under normal full flow conditions. The optimum location for the top clamp is 10 3/4" above the pipe lip (fixed distance using the Flo-Tractor).

Upstream and downstream flow disruptions may be checked using a mirror and flashlight. It is desirable to locate the sensor on the upstream wall but it will operate as well on the downstream wall.

After determining the general wall location, proceed with marking and securing the frame assembly as described in the following procedures.

Locate the installation points

- 1 Using the Flo-Tractor, place the hook inside the lip of the pipe (see figure).
- 2 Ensure the hook is centered over the flow in the middle of the pipe.
- 3 Extend the ruled edge of the Flo-Tractor (in an 'L' shape) until the tip just touches the wall.
- 4 Tighten the Flo-Tractor when the angle is 90°.
- 5 Mark the wall indicated by the Flo-Tractor tip. This will be the top hole. The optimum distance from the pipe lip is 10-3/4".

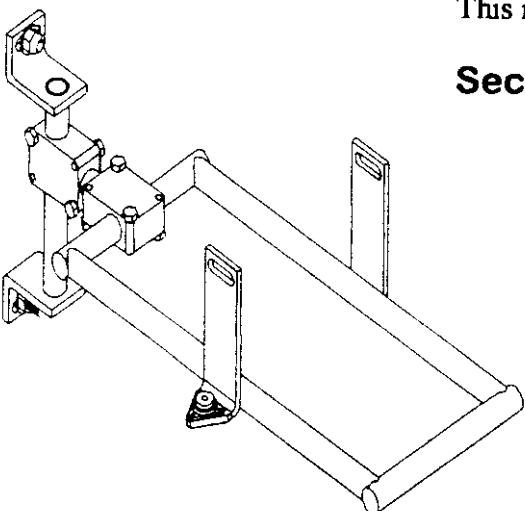
Installing the sensor mount

This installation procedure includes securing and adjusting the frame.

Securing the mounting hardware (top hole)

NOTE

The hole must be at least 1-1/4" to 1-1/2" inch deep. Tape the drill bits at 1-1/2" to ensure that the hole is deep enough.



- 1 Drill a pilot hole using the 1/4" drill bit.
- 2 Drill out the hole using a 3/8" drill bit.
- 3 Remove all debris from the hole.
- 4 Insert the anchor, wedge end first.
- 5 Use the mallet to fully seat the anchor in the hole.
- 6 Slide the top bracket of the wall mount over the threaded portion of the anchor bolt.
- 7 Slide the washer onto the threaded portion flush to the bracket.
- 8 Position, then tighten the nut using a 9/16" socket to draw the wedge into the collar that expands against the hole. Do not over-torque.

Securing the mounting hardware (bottom hole)

- 1 Remove the top bracket in order to slide the bottom bracket onto the wall mount.
- 2 Position the other bracket at the bottom of the wall mount.
- 3 Reposition the top bracket on the anchor and slide the bottom bracket until a suitable drilling surface is found.
- 4 Mark the wall through the bracket slot and remove the wall mount and brackets.
- 5 Drill and clean the second hole using the 1/4" and 3/8" drill bits.
- 6 Insert the anchor, wedge end first.
- 7 Reposition the top and bottom brackets onto the anchors.

NOTE

Loosen top bracket as needed to insert the wall mount into the bracket.

- 8 Slide the washer onto the threaded portion flush to the brackets.
- 9 Position, then tighten the nuts using the 9/16" socket.
- 10 Tighten the both nuts.

Final sensor mount assembly

- 1 Install frame assembly into wall mount clamp.
- 2 Ensure the spacer is fully inserted into the wall mount clamp.
- 3 Ensure that the wall mount clamp is positioned just under the top bracket.
- 4 Tighten all clamp bolts just enough to stabilize frame position.

Vertical adjustment of the frame

- 1 Ensure clamp bolts are just loose enough to move the frame, but tight enough to hold the frame steady once positioned.
- 2 Using the Flo-Tractor, measure the length of the pipe lip.
- 3 Determine how far the wall mount clamp must be lowered using the chart.

Using the 2 1/4" Spacer		Using the 8" Spacer	
If Lip is	Move Clamp Down	If Lip is	Move Clamp Down
0.0"	0.0"	5.7"	0.0"
0.7"	0.5"	6.4"	0.5"
1.4"	1.0"	7.1"	1.0"
2.1"	1.5"	7.8"	1.5"
2.8"	2.0"	8.5"	2.0"
3.5"	2.5"	9.2"	2.5"
4.2"	3.0"	9.9"	3.0"
4.9"	3.5"	10.6"	3.5"
5.6"	4.0"	11.3"	4.0"

- 4 Using the Flo-Tractor, measure down from the underside of the top wall mount bracket.
- 5 Lower the wall mount clamp until the top of clamp aligns with the measurement.
- 6 Tighten clamp bolts.
- 7 Ensure bolts are tight enough to hold the frame steady.

Horizontal adjustment of the frame

- 1 Assemble the alignment tool with the laser pointer in the level sensor hole.
- 2 Position the alignment tool in the frame.
- 3 Check bubble level after each frame movement.
- 4 Loosen frame mount clamp bolts just enough to enable tapping the frame into position.
- 5 Position the tape measure just inside the pipe midpoint horizontally across the flow.
- 6 If the laser beam does not align on the center measurement, tap frame side to side on the front end of the frame (horizontal).
- 7 If the frame assembly still cannot be centered, tap the rear end of the frame (yaw).
- 8 When the bubble is centered and the beam is centered, tighten all bolts.

Remaining adjustments of the frame

- 1** Position the laser pointer in the velocity hole of the alignment plate.
- 2** Check bubble level after each frame movement.
- 3** Loosen frame and wall mount clamp bolts just enough to tap the frame into final position.
- 4** Center the bubble by moving the rear of the frame up and down (pitch), left and right (yaw), or by rotating the frame around the spacer axis (roll).
- 5** It may be necessary to re-position the frame horizontally by tapping the front end of the frame.
- 6** Check that the vertical clamp has not moved.
- 7** When the bubble is centered and the beam is aligned with the flow, tighten all bolts.
- 8** Remove the alignment plate and detach the laser pointer.

Alternate adjustment of the frame

Use this alignment when the laser pointer and alignment tool are unavailable.

- 1** Check bubble level after each frame movement.
- 2** Loosen frame and wall mount clamp bolts just enough to tap the frame into final position.
- 3** Fully extend the Flo-Tractor and tighten the wing nut.
- 4** Determine the center point of the flow using the tape measure.
- 5** Holding the tape measure across the pipe, use the Flo-Tractor to sight the inside center of the front frame (knurled area) down to the tape measure.
- 6** Hold the Flo-Tractor at the top approximately 3 1/2" in front of the uprights of the frame with two fingers so that it naturally comes to rest perpendicularly to the flow.
- 7** Move the Flo-Tractor until the center point of the tape measure is found.
- 8** Note where the Flo-Tractor top aligns with the middle of the knurled area.

