4230 Bubbler Flow Meter

The 4230 Bubbler Flow Meter Pocket Guide is provided as a handy field reference. It is not intended to replace the instruction manual, but complements it by providing condensed instructions. Study the manual thoroughly before installing or operating the flow meter.

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⚠ WARNING

The installation and use of this product may require you to work in locations where you could be seriously injured or even killed. Take whatever precautions are necessary to ensure your safety before entering the installation. Never work alone or unsupervised. Install and operate this product in accordance with all applicable safety and health regulations, as well as any appropriate local ordinances.

This product is often installed in confined spaces. Examples of confined spaces are manholes, pipelines, digesters, and storage tanks. These places can be dangerous or fatal if you are not suitably prepared. The primary hazards are the presence of poisoned air, the lack of ventilation, and the possibility of falls. Other hazards may be present, as well. Work in such places is governed by OSHA 1910.146, and may require a permit before entering.

Material Safety Data Sheets (MSDS) for chemical agents supplied or recommended for use with this product are in the MSDS Appendix in the back of the instruction manual. These sheets provide information about possible hazards from the chemicals. Additional MSDS, covering various proprietary agents (name-branded or trademarked mixtures) that can also be used with this product, are available from the manufacturers of those agents.

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4230 Bubbler Flow Meter

Section 1 Getting Started

1.1 Becoming Familiar with the 4230 Flow Meter

The 4230 Flow Meter is a microprocessor-equipped flow meter capable of measuring flow rate in a wide variety of open channels. The 4230 Flow Meter uses the bubbler method for sensing level. A small air pump and reservoir provide a source of pressurized air. A transducer inside the flow meter senses the air pressure necessary to force a bubble from the end of a tube submerged in the flow stream. As the liquid level increases, the pressure required to release the bubble also increases.

The flow meter converts the output from the pressure transducer to a level reading. Built-in level-to-flow rate tables convert the level to flow rate. The level and flow rate appear on a two-line, eighty character liquid crystal display (LCD). These flow meters are equipped with an internal printer to provide a continuous printed record of level, flow rate, and other information

that may be used for later reference. The Flow Meters also have memory allocated that you can set up to store level and other readings. You must use Flowlink®, Teledyne Isco's proprietary data processing and acquisition software to initialize (set up) and access this memory.

1.1.1 Selection of a Power Source

Teledyne Isco offers a variety of power sources to operate the flow meter. For commercially-powered installations, there is the AC Power Supply. Also available is a power supply with a 1.2 Ah (Ampere-hour) standby battery built in, the Battery-Backed Power Supply. For applications where there is no AC power connection available, Teledyne Isco offers a 4 Ah nickel-cadmium battery (Nickel-Cadmium Battery), or a 6 Ah gelled-electrolyte battery (Lead-Acid Battery). All these power sources mount on top of the flow meter and are secured with rubber draw catches. The cable with the two-pin connector (12 volt) attaches to the +12 VDC connector on the flow meter.

Battery life expectancy varies from about seven to fourteen days between recharge cycles, depending on the settings for the bubble rate and the setting for the printer chart speed. For very remote sites where changing the battery is difficult, Teledyne Isco offers the Solar Panel Battery Charger, used with the Lead-Acid Battery. You may also power the 4230 Flow

Meter with a deep-cycle R-V or marine battery. You must mount these larger batteries externally, as they are quite large. Teledyne Isco offers a special connect cable for them.

1.1.2 Turning the Flow Meter On

After you have connected the flow meter to power, turn the flow meter on with the ON button located on the keypad. When the flow meter is turned on, the air pump will run for awhile, and then stop when the reservoir tank is pressurized. If it does not stop, locate the Bubble Rate Adjust Valve on the side of the flow meter cabinet and turn it clockwise until it just seats. Do not over-tighten or force the valve; the needle-and-seat are fragile and can easily be broken.

1.1.3 Adjusting the Bubble Rate

Locate the Bubble Rate Adjust valve on the flow meter's side. If it is locked, use the small hex wrench supplied with the flow meter to release the lock. (Refer to the manual for details.) Attach a bubble line (identical in diameter and similar in length to the one that will be used) to the Bubble Line outlet. Place the free end of the bubble line in a container (preferably clear) of water. Set the container beside the flow meter so you can watch the bubbles coming out of the end. Adjust the valve until a bubble rate of one bubble per second is reached. Lock the valve handle with the hex wrench supplied with the flow meter.

☑ Note

Teledyne Isco recommends setting the bubble rate in the shop first, as this is easier with a small container of clear water placed beside the flow meter. Using a different length and diameter bubble line than the installation will result in an inaccurate setting. In any case, you should still recheck the bubble rate after installation, particularly if the bubble line will be under several feet of water in the flow stream.

1.2 Checking the Installation

At the job site it is worthwhile to check the installation to see that it was made correctly and to make sure nothing has changed which could affect the accuracy of the measurements made by the flow meter. If the flow meter or bubble line is installed in a sewer or manhole please read and observe the following warning:

⚠ DANGER

YOU CAN BE KILLED working in sewers or manholes if you do not follow proper safety procedures. Besides the risk of falling, poisonous gases in most sewers can overcome you quickly, without warning. Safety information is provided in the 4230 Flow Meter Instruction Manual under the heading of Safety Considerations. Please read and follow these procedures; the life you save may be your own.

If the installation is temporary, make sure the flow meter is installed so it is not difficult to reach in case you need to change the programming or chart paper. The unit should not be a hazard to anyone entering the manhole. You can lay the flow meter horizontally or hang it vertically with a suspension harness from the ladder. Make sure the flow meter is suspended well above the maximum level the flow stream can reach; water drawn into the desiccator cartridge will cause serious damage to the unit. If this is not possible, attach a vinyl line to the open end of the desiccator cartridge and route the line to a place well above the maximum expected liquid level.

If the installation is permanent, check to make sure that any work going on in the area has not caused any damage to the wiring or bubble lines. Check the bubble line where it attaches to the flow meter to see if flexing has cut the silicone tubing used to connect the $^1/_8$" bubble line to the barbed fitting. A crack in the silicone tubing will appear as a white line across the middle of the tubing. The resulting leakage will seriously affect the accuracy of the readings.

Check to make sure the bubble line is secure from the flow meter to where it enters the flow stream. Keep the bubble line as short as possible between the flow meter and the measuring point in the flow stream. Cut off any excess length of tubing. Do not coil it up or let it drift in the stream. Make sure the end of the

bubble line is installed correctly (at a right angle to the flow) and securely at the proper measuring place in the primary device.

This point is usually below the “zero” level of the primary device and a prescribed distance upstream from the crest of the device. (This distance cannot be called out specifically; it depends on the primary measuring device.) Refer to the *Isco Open Channel Flow Measurement Handbook* for this information. Flumes can be made with a specific location for the bubble line. The Adjust Level/Parameters programming step lets you install the bubble line anywhere between ten feet above or below the actual “zero” level of the primary device. In practice, the installation is usually close to the “zero” point.

☑ Note

The 4230 Flow Meter cannot measure level below the bubble line outlet. If you wish to measure accurately down to the “zero” level of the device, install the bubble line outlet one to two inches below the “zero” point of the primary device, and adjust the level appropriately at the flow meter. This way the liquid level will always be higher than the bubble line outlet.

1.2.1 Bubble Lines in High-Velocity Streams

If the velocity of the flow stream is more than five feet per second, and the bubble line outlet is mounted at a right angle to the flow, the measured level will tend to be lower than actual. You can use the Adjust Level/Parameters step to compensate for this

difference when the level (and velocity) are at a high point, but a reduction in the flow rate will result in inaccurate settings. The best way to overcome this problem is to use a stilling well. You can also make a depression in the bottom of the flow stream and place the bubbler there, but flow streams with significant solids content may fill the depression and restrict the bubbler. Or, you can form a 90° bend about two inches from the end of the bubble line and then place this bend so it points downstream, parallel with the flow.