- 9** Move the frame horizontally by tapping the front end of the frame.
- 10** Center the bubble by moving the rear of the frame up and down (pitch), left and right (yaw), or by rotating the frame around the spacer axis (roll).
- 11** It may be necessary to reposition the frame horizontally by tapping the front end of the frame.
- 12** Check that the vertical clamp has not moved.
- 13** Check that the horizontal placement is still centered.
- 14** When the bubble is centered and the beam is aligned with the flow, tighten all bolts.

Measuring the height above flow

This calculation is critical. This will enable the sensor to determine the height above the bottom of the pipe (for the level transducer) and to enter into a surcharge mode when the flow breaches the crown of the pipe.

- 1** Assemble the Flo-Tractor into an "L" configuration.
- 2** Position the Flo-Tractor pointer section under the center lip into the pipe at least six inches to form a firm base.
- 3** Adjust the vertical extension length of the Flo-Tractor at the base to fully extend beyond the frame clamp.
- 4** Check that both sections of the Flo-Tractor are flush at the base (zero inches). When the extension is fully upright at 90 degrees, tighten the wing nut.
- 5** Slide the pointer section along the inside pipe until the top of the extension contacts the inside face of the alignment tool (approximate bottom of the level transducer).
- 6** Record the height measurement as read along the top of the alignment tool.

This measurement will be entered into the Site Setup procedure as the Sensor Level Offset. The fixed distance between the bottom of the level transducer and the top of the frame clamp will be accounted for in the software calculations.

Alternate measurement: height above flow

This calculation is critical. This will enable the sensor to determine the height above the bottom of the pipe (for the level transducer) and to enter into a surcharge mode when the flow breaches the top of the pipe. Use this alignment procedure when the alignment tool is unavailable.

- 1** Assemble the Flo-Tractor into an "L" configuration.
- 2** Position the Flo-Tractor pointer section under the center lip into the pipe at least six inches to form a firm base.
- 3** Adjust the vertical extension length of the Flo-Tractor at the base to fully extend beyond the frame clamp.
- 4** Check that both sections of the Flo-Tractor are flush at the base (zero inches). When the extension is fully upright at 90 degrees, tighten the wing nut.
- 5** Position the Flo-Tractor extension approximately 3 1/2" in front of the uprights.
- 6** Subtract one inch (1") and record the height measurement as read along the top of the frame clamp. Ensure zero inches at the base before making the height reading.

This measurement will be entered into the Site Setup procedure as the Sensor Level Offset. The fixed distance between the bottom of the level transducer and the top of the frame clamp will be accounted for in the software calculations.

Measuring the pipe inside diameter

This calculation is also critical. This will enable the sensor to determine the height above the bottom of the pipe (for the level transducer) and to enter into a surcharge mode when the flow breaches the top of the pipe.

- 1** Assemble the Flo-Tractor into a "V" configuration.
- 2** Position the Flo-Tractor pointers inside the center of the pipe walls.
- 3** Check inside pipe diameter at three locations.
- 4** Re-tighten the Flo-Tractor after each measurement.
- 5** Use the tape measure to record the outside distance between the Flo-Tractor tips after each measurement.
- 6** Take the average of the three measurements to represent the inside diameter of the pipe.
- 7** Record the pipe inside diameter (ID) measurement.

- 8 Adding the two height measurements (Pipe ID and Sensor Level Offset) will be performed in software to determine the overall distance between the level transducer and the bottom of the pipe.

Alternate measurement: pipe inside diameter

This calculation is also critical. This will enable the sensor to determine the height above the bottom of the pipe (for the level transducer) and to enter into a surcharge mode when the flow breaches the top of the pipe. Use this procedure when the Flo-Tractor is unavailable.

- 1 Use the tape measure to record the inside pipe diameter in at least three places.
- 2 If using the tape measure is impractical (for larger pipes), use a straight edge and marker in at least three places.
- 3 Record each measurement.
- 4 Take the average of the three measurements to represent the inside diameter of the pipe.
- 5 Record the pipe inside diameter (ID) measurement.

Adding the two height measurements (Pipe ID and Sensor Level Offset) will be performed in software to determine the overall distance between the level transducer and the bottom of the pipe.

Installing the sensor

The sensor may be moved from one site to another without entering the manhole. Only the initial frame installation requires entering the manhole. The cable connects the sensor unit (factory installed) to the secondary unit (customer installed). Do not remove the cable at the sensor end unless required to do so. See Chapter 8, Flo-Dar System Maintenance.

CAUTION

Never raise or lower the sensor with the cable. Always use the pole.

Sensor installation

The sensor only fits into the frame one way. Properly installed, the sensor handle will point away from the wall. The sensor is positioned and locked into the frame using a pole with the hook attachment. The hook fits into the locking bar of the sensor and lowered into the frame with the cable trailing away to the center of the manhole.

- 1** Check cable connection to sensor. Connector is keyed to fit only one way.
- 2** Ensure hook attachment is securely attached to the end of the pole.
- 3** Position hook into sensor locking bar.
- 4** Lower sensor with cable trailing away from the manhole wall onto the frame.
- 5** Turn pole clockwise to engage the locking bars into the frame side mounts.

CAUTION

The locking bars will only turn so far. Do not force the bars beyond the stops.

- 6** Coil excess cable and secure to top rung of manhole.

CAUTION

Do not apply stress to the sensor end of the cable. Allow some slack after the coil is secured

Optional installation

The sensor may be reinstalled without entering the manhole. The procedure above may be used in those instances. The frame must be installed by entering the manhole just once. At that time, the sensor may be installed to check the system alignment. In this instance you will not need the pole and hook attachment. The sensor lock may be turned by hand. If the sensor is installed, observe all cautions concerning the cable described in the standard installation.

Installing the Monitor Unit

The monitor unit is housed in a weather-tight enclosure (NEMA 4). The basic installation includes three steps:

- 1** Determine the installation location.
- 2** Mounting the electronics housing.
- 3** Connect sensor cable, I/O connections and power. For the I/O connections use 22 AWG, stranded, twisted pairs with a minimum 65% overall braid. For the power connection use 18 AWG, stranded with 85% overall braid.