1.2.2 Clogging Bubble Lines

In some flow streams, clogging of the bubble line from algae, silt, or suspended solids may be a problem. There are several possible solutions you can try. You can increase the automatic purge frequency. This is preferable to increasing the bubble rate, and is highly recommended where the flow meter is powered from AC. Teledyne Isco has stainless steel bubble line extensions available that may be helpful, and for situations where algae tends to grow in the lines, copper tubing is useful. The copper salts formed over time in the flow stream are algicidal agents and will inhibit the growth of algae.

1.3 Options and Capabilities

1.3.1 Flow Metering Inserts

For temporary monitoring purposes in 6", 8", 10", and 12" round sewer pipes, Teledyne Isco offers flow metering inserts that have a built-in bubbler and form a round orifice or v-notch weir in the flow stream. An inflatable rubber bladder keeps the insert firmly seated inside the round pipe. The inserts should not be considered permanent, as they do place a restriction in the pipe and are subject to clogging.

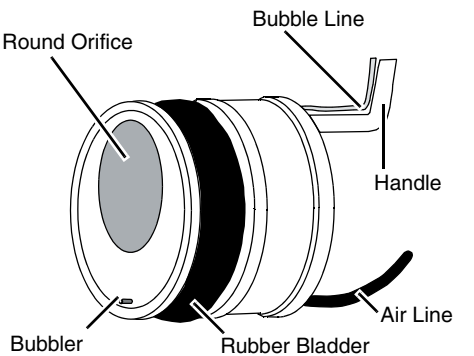

Figure 1-1 Flow Metering Insert Diagram

1.3.2 Connection to a Sampler

A 4230 Flow Meter can control a sampler in a flow-proportional sampling mode. This means the sampler will take a sample after a specific volume has passed through the flow stream, rather than after a particular interval of time. In this mode, the sampler and flow meter can compensate for varying flow rates. You can use the 4230 Flow Meter with Isco samplers or samplers made by others.

Connecting an Isco Sampler to a 4230 Flow Meter requires an Isco flow meter-to-sampler connect cable. The cable is 25 feet long. If you plan to use the sampler enable feature (see Section 2 - *Programming*), make sure you use the newer cable that has all six pins connected. Older cables do not have a connection between the F pins and this keeps sampler enabling from working. If in doubt, use an ohmmeter or continuity checker to test your cable.

1.3.3 Adjusting Level

Generally, you measure the level in the flow stream with a gauge. Make this measurement accurately, as the level setting on the flow meter will determine the accuracy of all subsequent level and flow rate measurements made by the flow meter. When you are satisfied that the flow stream has been measured accurately, you can change the level reading on the flow meter to show this reading.

First, make sure the bubble line is properly installed and set at or below the “zero” point in

the flow stream. Then set the level by selecting Adjust Level/Parameters step in the flow meter program. You may then adjust the level by entering the measured level value through the number keys. When the proper value is displayed, enter the number into memory by pressing the Enter/Program Step key.

☑ Note

It is very important that you measure the level in the stream accurately, as all subsequent calculations of flow will be based on this measurement. If the level value entered is incorrect, all subsequent flow calculations will be incorrect also.

1.3.4 Data Acquisition and Storage (Flowlink®)

As mentioned in previously, all 4230 Flow Meters contain memory you can allocate to store level, rainfall, and sample data. You can interrogate this information for later processing. To set up the flow meter's memory for data storage, you must use Flowlink, Teledyne Isco's proprietary data acquisition and processing software. Programs from Flowlink allow you to set up the flow meter for memory initialization. data acquisition, and interrogation from a different location through an IBM PC® compatible computer. The computer and the flow meter connect together through a standard dialup telephone line with modems. (The modem in the flow meter is an optional accessory.) Multiple flow meters can be initialized and interrogated by the same

computer. You can also use Flowlink to access the flow meter at the installation site with a laptop computer plugged into the Interrogator connector on the flow meter. Other programs in Flowlink allow the processing of the data retrieved from the flow meter. Refer to the Flowlink manual for further information.

☑ Note

Storage of data is not automatic in the 4230 Flow Meter. You must use programs from Flowlink software to initialize, partition, and size the memory, and also to retrieve the stored data.

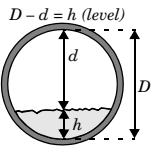

Figure 1-2 Recommended level measurement method

☑ Note

Note that you are actually measuring the distance from the top center of the pipe to the surface of the flow stream. The level (h), then is the distance from the top center of the pipe, d, subtracted from the diameter of the pipe, D. *You must know the correct diameter of the pipe.*

1.3.5 Parameter Sensing with the 4230 Flow Meter

The 4230 Flow Meter also has the capability of displaying, recording, and (if Flowlink software is used) storing data from parameter sensors. The sensors available from Teledyne Isco for the 4230 Flow Meter measure temperature, pH (the relative acidity or alkalinity of a solution) and D.O. (dissolved oxygen). The YSI Model 600 Multiparameter Sonde offers pH, D.O., temperature, and conductivity. You can also measure and record rainfall with the Isco 674 Tipping Bucket Rain Gauge, which connects to its own port on the flow meter.

All parameter probes require constant and complete submersion in the flow stream for proper operation. Dry operation can damage the pH and D.O. probes. The pH and D.O. probes are extremely sensitive devices and require the use of the 201 pH Module and 270 D.O. Modules (signal amplifiers) between the probes and the flow meter. The modules are not interchangeable.

☑ Note

The 270 D.O. module has been discontinued. Probes, service kits, and accessories are still available to maintain existing field units.

The probes can be installed in a variety of places, but typical installation is in round pipes. Teledyne Isco offers a series of rings that provide simplified mounting for all probes inside round pipes.

Each probe snap-mounts to a specialized sensor carrier.

- The sensor carrier then attaches to the mounting rings by sliding tabs into mating slots.
- The probe cable is routed from the stream to the parameter module.
- The module is installed and its cable routed to the flow meter's Parameters connector.

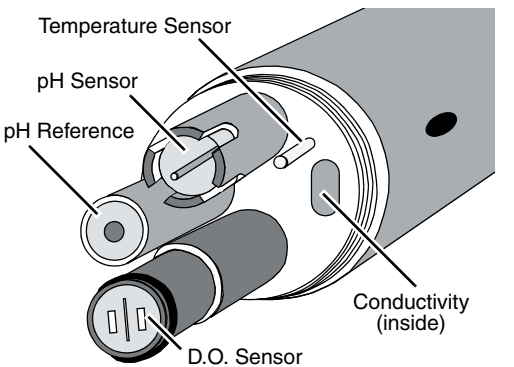

Figure 1-3 YSI 600 Multi-Parameter Sonde (End cover removed to show sensors)

☑ Note

The 4230 Flow Meter has only one parameter sensing port. You must select temperature, D.O. with temperature, or pH with temperature. (D.O. and pH require temperature monitoring for proper operation.) If

you want to change your selection later, you can. You will need the correct probe and module and you will have to change the program in the flow meter.

☑ Note

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4230 Bubbler Flow Meter

Section 2 Programming Introduction

2.1 Why Programming Is Necessary

You must program the 4230 Flow Meter to accurately monitor a flow stream. You must also install the level measuring device, a bubbler tube. The installation usually includes a primary measuring device, a structure placed in the stream that regulates flow. This section describes programming the flow meter with the keypad and display. There are nine program steps that control the operation.

Teledyne Isco ships the flow meter with a program installed called the default program. This program is an example of the flow meter's capabilities. Note that the default program is to test the unit at the factory. The flow meter's internal computer must always have something programmed, so that becomes the default program. Your flow situation will usually require other programming. The text provided

with each screen explains the reasons for the various menu options.

2.1.1 Operation of the Keypad and Display

The display is a two-line, forty character-per-line liquid crystal (LCD). It has a backlight for easy viewing in low light situations. The display has three different operating modes, normal, programming, and messages. In the normal mode, the display shows such things as level, flow rate, total flow, parameter measurement, *etc*. In the programming mode, the top line of the display shows each step as you work through the program while the bottom line shows the choices available for that step. In the message mode, the display provides instructional information, such as how to leave programming, or what to do if you have entered a number that is out-of-range.

Following is a “normal” display on the flow meter. This is typical of what the flow meter will display when it is in the normal operating mode and you are not programming it.

```
 0000004.78 CF  1.13 FT    16-MAR-04
 1.03 CFS    (X X)       8:25:37
```

An interpretation of the numbers on this display would be as follows: Time and date are replaced by pH/D.O. and temperature if you are sensing parameters. The (X X) to the right of the time indicates letters that may appear from time to time on the 4230 Flow Meter.

The letter C appears when the flow meter is communicating with a remote computer (Flowlink applications only). The letter Z appears when the flow meter is doing an auto-zero. The letter P appears when the flow meter is purging the bubble line. The letters E or D appear (Enable or Disable) when the sampler enable function (step 6) is programmed by condition. (Programmed by condition means that the flow meter will enable the sampler only when a certain condition or set of conditions, sensed by the flow meter, are met.)

```
Total Flow Current Level Date (or pH/D.O.)
Flow Rate          Time (temperature)
```

Following is a typical programming display on the flow meter: (One of the items in the second line will be flashing. The item flashing is the selection currently held in memory.)

```
TOTALIZED VOLUME UNITS
• CF • • GAL • • M3 • • AF • • L • • MGAL •
```

Following is a typical display providing information:

```
CHANGES HAVE BEEN MADE IN STEP
PRESS '0' TO CONTINUE, PRESS '1' TO DISCARD
```

☑ *Note*

If you stop programming for more than two minutes, the flow meter will time out, and whatever is on the display, (message or program step) will revert to the “normal” display, shown previously.

The program consists of steps and substeps. The steps are listed on the flow meter front panel. Most steps contain several substeps. Generally, you need to complete all the substeps before stopping, or the flow meter will reject the changes you made for that step after it times out. There are some exceptions.

The flow meter keeps in memory any changes that you made for the finished steps (all substeps completed before stopping). Most steps not finished when you stop will return to the previous selection.

2.2 Keypad Functions

Use the keypad in response to messages on the display. The following sections describe the function of each key.

- **OFF and ON**–These two keys turn the flow meter off and on.
- **Go To Program Step**–Pressing this key lets you go directly to a particular step without passing through all the steps of the program. The display will ask you to enter the number of the step you want to program. Enter the number by pressing one of the number keys. There are nine program steps, so numbers from one to nine are valid.
- **Exit Program**–Press this key when you want to leave the programming mode and return to the normal operating mode.

- **Clear Entry**–Lets you return to the previous entry for a program step if you have changed the entry, but have not yet pressed Enter.
- **Enter/Program Step**–This key has two functions. One is to enter a program selection into the flow meter's memory (Enter). The other is to step through the program (Program Step).
- **Print Program**–Pressing this key makes the flow meter print out a complete list of the current program kept in memory.
- **Print Report**–One of the functions of the flow meter is to print periodic reports of the activity recorded on the flow meter at regular intervals. The contents of these reports are defined in step 1. If you set up the flow meter to generate these reports, you can have a report printed at any time by pressing this key. The report will cover the time interval from the last scheduled report up to the time you press this key.

  The flow meter will print the next report at the next scheduled time. Note that if power fails for five minutes or more, the flow meter will print a report when power is restored that will cover the interval between the last report and the time that the power failed. The next report will cover the time from the power failure to next scheduled report time.

- **Chart Advance**–Pressing this key causes the paper chart to advance through the printer at the fastest possible speed. Nothing will be printed while you press this key.
- **Chart Reroll**–You can unroll the chart from the take-up roll to look at it by pulling it out with your hands. Pressing this key rewinds the chart onto the take-up roll.
- **Number keys**–These keys let you enter numeric values.
- **Decimal Point**–This key enters a decimal point into a number when programming. On flow meters equipped with the modem, you can use this character as a comma (delay) when entering telephone dialout numbers.
- **Arrow keys**–These keys, referred to as the left and right arrow keys let you select a programming option by moving across the menus shown on the second line of the display.
- **+/– key**–This key lets you enter a plus or minus to a quantity. Its most common use is in entering values for the equation, a method of flow conversion. On flow meters equipped with the modem, use this character as a dash when entering dialout numbers.

- **Manual Purge key**–This key lets you purge the bubble line on the 4230 Flow Meter at any time.

2.3 Programming Procedure

To begin programming, turn on the flow meter and wait for the display to settle. Then either press the Enter/Program Step key (generally referred to as Enter) or the Go To Program Step key.

The display will change to two lines; the first line describes the step you are programming, and the second line shows the choices available. One of the choices will be flashing. The flashing indicates that this choice is the one in memory. If you are satisfied with this choice, press Enter, and the flow meter will advance to the next step.

If you want a different choice from that flashing, move across the display using the left and right arrow keys. Each time you press the right arrow key, the flashing selection will move one position to the right. This will continue until the last selection is flashing.

From time to time you will notice an arrow pointing to the right edge of the display. This indicates more choices are available beyond what the display shows. Continue to press the right arrow key and you can view these options. After reaching the furthest option, the arrow will move to the left side of the display, indicating that there are options to the left. These are the options you started with. If you

want to go back, use the left arrow key until the option reappears. When the desired selection is flashing, press Enter. The display will then automatically advance to the next step of the program.

All of the program steps contain several "substeps" that must be completed before you advance to the next program step. Some steps, like Reset Totalizer contain only a few substeps. Some steps will require the entry of a numeric value.

Program these steps by using the number and decimal keys to enter the correct value.

☑ Note

You can program most of the flow meter in the shop, rather than at the job site, with the exception of step 3, Adjust Level/Parameters. To set level you must make an accurate measurement of the level in the flow stream and then enter that value. This can only be done at the job site.

If you are programming the flow meter for the first time, generally you will press Enter, start with step 1, and go on from there. If the flow meter has been in use and you need to change only a certain part of the program, you would more likely use the Go To Program Step key. With this key you can go directly to the program step you need to change, saving time.

If you change an entry and do not like it, you can make the display go back to the original entry by pressing Clear Entry. If you have already pressed Enter, however, the new value

will be in memory. To change it, press Exit Program and return to that step. If you are in the middle of a step with multiple substeps, the flow meter will display, “Changes have been made in step; press 0 to continue or 1 to discard.” If you press 1, the display will return to normal and the last step you were working on will return to its previous selection. (Any step you completely change before you exit will remain changed.)

You can re-enter the program with either Enter or the Go To Program Step keys. If you become confused while programming, the best suggestion is to press Exit Program and start over. Also remember that you can have the flow meter print a complete list of your program choices by exiting the program and by pressing the Print Program key as soon as the display returns to the normal operating condition, displaying level and total flow, *etc*.

Following are the steps to program a 4230 Flow Meter:

1. Operating Mode
2. Flow Conversion
3. Adjust Level/Parameters
4. Reset Totalizer
5. Sampler Pacing
6. Sampler Enable
7. Alarm Dialout
8. Printer
9. Reports/History

2.4 Description of Program Steps

2.4.1 Step 1 - Operating Mode

Step 1, Operating Mode, determines how you set up the flow meter. In this step there are two choices, Program and Setup. Program advances you to step 2, and from there on you correlate the flow meter to the flow stream. Setup selects various basic "housekeeping" features for the flow meter. Here you determine the internal clock, site identification, measurement setup, hysteresis, report contents, operation of the display backlight, and program lock. In Program you select the units of measure the flow meter will use for the display, calculations, and reports.

☑ *Note*

If you choose NOT MEASURED for any selection, the flow meter will make no further reference to that value or function for the rest of the program, and you will not be able to activate that process or function later on unless you reprogram step 1.

If there is a feature or option you need that does not appear on your display when the manual says it should, return to step 1 and make sure you have not inadvertently it turned off in the Program or Setup menus.

Note that selecting some features automatically excludes others. For example, selection of pH or D.O. excludes the other parameter, unless you use the YSI 600 Multi-Parameter Sonde, which measures pH, D.O., and conductivity at the same time.

This method keeps program size manageable and makes programming more efficient. By turning off unneeded features early, you do not have to keep de-selecting those features over and over.

Consequently, choose carefully from the first step. Study the program first, then fill out the Programming Worksheet (in the back of the manual), and then program the flow meter last.

2.4.2 Step 2 - Flow Conversion Type

Step 2, Flow Conversion Type, determines how the flow meter calculates flow rate and total flow. For a 4230 Flow Meter, flow rate is calculated by knowing the measured level and (usually) the characteristics of a structure called a primary measuring device.