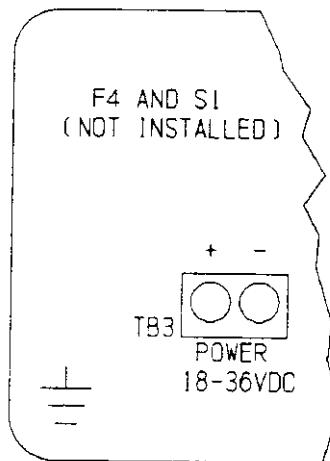
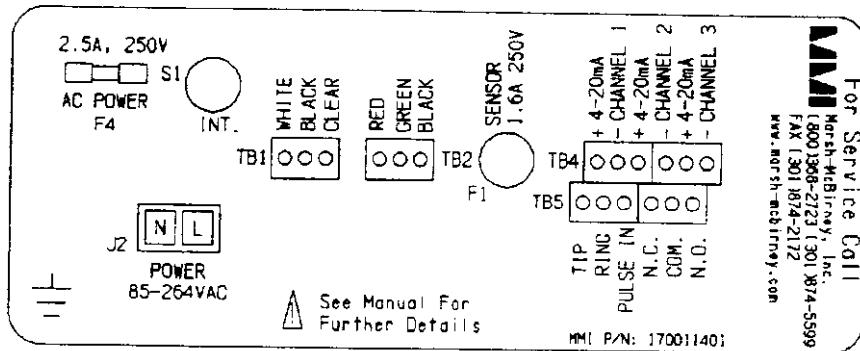
Securing the monitor

Mount the monitor at eye level in an electronics shed, environmental enclosure, or outdoors with protective covering. The monitor is not suitable for manhole installations. The monitor uses two side channels as templates to locate the eight mounting holes.

- 1** Position the unit against at the desired with the side channels in place (as delivered).
- 2** Install the top two screws (left and right) first. The unit should be approximately level with the plugged end facing downward.
- 3** Continue to install the remaining six screws, alternately left and right.
- 4** Ensure unit is secure.

CAUTION

Always disconnect the power before attempting any electrical connections.



Connecting the earth ground

The earth ground wire should be connected first. A protective earth ground post is located on the bottom left of the unit.

- 1 Locate the earth ground post.
- 2 Using a screwdriver, secure the earth ground wire.
- 3 Confirm earth ground rod connection secure.

Connecting the AC power (use 18 AWG, stranded with 85% overall braid)

Remove the bottom cover. Note that the location and nomenclature of all connections are labeled on the inside of the cover.

The ground wire should be connected first. The protective grounding terminal is located in the lower left corner of the box.

- 1 Ensure earth ground connection in place.
- 2 Locate AC power connector.
- 3 Thread the cable through the adapter.
- 4 Using a screwdriver, connect the ground wire.

- 5 Using a screwdriver, connect the remaining two connections to the AC power jack (J2).
- 6 Confirm AC power cable leads connected properly before connecting to power source.

Connecting the DC power (Use 18 AWG, stranded with 85% overall braid)

The DC power cord ground wire should be connected first.

- 1 Ensure earth ground connection in place.
- 2 Locate DC terminal board (TB3).
- 3 Thread the cable through the adapter.
- 4 Using a screwdriver, connect the ground wire.
- 5 Using a screwdriver, connect the negative lead first and then the positive lead.
- 6 Confirm DC power cable leads connected properly before connecting to power source

Connecting the sensor cable

CAUTION

If conduit is installed from the monitor to the sensor the conduit must be sealed to keep sewer gases out of the electronics.

WARNING

Disconnect power before making connections.

- 1 Ensure the earth ground is connected.
- 2 Note that the location and nomenclature of all connections are labeled on the inside of the bottom cover.
- 3 Locate the terminal blocks for the sensor cable connections (TB1) and power (TB2).
- 4 Thread the cable through the closest feet thru to the terminal boards (TB1 and TB2).

- 5 Use a small screwdriver to secure each. Confirm connections using the color code.

Connecting the 4-20ma outputs (Use 22 AWG, stranded, twisted pair with minimum 65% overall braid.)

WARNING

Disconnect power before making connections.

- 1 Ensure earth ground is connected.
- 2 Remove plug closest to the current loop terminals.
- 3 Install feed through.
- 4 Note that the location and nomenclature of all connections are labeled on the inside of the bottom cover.
- 5 Thread the cable through feed thru to the terminal board (TB4).
- 6 Connect cable drain wire or shield to conduit nut
- 7 Each terminal is labeled for polarity (+, -). This is the voltage polarity when a load resistance is placed across the terminals.
- 8 Use a small screwdriver to secure each connection

Connecting the external pulse input

WARNING

Disconnect power before making connections.

- 1 Ensure earth ground is connected.
- 2 Note that the location and nomenclature of all connections are labeled on the inside of the bottom cover.
- 3 Locate the terminal for the pulse in connection. (TB5).
- 4 Thread the cable through the closest feed thru to the terminal board (TB5).

5 Connect cable drain wire or shield to conduit nut.

6 Use a screwdriver to secure each connection

Connecting the contact closure (Use 22 AWG, stranded, twisted pair with minimum 65% overall braid)

WARNING

Disconnect power before making connections.

1 Ensure earth ground is connected.

2 Install $\frac{3}{4}$ " conduit adapter or feed thru.

3 Note that the location and nomenclature of all connections are labeled on the inside of the bottom cover.

4 Thread the cable through the closest adapter to the terminal board (TB5).

5 Connect cable drain wire or shield to conduit nut.

6 Use a small screwdriver to secure each connection as listed in the accompanying chart. Confirm connections using the accompanying chart.

Final check prior to connecting power

1 Check all connections.

2 Replace bottom panel cover.

3 Tighten screws on cover.

WARNING

Hazardous supply voltage can shock or cause death.

Connect to Power Source

WARNING

Do not connect AC power to a DC Monitor.

Recording installation measurements

- 1 Fill out form with site peculiar data (location, ID, description).
- 2 Enter the installation date.
- 3 Record the serial numbers of the monitor and sensor.
- 4 Record pipe Inside Dimension (ID) number.
- 5 Record sensor level offset (Level Transducer height above pipe crown) number.

SITE LOCATION:	SITE ID:	INSTALL DATE:
SITE DESCRIPTION:		
SENSOR SERIAL NUMBER	MONITOR SERIAL NUMBER:	
PIPE ID:	NOTES	
SENSOR LEVEL OFFSET		
SEDIMENT LEVEL OFFSET		

Chapter 5

Flo-Dar System Operations

Before applying power to the equipment

Make sure the secondary unit is properly secured and all cables are connected according to the procedures in Section 5.

Applying power to the equipment

The monitor is shipped from the factory as either an AC powered unit or as a DC powered unit. The AC powered unit can accept either 110 VAC or 220 VAC input power. When power to the unit is first applied, the MMI logo appears for a short time and is replaced automatically by the MAIN menu.

Using the Monitor Unit

The touchscreen is accessible by lifting the hinged clear plastic top. The touchscreen is backlit upon demand by either swiping the touchscreen face anywhere or pushing the touch screen activate button on the unit. An internal timeout circuit removes the +5Vdc that lights the screen if no activity is sensed and the counter reaches zero after two minutes. To backlight the screen again, simply swipe the touchscreen anywhere or push the touch screen activate button on the unit and the counter resets to two minutes.

Using the Touchscreen

The first touch of a key queues the function (color changes gray to green). The second touch initiates the task (green to gray). With the selected key green, an associated display is available for data entry. Keypads are used to enter alpha or numeric characters. The alpha characters are first selected into an unused keypad field and then selected to the display area. Numbers are entered directly to the display areas. Dialogs are used to prompt the operator for selections on each submenu. Pop-up warnings are used to ensure that there is no data lost or data overwritten.

ACCEPT key

The ACCEPT key is used to record the data from a submenu and exit to the MAIN menu.

CANCEL key

The CANCEL key can be used at anytime to reset the submenu to the previous state and return to the previous menu.

BKSP key

The BKSP (Backspace) key is used to remove any characters entered in error.

A/N key

The A/N (Alpha/Numeric) key is used to switch between the alpha and numeric keypads.

MAIN menu

This page enables access to the 12 submenus.

PASSWORD submenu (TBD)

The password submenu enables access to the interactive submenus or permits the operator to either change and verify the existing password or to deactivate the password function.

PASSWORD Key

- 1** Select the PASSWORD key. The PASSWORD key illuminates GREEN.
- 2** Enter the password.
- 3** Use the Alphabetical keypad to select the letter.
- 4** Touch the displayed character key to enter the letter.
- 5** An asterisk (*) will appear in the PASSWORD display.
- 6** With all characters entered (and asterisks displayed), touch PASSWORD again to execute.
- 7** The PASSWORD key changes to GRAY if the password was entered correctly.

- 8 If the password was entered incorrectly, all displayed asterisks are removed, the PASSWORD key illuminates GREEN, and the process must be repeated.
- 9 Touch the PASSWORD key to begin again.
- 10 Use the ACCEPT key to exit back to the MAIN menu.

NEW key

- 1 Be sure to enter the existing password to access the NEW key function.
- 2 Select the NEW key to activate the new password function. The NEW key illuminates GREEN.
- 3 Enter the new password.
- 4 Use the Alphabetical keypad to select the letter.
- 5 Touch the displayed character key to enter the letter.
- 6 An asterisk (*) will appear in the NEW (Password) display.
- 7 With all characters entered (and asterisks displayed), touch NEW again to execute.
- 8 The NEW key will change to GRAY (subdued).

VERIFY key

- 1 The VERIFY key will remain GRAY until the NEW key function has been executed. Select the VERIFY key to activate the verify new password function. The VERIFY key illuminates GREEN.
- 2 Enter the new password again.
- 3 Use the Alphabetical keypad to select the letter.
- 4 Touch the displayed character key to enter the letter.
- 5 An asterisk (*) will appear in the VERIFY (Password) display.
- 6 With all characters entered (and asterisks displayed), touch VERIFY again to execute.
- 7 The VERIFY key will change to GRAY (subdued) if the verification is successful.
- 8 If the verification is not successful, the VERIFY key will remain GREEN.

- 9 Select the ACCEPT key to record the new password and to exit to the Main menu.

Disabling the password function

- 1 Enter the existing password to access all menu functions.
- 2 Touch the NEW key twice to enter no characters as the new password. The NEW key illuminates GREEN then GRAY.
- 3 Touch the VERIFY key twice to verify no characters in the new password. The VERIFY key illuminates GREEN then GRAY.
- 4 Select the ACCEPT key to record that the password function is deactivated and to exit to the MAIN menu.

BKSP key

Use the BKSP (Backspace) key to remove any characters entered in error.

SET-UP ALL key (TBD)

This Main menu function, SETUP ALL key, will lead a first time user through all installation and setup options. Touching the SET-UP ALL key displays a pop-up warning "CHOOSING THIS OPTION WILL INITIATE A COMPLETE SETUP SEQUENCE. ARE YOU SURE? NO YES". The submenus and options will be presented in a definite sequence as follows:

- **PASSWORD:** Activate, Deactivate, Change
- **SITE ID:** Language, Site identification, Site Description
- **UNITS OF MEASURE:** Flow, Velocity, Level, Totalizer
- **SHAPES & LEVELS:** Pipe Shape, Sensor Direction, Sensor Level Offset, Sediment Level
- **4-20mA OUTPUTS:** Flow, Velocity, Level
- **CONTACT CLOSURE:** Channel (Flow, Velocity, Level), Units of Measure, Set Point
- **TOTALIZER:** Reset Total, Units of Measure, Set Point

Refer to the submenu descriptions in this chapter before continuing. Select the SET-UP ALL key again to proceed.

DATA submenu

This submenu is the default (read-only) menu during normal operations with the exception of the display contrast controls, all other displays are read only

- Flow Rate: Displays the flow rate.
- Velocity: Displays the velocity.
- Level: Displays the liquid level.
- Total Flow: Displays total flow (Totalizer)
- Display Contrast Controls

Select the MAIN MENU key to return to the MAIN menu.

SITE ID submenu

The SITE ID submenu enables the user to define three site functions: site identification, installation date and site description. Instructions to the operator appear in a dialog box. The default instruction is "SELECT OPTION".

SITE ID key

- 1 Touch the SITE ID key (color changes to GREEN). The dialog "ENTER TEXT, RESELECT OPTION TO ACCEPT" appears when the SITE ID key is selected.
- 2 Enter the Site Identification characters.
- 3 Use the A/N key to toggle between the Alphabetical and Numeric keypad.
- 4 Touch the letter key to select the character.
- 5 Touch the displayed letter key to enter it to the SITE ID display.
- 6 Numeric keys are entered directly to the SITE ID display.
- 7 Touch the SITE DESCRIPTION key (changes back to GREY) to continue on this submenu or touch the ACCEPT key to record the Site Identification data displayed and exit to the MAIN menu.

INSTALL DATE key

- 1** Touch the INSTALL DATE key (color changes to GREEN). The dialog "ENTER TEXT, RESELECT OPTION TO ACCEPT" appears when the INSTALL DATE key is selected.
- 2** Touch the number key to enter the INSTALLATION DATE (8 characters) (Example: 01291999 – January 29, 1999)
- 3** Touch the INSTALL DATE key (changes back to GREY) to continue on this submenu or touch the ACCEPT key to record the Installation Date displayed and exit to the MAIN menu.

SITE DESCRIPTION key

- 1** Touch the SITE DESCRIPTION key (color changes to GREEN). The dialog "ENTER TEXT, RESELECT OPTION TO ACCEPT" appears when the SITE DESCRIPTION key is selected.
- 2** Enter the Site Description characters.
- 3** Use the A/N key to toggle between the Alphabetical and Numeric keypad.
- 4** Touch the letter key to display the character.
- 5** Touch the displayed letter key to enter it to the SITE DESCRIPTION display.
- 6** Numeric keys are entered directly to the SITE DESCRIPTION display.
- 7** With all characters entered and this submenu completed, touch the ACCEPT key to execute and automatically exit to the MAIN menu.
- 8** The SITE DESCRIPTION key changes to GRAY.

UNITS OF MEASURE submenu

Only one of the four keys is functional at one time. The default instruction is “SELECT OPTION”. Touch the desired parameter key repeatedly to cycle through the options, which are displayed immediately to the left. Touch the ACCEPT key to record selections and to exit to the MAIN menu.