A primary measuring device is a structure placed in a flow stream through which the entire stream flows. These devices are made in a number of styles and sizes, but they all have one thing in common: For any type of primary measuring device there is a known relationship between the level in the flow stream ahead of the device and flow rate through the device. Consequently, after you measure level, the flow meter can calculate flow rate and total flow from the level, by consulting built-in look-up tables.

Information about many common primary measuring devices is provided in the *Isco Open Channel Flow Measurement Handbook*. This useful book provides formulas, flow rates at

various levels, and values for maximum head, as well as much interesting descriptive material. This book is available free from Teledyne Isco by returning the request card shipped with the flow meter. If your installation uses a nonstandard primary device, you should consult the manufacturer of the device for flow rates at given levels. The flow meter will then calculate a flow conversion for such a device on the basis of the manufacturer's data you enter as data points or an equation. In some instances, a nonstandard primary device could be supplied with a flow equation; you can enter that equation into the flow meter and the flow meter will calculate the flow rate from that equation.

Flow Calculations Without Primary Devices – Note that it is not always necessary to have a primary measuring device. The 4230 Flow Meter can measure level and calculate flow without any primary device being installed in the flow stream. Sometimes the shape of the flow stream itself forms the primary device.

The Manning formula uses the shape of a pipe or channel and its slope to calculate flow in open (non-pressurized) pipes.

An accessory is available for the 4230 Flow Meter called the Flow Metering Insert. These inserts, used in round pipes of 6", 8", 10", and 12", form a primary device inside the pipe by restricting flow and measuring the level of the liquid backed-up behind the insert. The opening in the insert, either a smaller round

opening or a V-notch that forms a weir, forms a primary device.

The conversion types available are WEIR/FLUME, MANNING, DATA POINTS, EQUATION, and FLOW METERING INSERTS.

Use Weir/Flume flow conversion when your primary device is a weir or a flume. A weir is a wall or dam across the flow stream. Water must rise to the point where it flows over the top of the wall. The measured level upstream of the device and the appropriate formula are used to calculate flow. Flumes differ from weirs in that there is no wall or barrier, but instead a restriction, typically a sharp narrowing or change in the slope of the channel that restricts the flow.

Again, the measured level of the stream at some point ahead of the restriction is used by the flow meter to calculate flow. In this flow conversion mode, the flow meter uses internal look-up tables for many common primary measuring devices.

An Equation is used when you have a non-standard primary device, or want to use different values from those programmed into the look-up tables of the flow meter. Equation uses the standard flow equation:

$$Q \equiv k1H^{p1} + k2H^{p2}$$

Where Q equals flow rate; k1 and k2 are constants; H is level (or head), and ^{P1} and ^{P2}

are the powers to which the two H terms are raised. (Your equation may not have the second term, in which case you would enter 0 for the second constant, k2.) Most common primary devices are supported in the flow meter's software, so generally you will not need this option. But it is available for those needing to enter their own values, or for those who have a nonstandard primary device for which an equation can correlate level and flow.

Manning Flow Conversion – uses the Manning formula to calculate flow in open or closed (nonpressurized) gravity-flow situations based on slope, diameter, and roughness of the pipe. There is no primary measuring device as such. Instead the pipe, with considerations for its slope and internal roughness, serves as the primary device. The 4230 Flow Meter can calculate flow in round pipes, rectangular, U-shaped, or trapezoidal channels based on this formula.

Data Point Flow Conversion (DATA POINTS) – calculates flow based on a set of user-entered data points for a flow stream. Data consist of correlated level and flow measurements for the stream. Like the Equation method of flow conversion, this flow conversion is most commonly used where the primary measuring device is nonstandard, but where tables of level and flow rate data are available from the device manufacturer. The 4230 Flow Meter has space for four sets of data with as many as fifty points per set. The flow

meter then calculates flow from these data tables using a three-point interpolation.

Flow Metering Insert Conversion – The inserts are installed in upstream pipes and held with compressed air pressurizing a bladder. They are set from street level with a handle that can be extended as far as sixteen feet. The inserts contain a bubble line outlet and have an opening in the face that is either round or triangular. The 4230 Flow Meter reads the upstream level (the water backs up behind the insert) and calculates the flow through the insert from this measured level.

2.4.3 Step 3 - Adjust Level, Parameters

Adjust Level, Parameters calibrates the sensors that provide the flow meter with level and other information. In this step you set the level in the flow stream. First you measure the level, as accurately as possible. Then you enter this value with the numeric keys. Accuracy is important. This measurement provides the basis for all subsequent flow calculations in the flow meter.

The flow meter also has an input port for measurements other than level. This is the Parameter Port. Here you can sense such variables as temperature, pH (the acidity or alkalinity of a solution) and D.O. (dissolved oxygen) in the flow stream. You can have either pH with temperature, D.O. with temperature, or temperature alone. The port is not dedicated to a particular sensor, except through

programming. You can change the sensor. For example, you can change from a pH probe to a D.O. sensor if you change the programming. Selection of either parameter will keep the other from appearing later on the menus. Note, however, that it is possible to measure several different stream conditions including pH and D.O. at the same time with the YSI 600 Sonde.

The YSI 600 Sonde – The YSI 600 Sonde is a multi-purpose, water quality measurement device. It is intended for use in research, assessment, and regulatory compliance. The sonde attaches to the modified RAIN GAUGE connector on the 4230 Flow Meter. Flow meters having only a 4-pin rain gauge connector will not support the YSI Sonde. If you wish to upgrade your flow meter to use this system, contact the factory. Note that you can have both the YSI 600 Sonde and the Rain Gauge connected to the flow meter at the same time by using a special Y-connect cable.

The YSI 600 can measure the following water qualities: dissolved oxygen (D.O.), conductivity, temperature, and pH. Conductivity measurements made by the sonde can be used to calculate specific conductivity, salinity, and total dissolved solids. A brief description and specifications for the YSI 600 are printed in Section 4 (Accessories) in the manual. You may also contact the factory or your Teledyne Isco representative. More information on the sonde is found in the YSI 600 Manual, shipped with each YSI 600 Sonde.

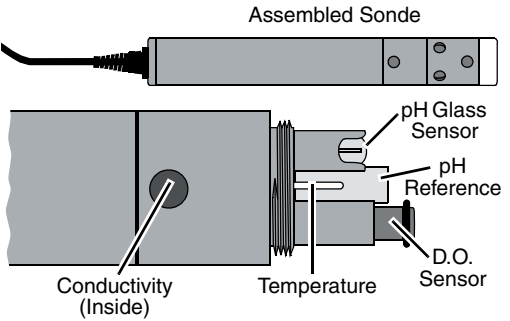

Figure 2-1 YSI 600 Sonde (cover removed)

2.4.4 Step 4 - Reset Totalizer

In this step you decide whether you want to reset the flow meter's internal flow totalizers. If the installation is permanent you generally won't reset the totalizer. If you are using the flow meter as a portable recording unit and are moving it from one site to another, you generally reset the totalizer between sites.

2.4.5 Step 5 - Sampler Pacing

It is common to use a flow meter with an Isco sampler. Typically the flow meter signals the sampler to take a sample after a certain volume has passed. This might also occur after a condition or set of conditions has either changed or been met. This step allows you to determine that control. There are several possible options—DISABLE, CONDITIONAL, VOLUME, and FLOWLINK. DISABLE will

keep the sampler from receiving any flow pulses from the flow meter. VOLUME allows the flow meter to signal the sampler whenever a specific flow volume has passed. FLOWLINK (this option only appears if you are using Flowlink software), allows the sampler to be signalled from the flow meter as a result of conditions determined by Flowlink.

☑ Note

If you choose CONDITIONAL for sampler pacing and it doesn't seem to work properly for you, read the section on hysteresis. Then check the hysteresis setpoints for your conditions. (The defaults are all zero.)

You must also have the appropriate sensors to measure temperature, dissolved oxygen, conductivity, or pH; the flow meter cannot do this by itself, nor does it occur automatically.

Flowlink is Teledyne Isco's proprietary data acquisition and management software. Flowlink works with personal computers, modems, and laptop computers to monitor flow meters from a distance. Consult the factory for more information.