FLOW RATE key

- GPS – Gallons per second
- GPM – Gallons per minute
- GPH – Gallons per hour
- LPS – Liters per second
- LPM – Liters per minute
- LPH – Liters per hour
- MGD – Million Gallons per Day
- AFD – Acre Feed per Day
- CFS – Cubic Feet per Second
- CFM – Cubic Feet per Minute
- CFH – Cubic Feet per Hour
- CFD – Cubic Feet per Day
- CMS – Cubic Meters per Second
- CMM – Cubic Meters per Minute
- CMH – Cubic Meters per Hour
- CMD – Cubic Meters per Day

VELOCITY key

- FPS – Feet per second
- CPS – Centimeters per second

LEVEL key

- In – Inches
- Ft – Feet
- Cm – Centimeters
- M – Meters

TOTAL FLOW key

- GAL – Gallons
- MG – Million Gallons
- CF – Cubic Feet
- AF – Acre Feet
- L – Liters
- ML – Million Liters
- CM – Cubic Meters

ACCEPT key

Touch the ACCEPT key to record the data from this submenu and exit to the MAIN menu.

CANCEL key

Touch the CANCEL key anytime to reset the submenu to the default state and return to the MAIN menu.

SHAPES & LEVELS submenu

This submenu defines the pipe shape, the sensor offset and the sediment level required for the monitor to determine the cross-sectional area of the channel. The four shapes are mutually exclusive in that only one may be selected. It also permits the user to define the direction of the sensor relative to the flow in the pipe.

SHAPE keys

- 1 Touch the SHAPE key repeatedly to display the shape of the pipe below the sensor. The choices are Round, Rectangle, Oval, and Egg.
- 2 Once the shape is displayed, select one of the associated keys to input the pipe dimensions. The dialog "ENTER TEXT, RESELECT OPTION TO ACCEPT" appears when the associated dimension key is selected. The numeric keypad will temporarily obscure the right-hand side until all pipe dimensions for that shape have been entered.

ROUND key

If the ROUND shape was selected:

- 1 Touch the PIPE I.D key (color changes to GREEN).
- 2 Use the numeric keypad to enter the inside diameter of the pipe.
- 3 Touch the PIPE I.D key (changes to GREY).

RECTANGLE key

If the RECTANGLE shape was selected:

- 1 Touch the HEIGHT key (color changes to GREEN).
- 2 Use the numeric keypad to enter the inside pipe height.
- 3 Touch the WIDTH key: (the WIDTH key changes to GREEN and the HEIGHT key changes to GREY).
- 4 Use the numeric keypad to enter the inside pipe width.
- 5 Touch the WIDTH key (changes to GREY).

OVAL key

If the OVAL shape was selected:

- 1** Touch the HEIGHT key (color changes to GREEN).
- 2** Use the numeric keypad to enter the inside pipe height.
- 3** Touch the WIDTH key: the WIDTH key changes to GREEN). The HEIGHT key changes to GREY.
- 4** Use the numeric keypad to enter the inside pipe width.
- 5** Touch the WIDTH key (changes to GREY).

EGG key

If the EGG shape was selected:

- 1** Touch the TOP RADIUS key (color changes to GREEN).
- 2** Use the numeric keypad to enter the inside top radius.
- 3** Touch the SIDE RADIUS key: the SIDE RADIUS key changes to GREEN. The TOP RADIUS key changes to GREY.
- 4** Use the numeric keypad to enter the inside side radius.
- 5** Touch the BOTTOM RADIUS key: the BOTTOM RADIUS key changes to GREEN. The SIDE RADIUS key changes to GREY.
- 6** Use the numeric keypad to enter the inside bottom radius.
- 7** Touch the BOTTOM RADIUS key (changes to GREY).

SENSOR DIRECTION key

Touch the SENSOR DIRECTION key to display either UPSTREAM or DOWNSTREAM depending upon which way the sensor is pointing.

SENSOR LEVEL OFFSET key

This key is used to define the distance between the top of the sensor mounting frame and the bottom of the pipe or channel.

- 1** Touch the SENSOR OFFSET key (color changes to GREEN).
- 2** The numeric keypad will temporarily obscure the left-hand side until the key is touched again.

- 3** Use the numeric keypad to enter the measured distance between the top of the sensor mounting frame assembly and the bottom of the pipe.
- 4** Touch the SENSOR OFFSET key (changes to GREY) or select the SEDIMENT LEVEL key.

SEDIMENT LEVEL key

- 1** Touch the SEDIMENT LEVEL key (color changes to GREEN).
- 2** The numeric keypad will temporarily obscure the right-hand side until the key is touched again.
- 3** Use the numeric keypad to enter the measured or estimated height of in the pipe.
- 4** Touch the SEDIMENT LEVEL OFFSET key (changes to GREY).

ACCEPT key

Touch the ACCEPT key to record the data from this submenu and exit to the MAIN menu.

CANCEL key

Touch the CANCEL key anytime to reset the submenu to the default state and exit to the MAIN menu.

BKSP key

Use the BKSP (Backspace) key to remove any numbers entered in error.

4 - 20 mA OUTPUTS submenu

This submenu enables the user to define the range of measurement (both minimum and maximum) of the three 4-20 mA outputs (TOTAL FLOW, VELOCITY and LEVEL). If the 4-20 mA output(s) are being used with a chart recorder, a particular range may be chosen to maximize the resolution for a particular scale. For example, suppose the chart is scaled from 0 to 70 GPM. To match the 4-20 output to the chart scale, the 4-20 mA output is set for 0 to 100 GPM.

TOTAL FLOW key

- 1 Touch the TOTAL FLOW key (color changes to GREEN).
- 2 The 4mA display segment is highlighted.
- 3 Use the numeric keypad to enter the low end of the measurement range
- 4 Touch the TOTAL FLOW key again.
- 5 The 20mA display segment is highlighted.
- 6 Use the numeric keypad to enter the high end of the measurement range
- 7 Touch the TOTAL FLOW key again or touch the VELOCITY key to continue.
- 8 The TOTAL FLOW key changes to GREY.

VELOCITY key

- 1 Touch the VELOCITY key (color changes to GREEN).
- 2 The 4mA display segment is highlighted.
- 3 Use the numeric keypad to enter the low high end of the measurement range
- 4 Touch the VELOCITY key again.
- 5 The 20mA display segment is highlighted.
- 6 Use the numeric keypad to enter the high end of the measurement range
- 7 Touch the VELOCITY key again or touch the LEVEL key to continue.
- 8 The VELOCITY key changes to GREY.

LEVEL key

- 1** Touch the LEVEL key (color changes to GREEN).
- 2** The 4mA display segment is highlighted.
- 3** Use the numeric keypad to enter the low end of the measurement range
- 4** Touch the LEVEL key again.
- 5** The 20mA display segment is highlighted.
- 6** Use the numeric keypad to enter the high end of the measurement range
- 7** Touch the LEVEL key again. (color changes to GREY).

ACCEPT key

Touch the ACCEPT key to record the data from this submenu and exit to the MAIN menu.

CANCEL key

Touch the CANCEL key anytime to reset the submenu to the previous values.

BKSP key

Use the BKSP (Backspace) key to remove any numbers entered in error.

CONTACT CLOSURE submenu

The contact closure output is an electrical relay switch used to activate an external device when a selected parameter (VELOCITY, LEVEL OR TOTAL FLOW) reaches a predetermined set point (TOTAL FLOW) or is less than, equal to or greater than the set point (VELOCITY AND LEVEL). The relay switch closure can either be continuous (switch stays closed as long as the TYPE and SET POINT conditions are met) or momentary (switch momentarily closes when the TYPE and SET POINT conditions are met). This submenu enables the user to define the PARAMETER, TYPE, SET POINT and CLOSURE characteristics.

PARAMETER key

The PARAMETER key is used to cycle through the associated display for Velocity, Level, and Total Flow. The three channels are mutually exclusive in that only one may be selected. Touch the PARAMETER key repeatedly to display the desired channel.

TYPE key

The TYPE key permits the user to toggle through the type of parameter closure desired.

- 1 For VELOCITY, touch the TYPE key to toggle between GTR THAN (greater than), LESS THAN (less than), or EQUAL TO (equal to) for the set point to be entered.
- 2 For LEVEL, touch the TYPE key to toggle between GTR THAN (greater than), LESS THAN (less than), or EQUAL TO (equal to) for the set point to be entered.
- 3 For TOTAL FLOW, touch the TYPE key to toggle between POS FLOW (positive total flow), NEG FLOW (negative total flow), or NET FLOW.

SET POINT key

The SET POINT key permits the user to select the point at which the switch closure occurs.

- 1 Touch the SET POINT key (color changes to GREEN).
- 2 Use the numeric keypad to enter the set point of the parameter selected.
- 3 Next, touch the CLOSURE key to SELECT the type of switch closure (continuous or momentary)

- 4 If MOMENTARY is selected, use the numeric keypad to enter the number of milliseconds that the switch will remain closed.

ACCEPT key

Touch the ACCEPT key to record the data from this submenu.

CANCEL key

Touch the CANCEL key anytime to reset the submenu to the previous setting.

BKSP key

Use the BKSP (Backspace) key to remove any numbers entered in error.

TOTALIZER submenu (TBD)

The TOTALIZER submenu provides options to reset the totalizer flow data and to select the positive or negative flow.

RESET TOTAL key

The RESET TOTAL key permits the user to reset the total flow value to zero and begin another cycle.

- 1 Touch the RESET TOTAL key (illuminates GREEN).
- 2 Touching the RESET TOTAL key pops up a warning "ARE YOU SURE? YES NO".
- 3 If the operator selects YES, the RESET TOTAL key changes to GRAY and the associated units of measure shows a zero value.
- 4 If the operator selects NO, the RESET TOTAL display remains unchanged and the pop up dialog box disappears.

TYPE key

The TYPE key permits the user to toggle through the type of totalizer to be viewed. The default view is POSITIVE flow. The default instruction is "SELECT OPTION".

- 1 Touch the TYPE key for negative total flow selection.
- 2 Touch the key again to toggle back to the positive total flow selection.

ACCEPT key

Touch the ACCEPT key to record the data from this submenu and to exit to the MAIN menu.

CANCEL key

Touch the CANCEL key anytime to reset the submenu to the default state.

BKSP key

Use the BKSP (Backspace) key to remove any numbers entered in error.

TESTS submenu

The TESTS submenu enables the user to test the 4-20 mA outputs and the relay closure.

FLOW key

- 1 Select the FLOW key (color changes to GREEN) to enter a mA value within the specified range of the 4 – 20mA. The dialog ‘ENTER TEXT, RESELECT OPTION TO ACCEPT’ appears when the key is selected.
- 2 Using the numeric keypad, enter a value between 4 and 20.
- 3 Re-select the FLOW key to activate the test
- 4 Using an ampmeter, measure the output at the remote recording device or at the monitor 4-20 mA output. (Channel 1)
- 5 The test may be terminated by touching the MAIN MENU key.

VELOCITY key

- 1 Select the VELOCITY key (color changes to GREEN) to enter a mA value within the specified range of the 4 – 20mA. The dialog ‘ENTER TEXT, RESELECT OPTION TO ACCEPT’ appears when the key is selected.
- 2 Using the numeric keypad, enter a value between 4 and 20
- 3 Reselect the VELOCITY key to activate the test.
- 4 Using an ampmeter, measure the output at the remote recording device or at the monitor 4-20 mA output. (Channel 2).
- 5 This test may be terminated by touching the MAIN MENU key.

LEVEL key

- 1 Select the LEVEL key (color changes to GREEN) to enter an mA value within the specified range of the 4-20mA. The dialog ‘ENTER TEXT AND RESELECT OPTION TO ACCEPT’ appears when the key is selected.
- 2 Using the numeric keypad, enter a value between 4 and 20.
- 3 Reselect the LEVEL key to activate the test.

- 4 Using an ammeter, measure the output at the remote recording device or at the monitor 4-20 mA output. (Channel 3).
- 5 This test may be terminated by touching the MAIN MENU key.

CLOSURE key

- 1 Select the (Contact) CLOSURE key to toggle between an OPEN or CLOSED condition.
- 2 Using an ohmmeter, check for the selected condition at the remote device or at the monitor contact closure output.

MAIN MENU key

Touch the MAIN MENU key to exit to the MAIN menu and terminate the tests.

BKSP key

Use the BKSP (Backspace) key to remove any numbers entered in error.

CONFIGURATION submenu (TBD)

Site ID submenu

- Site Identification: displays site identification number (e.g., manhole number)
- Description: displays location of site (street address)
- Sensor Software Version: displays software version number
- Sensor Serial Number: displays sensor serial number
- Certification Date: performed by MMI worker
- Monitor Software Version: displays software version number
- Monitor Serial Number: displays sensor serial number

Units of Measure submenu

- Flow: displays units of measure for flow (MGD, GPM, CFS, m³/H, l/s, m³/S)
- Velocity: displays units of measure for velocity (l/s, mm/s, Ft/s)
- Level: displays units of measure for level (l, mm, Ft, M)

- Totalizer: displays units of measure for totalizer (GAL, CF, MG, m³, l, ACFT)

Shapes & Levels submenu

- Round: displays inside diameter of pipe
- Rectangle: displays pipe height and width dimensions
- Oval: displays pipe height and width dimensions
- Egg: displays top, side, and bottom radius dimensions
- Sensor Direction: displays direction of sensor (upstream or downstream)
- Sensor Level Offset: displays the measured distance between the sensor and the liquid level
- Sediment Level: displays the sediment number to offset the measured liquid level

4-20mA Outputs submenu

- Flow: displays 4-20 mA range for flow
- Velocity: displays 4-20 range for velocity
- Level: displays 4-20 mA range for level

Contact Closure submenu

- Channel: displays selection of Flow, Velocity, Level, or Totalizer
- Units Of Measure: displays selected unit of measurement (GAL, CF, MG, m³, l,)
- Set Point: displays current set point value

Totalizer submenu

- Totalizer View: displays present total
- Totalizer Type: displays totalizer type for positive flow or negative flow

Tests submenu

- Flow, Velocity, Level: displays last date of 4-20mA tests
- Contact Closure: displays last date of Contact Closure test
-

MAIN MENU key

Touch the MAIN MENU key to exit to the MAIN menu.