VOLUME causes the flow meter to pace the sampler after a specific volume has passed through the flow stream.

CONDITIONAL allows pacing of the sampler by the flow meter when a particular condition has been met, or has changed. Among these conditions are changes in level, flow rate, temperature, rainfall, (if you are using the optional rain gauge), dissolved oxygen, or pH.

You can also use a pair of conditions, or if you are using the YSI 600 sonde, you can select multiple conditions from its sensors.

2.4.6 Step 6 - Sampler Enable

Sampler Enable means that in a combination flow meter/sampler pair, the flow meter controls the sampler's ability to run its own program. The difference between step 5, sampler pacing, and step 6, sampler enable is that in sampler pacing, the flow meter merely sends flow pulses to the sampler from time to time. The sampler counts these flow pulses to determine when to take a sample (according to its own programming).

With sampler pacing, the sampler is always enabled. With sampler enabling, the flow meter can actually stop operation of the sampler. The sampler is still set up to run its own program, but the inhibit/enable line from the flow meter will determine when and whether the sampler runs its program. This feature is useful for storm water runoff monitoring applications, where it may be necessary for the flow meter/sampler pair to have to wait a long time between storm intervals.

Again, changing or meeting a condition or set of conditions triggers the enabling. The conditions that can be used for sampler enabling are similar to those used for sampler pacing: level, flow rate, rainfall, temperature, dissolved oxygen, pH, or a combination of these conditions. The YSI 600 Sonde provides several

measurements at the same time. You must have the appropriate sensors for rainfall, temperature, D.O., pH, and the YSI outputs.

2.4.7 Step 7 - Alarm Dialout Mode

This feature lets you program a 4230 Flow Meter to signal a remote location through a telephone line. This feature is useful for transmitting alarm conditions or other information to a remote location.

☑ Note

You must have the optional modem installed to make use of this program step. The menus will not even appear unless the flow meter has a modem installed.

The Alarm Dialout feature is useful if you need to signal a remote location when there is a change of condition in the flow stream that could constitute an alarm. You can program as many as five different twenty-digit telephone numbers into the flow meter in decreasing order of importance. The modem is capable of speech.

DISABLE inhibits this function altogether. CONDITIONAL lets you program the flow meter to signal these alarms for a variety of reasons. You can use rainfall, time, level, flow rate, dissolved oxygen, pH, rate-of-change, a combination of conditions, or define the operation through Flowlink software from another computer. STORM lets you set the alarm through a combination of rainfall and time. You can also program the interval

between calls and set up the system to reset the alarm condition by dialing back from the remote telephone.

2.4.8 Step 8 - Printer

The 4230 Flow Meter has a built-in printer. The printer is also capable of plotting linear data along with printing alphanumeric (letters and numbers) messages. In this step you set the speed for the chart to advance, from $^1/_2$" to 4" per hour.

Set chart speed according to the amount of resolution you want to see on the chart. If there is a great deal of activity on the chart, you would generally choose a faster speed so the marks are more “spread out” and are easier to interpret. If there is little activity on the chart and you want the flow meter to run for long periods without having to change the chart paper roll, you would probably pick a slower speed.

The flow meter can plot three separate data lines on the chart in addition to messages. These lines may indicate such things as level, flow rate, pH, dissolved oxygen, or temperature. Note that you must have the appropriate sensors to take advantage of the availability of these plots. Rainfall is printed as a bar graph.

The printer can plot over-ranges for the data lines. The printer is in over-range if a data line goes off the chart on the right side and then

immediately starts over again plotting on the left side.

2.4.9 Step 9 - Reports/History

This step lets you program the flow meter to print out regular reports on the internal printer. The reports are a summary of activity recorded over a period of time. Included are such items as maximum and minimum flow rates, the time they were reached, sample records, *etc*.

The flow meter will create two separate reports, and you define what appears on them. Note that the contents of the reports are defined in Setup in step 1. Step 9 merely lets you turn them off and on and set the timing. You can define the start time, the interval between reports, and other aspects.

History provides a record of changes made to the flow meter's program or operation events. As many as 50 changes can be stored in the flow meter's memory at a time. The memory can store up to 50 history items and 200 sample events at a time.

2.5 Interpreting the Program Screens

Following are the program screens as they appear on the display of a 4230 Flow Meter. Explanations of most of the screens will be provided.

☑ Important

Some items that appear in these menus will have parentheses (...) around them. This means that the item may or may not appear on your flow meter. Choices you make early in the program will make some options unavailable later.

An example of this is the pH/D.O. (Dissolved Oxygen) sensor option. Selection of either in step 1 will keep the other from appearing in all following menus. If your installation does not use either sensor, you would select NOT MEASURED for both, and no further reference to either sensor would appear again for the rest of the program.

As you work through the program, your selections will rule out alternatives. This will cause those alternatives not to appear later in the program. Since there is no way of knowing what program choices will be made for a particular installation, it is necessary to provide all the possible menus in the manual, even though some of them will not appear on your instrument.

☑ Note

This list does not include all possible screens for the unit, but does cover the screens found in a typical programming sequence. Some diagnostic and error screens are discussed in Section 5 in the instruction manual.

4230 Bubbler Flow Meter

Section 3 Programming

3.1 Step 1 - Operating Mode

Turn on the machine. Wait for the display to settle. Then press the Enter/Program Step (Enter) key. The following will appear (step 1). If the following menu does not appear, press Exit Program, then Go To Program Step, then press 1.

```
SELECT OPTION
• PROGRAM • • SETUP •
```

PROGRAM is always the default. If you press Enter, the display will automatically advance to the next display, which will ask you to select units of measurement. If you select SETUP, the following will appear:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• SET CLOCK • • SITE ID • • MEASUREMENT SETUP •
```

If you press the right arrow key, the following options will appear on the display:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• STATUS • • ENABLE/ALARM HYSTERESIS •
```

Then:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• OPTIONAL OUTPUTS • • REPORT SETUP •
```

And:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• LCD BACKLIGHT • •(LANGUAGE) • •PROGRAM LOCK •
```

Finally:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• (LANGUAGE) • • PROGRAM LOCK • • PROGRAM •
```

LANGUAGE may not appear on your unit. This is intended primarily for export models, as they are programmed in different languages. Domestic models will contain English and Spanish.

If you select SET CLOCK, the following will appear:

```
YEAR MONTH DAY HOUR MIN
 XXXX      XX       XX      XX       XX
```

Enter the year (four digits), the month (01-12), the day (01-31), the hour (01-24), and the minute (01-59).

If you select SITE ID, the following will appear:

```
SITE ID: XXX
```

You can select any suitable three-digit number for the site identification.

If you select MEASUREMENT SETUP, the following will appear. You will have to use the

right arrow key to bring all the options on screen:

```
MEASUREMENT SETUP
• DO/PH READING INTERVAL • • YSI 600 READING INT-
```

```
MEASUREMENT SETUP
-ERVAL • • PURGE INTERVAL • • SUPER BUBBLE MODE •
```

DO/PH READING INTERVAL refers to the measurement of specific aspects of the flow stream other than amount. The 4230 Flow Meters support measurement of three different characteristics: temperature, pH (the relative acidity or alkalinity of a solution), and D.O., dissolved oxygen.

☑ Note

If you are using the Isco D.O. sensor or are sensing D.O. with the YSI Sonde, select as long an interval as is practical for your application. The reasoning is that the D.O. sensor is turned off between measurement intervals and this turned-off period prolongs the life of the sensor.

YSI 600 READING INTERVAL refers to the YSI 600 sonde. The flow meter can measure several different aspects of the stream at the same time, including pH, D.O., temperature, plus conductivity.

If you select PURGE INTERVAL, the following will appear:

```
PURGE INTERVAL
• 5 MIN • • 10 MIN • • 15 MIN • • 30 MIN • • 1 HR •
```

PURGE INTERVAL refers to how often the flow meter discharges a blast of air through the bubble line. These periodic blasts are intended to keep the end of the bubble line clear from any obstruction that could clog it, preventing it from releasing any bubbles. The option of setting the purge interval is offered for the sake of battery conservation.

If the bubble line tends to clog, characteristic of dirty flow streams, select a more frequent purge. If the stream is clean and the bubble line does not clog, you could try a less frequent purge. However, if your installation is battery-powered, you should try to get by with as few purges as possible to prolong the battery life. Some experimentation may be necessary to find the right setting.

If you select SUPER BUBBLE MODE, the following will appear:

```
SUPER BUBBLE MODE
• ON • • OFF •
```

Super Bubble is an Isco feature that increases the air supply to the bubble line when the flow meter senses a rapidly rising liquid level. This allows the level measurement to be more accurate and to react more quickly. In operation, Super Bubble resembles Purge in that it forces a blast of air through the bubble line; but the effect is different. Without Super Bubble, there would be a period when no bubbles come out of the bubble line when the level rises suddenly. Until the bubble rate is

re-established, the flow meter cannot accurately measure the level. Super Bubble helps maintain accurate level measurement by filling the bubble line with air, ensuring that the bubble rate will re-establish quickly when the level stabilizes.

Operation of Super Bubble will cause an increase in power consumption, because the air pump must run. If your flow meter operates from AC power, leave Super Bubble on. If your installation is battery-powered and the flow is generally stable (without sudden increases), you can turn Super Bubble off. Again, some experimentation may be necessary.

If you select DO/PH READING INTERVAL, the following will appear:

```
DO/PH READING INTERVAL
•CONTINUOUS••15 SEC••30 SEC••1 MIN••2 MIN••5 MIN•
```

Again, this selection is offered as a way to save battery power. (and prolong the life of the D.O. sensor). After selecting the appropriate interval, press Enter. The Setup menu will reappear. This time select YSI 600 READING INTERVAL from the menu. The following display will appear:

```
YSI 600 READING INTERVAL
•CONTINUOUS••15 SEC••30 SEC••1 MIN••2 MIN••5 MIN•
```

After selecting the appropriate parameter reading interval, press Enter.The Setup menu will reappear. This time select STATUS from

the Setup menu. Press Enter. The following will appear:

```
MODEL 4230 HW REV: XXXXXX SW REV X.XX
ID XXXXXXXXXXX
```

- HW REV refers to the hardware revision number.
- SW REV refers to the software revision number.
- ID is an internal identification number for the flow meter.

If you press Enter again, the flow meter will display the system voltage:

```
SUPPLY VOLTAGE: XX.X
PUMP DUTY CYCLE  XX.X%
```

This value should be from 10.5 to 13.5 (volts DC). PUMP DUTY CYCLE tells you how much the pump is running. This value is refreshed every few minutes and should generally average below 20%. If you see a value consistently higher than this, check the bubble line, look for leaks, or check the air system inside the flow meter.

☑ Note

If you do not press Enter after the first diagnostic menu appears, the flow meter will automatically advance the display through the next two screens and finally revert to the Setup menu after a short time-out.

```
YSI SOFTWARE REV: XX.X
```

Return to the Setup menu if the unit has not already done so. This time select ENABLE/ALARM HYSTERESIS from the menu. Press Enter. The following will appear:

```
LEVEL ENABLE/ALARM
HYSTERESIS X.XXX FT (or meters)
```

The HYSTERESIS menu lets you set the range over which the level (or other condition) can vary before the flow meter responds to the change.

In the PROGRAM section there are several steps that require a change in a condition to make the flow meter carry out certain actions. For example, step 6 programs the flow meter to enable (activate) a sampler. In that step, you select a condition (or set of conditions) that must occur before the sampler is enabled. Enter a value (level is an example) that must be met before the enabling occurs.

But what if this value is met briefly and then falls away? It is possible for a condition to vary rapidly over a narrow range. Without hysteresis, the flow meter would turn the sampler off and on repeatedly, causing a condition known as chattering, resulting in very erratic operation of the sampler.

With hysteresis, you can enter a value that will keep the flow meter from responding to small changes in the enabling condition. Select a value for hysteresis narrow enough to allow the flow meter to respond to any significant change,

but broad enough to ignore minor changes that could cause chattering.

Press Enter again and the following will appear:

```
FLOW RATE ENABLE/ALARM
HYSTERESIS X.XXX CFS (Or other units of measure.)
```

The next three menus may appear or not, depending on selections you made earlier in Program. They concern alarm/enable hysteresis set points for parameter sensing—temperature, pH, and D.O.

If you want to set hysteresis for any of these items, enable them when you work through the program section, then re-enter the Setup section (Hysteresis) and they will appear. Note that you can have temperature alone, or temperature with either pH or D.O. You must have temperature with either pH or D.O. You cannot have pH and D.O. at the same time unless you use the YSI 600 Sonde, and selection of one will prevent the other from appearing on the menus later.

The following will appear if you are measuring temperature:

```
TEMPERATURE ENABLE/ALARM
HYSTERESIS XX.XXX DEG F (or C)
```

The following will appear if you are measuring pH:

```
pH ENABLE/ALARM
HYSTERESIS X.XXX pH
```

The following will appear if you are measuring D.O:

```
DO ENABLE/ALARM
HYSTERESIS X.XXX PPM
```

(or mg./l depending on the units selected in Program.)

A set of menus similar to those shown above for pH, D.O., and temperature will then appear for the YSI 600 Sonde, if you have selected it. You can set hysteresis for YSI-pH, YSI-D.O., YSI-Conductivity, and YSI-temperature, if these parameters have been turned on in previous program selections.

After all the HYSTERESIS menus have been set, press Enter. The display will return to the Setup menu. This time select OPTIONAL OUTPUTS with the arrow key. Press Enter.

```
OPTIONAL OUTPUTS
• ANALOG OUTPUT • • SERIAL OUTPUT • • ALARM BOX •
```

ALARM BOX refers to an external accessory used to signal alarms from flow meter measurements. See Section 4 in the manual for more information about the Alarm Box. Note that choice of SERIAL OUTPUT will eliminate ALARM BOX as an option. Likewise, choice of ALARM BOX will eliminate SERIAL OUTPUT as an option.

If you select any of these OPTIONAL OUTPUTS, the flow meter will request that you turn them on or off. If you are running on battery, select OFF for all unused outputs.

ANALOG OUTPUT refers to the flow meter's capability of managing associated equipment through a 4-20 mA current loop. The 4-20 mA current loop is a common method used to control industrial processes that are variable (rather than just fully off or on). At the lower value (4 mA) the control is turned off (0%); at 20 mA the control is completely turned on (100%). In between, rates range from 1 to 99%. A typical application is a chlorinator, which must vary in application of the chlorine gas as the amount of water passing through the system increases or decreases. Current ranges other than 4-20 mA are also in use, although they are less common than 4-20 mA. Examples are 0-20 mA (supported by the flow meter on the internal card only) and for longer current loops, 10-50 mA (not supported by the flow meter).

Teledyne Isco offers two different arrangements for the 4-20 mA control circuit. You can have either or both with the same flow meter. One arrangement requires the use of an external accessory, the 4-20 mA Output Interface (see Section 4 in the manual). This module connects to the flow meter and a source of AC power and contains the circuitry necessary to create the 4-20 mA current loop. This accessory connects to the flow meter through the Interrogator connector.

The other 4-20 mA option is a board installed inside the flow meter that contains circuitry for three separate, isolated 4-20 mA current loops.

If you use both the external converter and the internal board, you can have a total of four current loops controlled by the same flow meter. The internal current loops are brought out to a 6-pin M/S connector in the slot where the Modem connector is usually mounted. Additional information for the internal analog output board, including specifications for the loops, is found in Section 4 of the manual.

⚠ CAUTION

Each 4-20 mA output represents a constant drain on the flow meter of at least 16 mA whether activated or not. While 4-20 mA applications are generally made in installations with commercial power available, Teledyne Isco suggests the following for those who have a 4-20 mA output in a battery-powered installation.

Use with battery powered flow meters only:

1. If the battery is continuously on charge (for example with a Solar Panel Battery Charger).
2. If the battery is very large, such as a deep-cycle or marine type battery, or an Isco 35 Ampere-hour lead-acid battery.
3. Use only one 4-20 mA output.
4. Keep in mind that programming choices also affect power consumption. Use “minimum” settings on the flow meter wherever possible. (See *Section 1, Table 1-8, in the manual.*)

Even with these circumstances, you may expect significantly shorter charge life from your battery. To determine the effect of this extra current draw on battery life, please refer to the

section *How to Make Battery Calculations*, at the end of Section 1 in the manual.

The following menus determine the behavior of the 4-20 mA current outputs. If you select ANALOG OUTPUT (another term for the 4-20 mA Output) and the flow meter is equipped with the optional internal board or the 4-20 mA external accessory has been turned on, RANGE, SMOOTHING, and MANUAL CONTROL will appear:

```
ANALOG OUTPUT
• EXTERNAL 4-20 MA • • (RANGE) • • (SMOOTHING) •
```

☑ Note

If you know for certain that you have the proper installed hardware for internal 4-20 mA outputs and you do not see the proper displays, return to the “normal” flow meter display and press 4 - 2 - 0.

☑ Note

If you do not have the proper hardware installed and you press 4 - 2 - 0 and the number of analog outputs is not zero, the external 4-20 mA converter will not work properly. If this occurs return to the 4 - 2 - 0 option, and at the prompt, enter 0 for the number of outputs activated. This will restore the external 4-20 mA converter capability.

MANUAL CONTROL will appear if you continue moving to the right. “RANGE” will appear with the ANALOG OUTPUT menu if the optional internal 4-20 mA converter is present in the flow meter.

If you select RANGE, the following will appear:

```
OUTPUT RANGE
• 0 – 20 mA • • 4 – 20 mA •
```

This menu lets you select the current value for zero-percent (baseline) compatible with your equipment (internal 4-20 mA board only).

If you select SMOOTHING from the ANALOG OUTPUT menu the following will appear:

```
SMOOTHING
• NONE • • 15 SEC • • 30 SEC • • 1 MIN •
```

The SMOOTHING option lets you stabilize operation of the outputs by preventing a rapid reaction to sudden sharp changes in the condition being monitored that quickly return to normal (transients). Selection of a smoothing interval will prevent the equipment controlled by the 4-20 mA loop from reacting too quickly, too much, or operating erratically. A low-pass filter algorithm is incorporated in the software.

If you select the MANUAL CONTROL option from the ANALOG OUTPUT menu the following will appear:

```
MANUAL CONTROL (OUTPUT 0 = EXTERNAL)
OUTPUT 0 = 0.0 MA
```

This option lets you control the operation of a 4-20 mA loop to check the operation of equipment controlled by the loop at any level from 0 to 100%. After connecting a 4-20 mA output to a controlled device, you can program the flow meter to put a specified current on a specific analog output. If you are using the

external 4-20 mA converter, the Analog Output number will be zero.

☑ Note

Selecting the MANUAL CONTROL option and programming any one of the ports will prevent the values transmitted by the other active 4-20 mA ports from being updated until the test is completed. The other ports will continue to transmit whatever value they held at the start of the test. Exiting from the MANUAL CONTROL menu at the end of the test will return all active 4-20 mA ports to normal operation.

Programming for the conditions and values that determine the operation of the 4-20 mA loop (or loops) is done in step 2.

Returning to the OPTIONAL OUTPUTS menu, you will see the SERIAL OUTPUT option. This feature lets the flow meter transmit the most recent values for all currently enabled ports as ASCII text. You can then write a simple program to retrieve this data periodically, or you can do it interactively using a terminal program.

☑ Note

The information in the following section is provided for those who can write their own software programs to process the data transmitted from the Serial Output port. Special cables may be required. Contact Teledyne Isco technical support for more information.

Command Line: (Use the INTERROGATOR connector.) The lines of text contain the port values for each port that is turned on. The

DATA command will use a special command response protocol.

The following table provides the ASCII codes for port types and standard units of measure.

Table 3-1 ASCII Output Codes

Code	Parameter	Units
DE	Description	String (enclosed in quotes)
ID	Unit specific identifier	Unsigned long
MO	Model	String (enclosed in quotes)
TI	Time since 1900	Days
BV	Battery Voltage	Volts
LE	Level	Meters
LSI	Level Signal Strength	0 - 100%
VE	Velocity	Meters per second
VSI	Velocity Signal Strength	0 - 100%
VSP	Velocity Spectrum Strength	0 - 100%
FL	Flow	Cubic meters per second
VO	Volume	Cubic meters
FV	Forward volume	Cubic meters
RV	Reverse volume	Cubic meters
SV	Sampler Enabled Volume	Cubic Meters
RA	Rain (rolls over every 255 tips)	Tips

Table 3-1 ASCII Output Codes		
Code	**Parameter**	**Units**
CR	Current day's rain (tips since midnight)	Tips
PR	Previous day's rain (tips since midnight)	Tips
PH	pH	pH units
DO	Dissolved Oxygen	Milligrams per liter
TE	Temperature	Degrees Celsius
YPH	YSI 600 pH	pH units
YDO	YSI Dissolved Oxygen	Milligrams per liters
YCO	YSI 600 Conductivity	Millisiemens per centimeter
YSP	YSI 600 Specific Conductance	Millisiemens per centimeter
YSA	YSI 600 Salinity	Parts per thousand
YTD	YSI 600 Total Dissolved Solids	Milligrams per liter
YTE	YSI 600Temperature	Degrees Celsius
YSP	YSI 600 Specific Conductance	Millisiemens per centimeter
YCO	YSI 600 Conductance	Millisiemens per centimeter
YSA	YSI 600 Total Salinity	Parts per thousand
YTD	YSI 600 Total Dissolved Solids	Milligrams per liter

Table 3-1 ASCII Output Codes		
Code	**Parameter**	**Units**
YTE	YSI 600 Sonde Temperature	Degrees Celsius
SS	Sampler Enable Status	Logical
B?	Bottle Number and Time	Days
CS	Check sum (does not include the check sum, carriage return, and line feed)	Unsigned long

☑ *Note*

The output string for a given flow meter will have values only for those parameters it is currently measuring. The order of the fields in this table is subject to change. Additional data types may be inserted anywhere in the list. Parsing routines for this output string should search by type identifier instead of depending on the position in the string. If an active port has an error flag set, the serial output will insert ERROR for the value.

You can enter the command line by connecting the interrogator cable with the interrogator sense line shorted to ground. Then send a series of '?' (question marks) until the flow meter transmits the unit's banner and prompt. The number of question marks necessary is a function of the baud rate auto detection. At the prompt, enter DATA<CR> and the flow meter will respond with the appropriate ASCII output string. You can send the DATA command as

often as you want. Type 'Q' to leave the command response interface.

In addition to the port values, the data includes the flow meter's current time, the bottle number and time stamp of the three most recent sample events, the previous day's rainfall total (midnight to midnight), the current day's rainfall total since midnight, and a rainfall tips counter that rolls over every 255 tips. The port values appear in a comma-separated values format. Each data field is preceded by a two or three-character type identifier. The table lists the type identifiers. Note that the flow meter's current time and the sample event time stamp appear as a number in standard spreadsheet format (days since 1900). The supported baud rates are 9600, 4800, 2400, and 1200 (no parity, eight bits and one stop bit).

Periodic Output: (Use a special RAIN GAUGE connector cable—contact the factory for assistance.) Note that the periodic output will terminate during phone connection and when the interrogator cable is connected.

⚠ CAUTION

It is important to use CHECKSUM if you plan to use internal modems or the interrogator. The UART is shared with these devices.

If you select SERIAL OUTPUT from the OPTIONAL OUTPUTS menu, the following display will appear:

```
PERIODIC SERIAL OUTPUT
• ON • • OFF
```

Selection of OFF from this menu will disable this feature, and there will be no further references to it.

The Serial Output data appears on the Interrogator connector of the flow meter. You should not use a standard interrogator cable for this application, as the sense line in the standard cable is shorted to ground.

Selection of ON from this menu will enable the feature and cause the following display to appear:

```
SELECT BAUD RATE (N81)
• 9600 • • 4800 • • 2400 • • 1200 •
```

After you select the appropriate baud rate, the program will advance to the following menu:

```
SERIAL OUTPUT INTERVAL
• 15 SEC • • 1 MIN • • 5 MIN • • 15 MIN •
```

This menu lets you select how often the flow meter transmits the ASCII text string.

Following is an example of a string showing all options: (Note that five lines are shown here; this is due to the confines of the text column. In actual practice, there are no carriage returns in the text string.)