FILES submenu (TBD)

SEND key

Transfers monitor configuration data to the sensor memory.

- 1** Touch the SEND key (illuminates GREEN) to pop up a warning “ARE YOU SURE? YES NO”.
- 2** Touch YES to send the data.
- 3** Touch NO to review monitor data before transfer.

RETRIEVE key

Transfers sensor configuration data to the monitor memory.

- 1** Touch the RETRIEVE key (illuminates GREEN) to pop up a warning “ARE YOU SURE? YES NO”.
- 2** Touch YES to send the data.
- 3** Touch NO to review sensor data before transfer.

MAIN MENU key

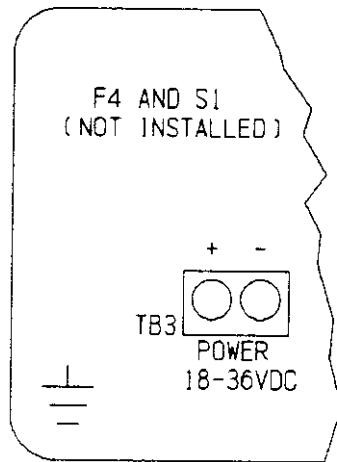
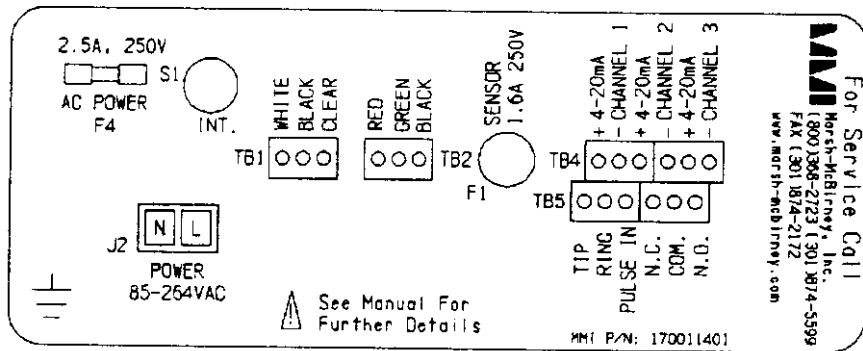
Touch the MAIN MENU key to exit to the MAIN menu.

Chapter 6

External Devices

4-20mA current loop output option

The secondary unit has three output (channel) terminals available for external device connections (such as a chart recorder). The terminals are accessed under the bottom removable panel of the monitor. Each terminal is labeled for polarity (+, -). This is the voltage polarity when a load resistance is placed across the terminals.



External pulse in (TBD)

The external pulse in is for an external device connection (such as a rain gage). When the gage reaches a predetermined level, a ground is sent to the monitor which records the event. The terminals are accessed under the bottom removable panel of the monitor.

Contact closure output

The contact closure output is an electrical relay switch used to activate an external device when a selected parameter (TOTAL FLOW, VELOCITY OR LEVEL) reaches a predetermined set point. The terminals are accessed under the bottom removable panel of the monitor.

Chapter 7

Flo-Dar System Maintenance

Cleaning the sensor

The sensor should rarely need cleaning because it is not in the flow. However, the sensor should be cleaned after each surcharge and checked once a year for debris obstructing the sensor bottom.

- 1** Remove all power to the sensor (AC power to the monitor or DC power from the sensor).
- 2** Secure the hook onto the pole (non-intrusive).
- 3** Unlock the sensor from the frame by hooking the locking mechanism and turning the pole counter-clockwise.
- 4** Do not disturb the pressure port on the underside of the sensor.
- 5** Do not use any cleansers or abrasives when cleaning the sensor.
- 6** Observe the cable for kinks when re-installing the sensor.
- 7** After cleaning the sensor, lower the sensor with cable trailing away from the manhole wall onto the frame.
- 8** Turn pole clockwise to engage the locking bars into the frame side mounts.
- 9** Re-apply power to the sensor (AC power to the monitor or DC power to the sensor).

CAUTION

The locking bars will only turn so far. Do not force the bars beyond the stops.

Do not apply stress to the sensor end of the cable. Allow some slack after the coil is secured

Cleaning the sensor cable

The sensor cable should rarely need replacing. However, if the cable becomes suspect (faulty) or frayed, the cable should be replaced.

- 1 Remove all power to the sensor.
- 2 Secure the hook onto the pole (non-intrusive).
- 3 Unlock the sensor from the frame by hooking the locking mechanism and turning the pole counter-clockwise.
- 4 Place the sensor on a secure platform.
- 5 Loosen the four hex-head bolts that attach the handle to the sensor.
- 6 Remove the two philips-head screws and the clamp on the sensor handle to permit clear access to the cable.

CAUTION

When removing the cable, be sure to pull straight back. Any bending of the pins could cause difficulties when inserting the keyed connector.

- 7 Pull the connector straight backwards.
- 8 Seat the new keyed cable.
- 9 Replace the handle clamp and tighten the two philips-head screws after ensuring the cable is properly set in the recessed notch.
- 10 Secure the sensor handle to the sensor using by tightening the four hex-head bolts.
- 11 Observe the cable for kinks when re-installing the sensor.
- 12 Position the sensor onto the hook.
- 13 Lower sensor with cable trailing away from the manhole wall onto the frame.
- 14 Turn pole clockwise to engage the locking bars into the frame side mounts.
- 15 Re-apply power to the sensor.

CAUTION

The locking bars will only turn so far. Do not force the bars beyond the stops.

Do not apply stress to the sensor end of the cable. Allow some slack after the coil is secured

Replacing Fuses

Sensor Power Fuse (F1) is located under the bottom panel between TB2 and TB4. The fuse is rated at 1.6 at 250V. The fuse must be replaced with an MMI PN 1080002501.

- 16** Remove all power to the monitor.
- 17** Remove the bottom terminal cover by loosening two screws on the cover.
- 18** Firmly grasp the fuse (F1) and pull straight upwards. **DO NOT TWIST.**
- 19** Replace the fuse in the HOLDER
- 20** Replace the cover and tighten the screws.

AC Power Fuse (F4) is located under the bottom panel just behind the AC power terminal. The fuse is rated at 2.5A at 250V. The fuse may be replaced using a 5X20 mm fuse , MMI PN 180002401.

- 1** Remove all power to the monitor.
- 2** Remove the bottom terminal cover by loosening two screws on the cover.
- 3** Firmly grasp the black fuse clip and pull straight upwards.
- 4** Replace the fuse in the clip.
- 5** Set the fuse clip in place over the fuse socket.
- 6** Press firmly down until the fuse clicks into the socket.
- 7** Secure the bottom panel.

Spare parts

Part Number	Description
XXX	Installation and Operation Manual
880002902	Monitor Assembly - Consisting of:
XXX	<ul style="list-style-type: none"> • Monitor Box
XXX	<ul style="list-style-type: none"> • Monitor Box Side Rails
XXX	<ul style="list-style-type: none"> • Philips Head Screws
880002901	Sensor Assembly
XXX	Cable Assembly
XXX	Flo-Tractor Tool
XXX	Locking Assembly
XXX	Hook Assembly
XXX	Alignment Plate
XXX	Laser Pointer
800011701	Frame Assembly - Consisting of:
422005401	<ul style="list-style-type: none"> • Sensor Mount Frame
422005301	<ul style="list-style-type: none"> • Wall Mount Frame
510011001	<ul style="list-style-type: none"> • Wall Mount Bracket
510011701	<ul style="list-style-type: none"> • Spacer Bar - 2"
510011601	<ul style="list-style-type: none"> • Spacer Bar - 12"
510011501	<ul style="list-style-type: none"> • Clamps
93803	<ul style="list-style-type: none"> • 1/4" Hex-Head Bolt
93047	<ul style="list-style-type: none"> • 3/8 Flat Washer
920003701	<ul style="list-style-type: none"> • 3/8 x 2 1/4" Anchor Wedge
93007	<ul style="list-style-type: none"> • 3/8-15 Hex Nut

Service

Under normal operating conditions the Flo-Dar System should not need to be returned for repair or calibration.

If the monitor unit, sensor unit or both need to be returned to the factory for repair, please do the following:

- 1** Identify the model number (450).
- 2** Identify the serial numbers of the sensor unit and the monitor unit.
- 3** Record the reason for return.
- 4** Call the MMI Customer Support Department (1-800-368-2723) and get a Return Materials Authorization (RMA) number.
- 5** Ship the equipment in the original packaging, if possible.

NOTE

Do not ship manuals, computer cables, or other parts with your unit (unless required for repair).

- 6** Please make sure the equipment is free from foreign debris and is dry prior to shipping.
- 7** Write the RMA number on the shipping label.
- 8** Ensure all return shipments are insured.
- 9** Address all shipments to:

Marsh-McBirney, Inc.
4539 Metropolitan Court
Frederick, MD 21704-8364
Attn: RMA# XXX

Specifications

MONITOR

Graphic Display

Passive matrix color LCD
320 x 240 quarter VGA
Dimensions - 4.6" x 3.6" (11.7 cm x 9.15 cm)
Displays flow rate, flow totals, average velocity and level.

Data Entry

Touch screen keypad
Menu-driven programming

Time base accuracy: 1 second per day

External Input - Accepts pulse (+5V leading edge triggered, less than 1 second pulse) from external devices (rain gages, etc.)

Outputs

4-20mA outputs: Isolated with up to 600 ohm load per output.
Two (2) outputs standard
Third output optional
Each output selectable between flow rate, velocity or level.

Proportional Contact Closure - one form C dry contact closure (rating: 1 amp at 28 volts)

Selectable for either total flow, flow rate, velocity or level.

Rating: 1A 30VDC (resistive)
0.5A 125VAC (resistive)

Power Requirements

AC: 85-264 VAC, 47-63 Hz, 32 watts
DC: 18-36 VDC
(Nominal 24 VDC @ 2 amps)

Enclosure

Material: NEMA 4, ABS Plastic
Dimensions: (with mounting bracket in place)
10.2" W x 13" H x 7.25" D
(25.9 cm W x 33 cm H x 18.4 cm D)

Weight - 7.5 lbs.

Temperature

Operating Range: 0° F to 122°F
(-18° C to 50° C)
(relative humidity non-condensing 10-90%)
Storage Temperature: -40° F to 140°F
(-20° C to 140°C)

SENSOR

Enclosure

Material: Polystyrene
Dimensions: 6.9" W x 16.65" L x 11.7" D
(17.5 cm x 42.3 cm x 29.7 cm)

Weight : 10.5 lbs.

Temperature

Operating Range: -32° F to 122°F
(0° C to 50° C)
Storage Range: -40° F to 140° F
(-20° to +60° C)

Sensor Cable

Material: Polyurethane jacketed
Standard Length: 30' (9.15m), maximum
500' (152.4 m).
Disconnectable at both sensor and monitor

VELOCITY MEASUREMENT

Method: Radar
Range: ±0.25 to 20 ft/s
(±0.08 m/s to 6.10 m/s)
Accuracy: ±0.5%; ±0.1 ft/s (±0.03 m/s)

LEVEL MEASUREMENT

Method: Ultrasonic
Operating Range - 0 to 60 in.
(0 to 152.4 cm)
Temperature Compensated
Accuracy: ±0.25 in. (±0.64 cm)
1% Accuracy

SURCHARGE LEVEL MEASUREMENT

Method - Piezo-resistive pressure transducer
Maximum Range - 275 inches (7 meters)

FLOW MEASUREMENT

Based on Continuity Equation.

Accuracy: $\pm 5.0\%$ of reading typical where
flow is in a channel with uniform flow
conditions and is not surcharged.

CERTIFICATION

FCC Rules Part 15

Industry Canada RSS 210

(No user license required.)

ORDERING INFORMATION

The Flo-Dar™ Model 450 Flowmeter is an AC or DC powered open channel flowmeter. The Standard Model 450 includes a monitor unit, sensor unit, one time mounting assembly including brackets and hardware, and an instruction manual. The monitor includes a NEMA 4 ABS plastic enclosure with a clear polycarbonate cover, a touch screen for site set-up and display selection, an external device (rain gauge) input, two 4-20 mA outputs and one flow proportional contact closure output. Display selections include flow rate, level, velocity and total flow. The sensor enclosure is submersible polystyrene and is supplied with 30 feet of disconnectable cable.

Options include one additional 4-20 mA output, and additional sensor cable.

Installation accessories include a Flo-Tractor Laser Alignment Tool, Sensor Placement/Retrieval Pole, and Sun Shield (recommended for installations in direct sunlight).

IMPORTANT

When ordering the Flo-Dar™ Model 450 Flowmeter please specify the following:

- AC or DC Power
- Optional third 4-20 mA output
- Sensor cable length if other than standard 30 foot length
- Installation accessories (Flo-Tractor Laser Alignment Tool, Sensor Placement/Retrieval Pole and Sun Shield)