```
DE, "Theresa Street", 4250 ALPHA 4,ID,0721577657,
```

```
MO,4250,TI,35317.343715,BV,12.3,LE,0.1000,VE,0.12
25,FL,0.001555,VO,2.199325,FV,2.199325,RV,0.00000
0,SV,2.195539,SS,1,B0,35317.307384,B0,35317.26990
7,B0,35317.232593,CS,10819
```

If you select any of these outputs, the flow meter will request that you turn them on or off. If you are running on battery and do not need these options, select OFF. Otherwise, select ON. After the OPTIONAL OUTPUTS menus have been set, press Enter. The display will return to the SETUP menu.

The alarm box, also called the High-Low Alarm Box is an Isco product that allows you to operate control relays to signal alarms when flow rate rises above or falls below a certain set value. You can set both the high and low alarm values from 1 to 99% of the controlling condition. (See Section 4 in the manual for more information about the alarm box.)

The mechanical totalizer is an electromechanical counter that is installed in the flow meter front panel just above the display. It is an optional feature; it is non-resettable and displays seven digits.

If you select any of these outputs, the flow meter will request that you turn them on or off. If you are running on battery and do not intend to use either of these options, select OFF. Otherwise, select ON. After the OPTIONAL OUTPUTS menus have been set, press Enter. The display will return to the SETUP menu.

This time, select REPORT SETUP with the arrow key. Press Enter.

```
REPORT SETUP
• REPORT A • • REPORT B •
```

This step lets you determine the contents of the reports generated by the flow meter. The report generator can create two different reports (A and B) that can be identical or very different. The reason for two reports is to allow the summary of flow meter recording over different time periods. For example you might generate report A weekly, and report B monthly. At this point we are only interested in selecting the items the flow meter will include in each report.

Press Enter and the following will appear:

```
REPORT SETUP
• FLOW • • DO/PH • • YSI 600 • • SAMPLE HISTORY •
```

FLOW METER HISTORY is just off the screen, to the right. If you select FLOW and press Enter, the following will appear:

```
LEVEL IN REPORT
• YES • • NO •
```

Select YES if you want LEVEL to appear in the report, then press Enter.

```
FLOW RATE IN REPORT
• YES • • NO •
```

Select YES if you want FLOW RATE to appear in the report, then press Enter again. Then:

```
RAINFALL IN REPORT
• YES • • NO •
```

Select YES if you want RAINFALL to appear in the report. Note that you must have a rain gauge connected to the flow meter to sense rainfall occurrence. Press Enter. The following will appear:

```
REPORT SETUP
• FLOW • • DO/PH • • SAMPLE HISTORY • • FLOW MET...
```

FLOW METER HISTORY is just off the screen.

This time select DO/PH. Press Enter. The following will appear:

```
PH OR DO IN REPORT
• YES • • NO •
```

Select YES if you want DO/PH to appear in the report. Note that you must have the appropriate sensor connected to the flow meter to sense parameters; the flow meter is capable of sensing temperature, pH and temperature, and D.O. (dissolved oxygen) and temperature. Press Enter. The following will appear:

```
TEMPERATURE IN REPORT
• YES • • NO •
```

Select yes if you want TEMPERATURE to appear in the report. Press Enter again and the display will return to the REPORT SETUP menu:

```
REPORT SETUP
• FLOW • • DO/PH • • YSI 600 • • SAMPLE HISTORY •
```

FLOW METER HISTORY is just off the screen.

This time select YSI 600. The following display will appear:

```
YSI DATA IN REPORT
• YES • • NO •
```

Press Enter again and the display will return to the REPORT SETUP menu.

```
REPORT SETUP
• FLOW • • DO/PH • • YSI 600 • • SAMPLE HISTORY •
```

Select SAMPLE HISTORY. Press Enter. The following will appear:

```
SAMPLE HISTORY IN REPORT
• YES • • NO •
```

Select YES if you want SAMPLE HISTORY to appear in the report. Press Enter again and the display will return to the REPORT SETUP menu:

```
REPORT SETUP
• YSI 600• • SAMPLE HISTORY• • FLOW METER HISTORY•
```

This time select FLOW METER HISTORY. Press Enter. The following will appear:

```
FLOW METER HISTORY IN REPORT
• YES • • NO •
```

Select yes if you want HISTORY to appear in the report. HISTORY is a list of the changes that have been made to the flow meter's program.

Press Exit to leave the program. Then press Enter and reselect SETUP. The Setup menu will reappear:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• STATUS • • REPORT SETUP • • LCD BACKLIGHT •
```

SET CLOCK, SITE ID, MEASUREMENT SETUP, PROGRAM LOCK, PROGRAM are off-screen and can be accessed with the arrow keys.

Select LCD BACKLIGHT with the arrow key. Press Enter. The following will appear:

```
LCD BACKLIGHT MODE
• KEYPRESS TIMEOUT • • CONTINUOUS • • OFF •
```

KEYPRESS TIMEOUT will cause the backlight to be turned on whenever you press a key on the keypad (other than On and Off). An internal timer is started that will keep the backlight on for approximately two minutes after you press a key.

Each time you press a key, the timer is restarted, so the backlight will never go off as long as you continue to program the flow meter, with keystrokes coming less than two minutes apart. At the end of programming, the backlight will go out, and will stay out until you start to program again.

This feature is designed to conserve battery power by de-energizing the backlight when it is not needed. The backlight is still available if it is necessary to program in a dark environment, such as a manhole. We recommend using this

selection if the flow meter is battery-powered, but installed in an environment where the lighting is poor.

CONTINUOUS will cause the backlight to be lit continuously. Where the flow meter is powered by an AC power supply, battery life considerations do not intervene. If the backlight makes the display easier to read, use it. Do not use CONTINUOUS in any installation that is battery-powered, as it will run the battery down in a matter of hours.

OFF will keep the backlight feature turned off under all circumstances. Select this option for maximum battery life in installations where there is sufficient ambient light to read the display without the backlight feature.

Press Enter. The SETUP menu will return. This time move the flashing cursor from LCD BACKLIGHT to LANGUAGE.

When LANGUAGE appears on your display, you may select an alternate language to program the flow meter. The other language depends on how the flow meter was ordered. The following display will appear:

```
LANGUAGE
• ENGLISH • • (second language, as ordered) •
```

Select the language appropriate for your application. The menus and the printed reports will appear in the selected language. Press Enter. The SETUP menu will reappear. This

time select PROGRAM LOCK from the menu. Press Enter:

```
PROGRAM LOCK
• ON • • OFF •
```

PROGRAM LOCK keeps the program from being changed. Select OFF while you are programming, and then go back and select ON if you need to lock the program. At that, we suggest using the lock only if there are compelling security reasons.

Further changes will require entry of the password, which is the model number of the flow meter, 4230. If you select ON, there is a time-out before the lock engages.

If you continue to work through the rest of the program, the lock will not engage until you are done. But if you stop programming longer than two minutes, the lock will engage, and you will not be able to make any further program changes.

☑ Note

If you choose NOT MEASURED for any selection, the flow meter will make no further reference to that function for the rest of the program, and you will be unable to activate that function later. If there is a feature you need that does not appear when the manual says it should, return to step 1 and make sure you have not accidentally left it turned off.

If you program a parameter value as a condition for sampler enabling, pacing, dialout, *etc*., and then turn that parameter sensor off,

the flow meter will also remove that condition from the program.

Consider all aspects of your program before you make any changes!

Press Enter and the SETUP menu will reappear. step 1 - Program:

```
SELECT OPTION
• PROGRAM • • SETUP •
```

PROGRAM will be flashing. (Note that PROGRAM is always the default choice. That is because you are more likely to need to make changes in the PROGRAM section of the software than in the SETUP section.)

Press Enter. The following will appear:

```
UNITS OF LEVEL MEASUREMENT
• FT • • IN • • M • • MM • • NOT MEASURED •
```

Selection of feet, inches, meters or mm depends on your situation. You would select NOT MEASURED if you were using the flow meter for some other form of sensing only, such as pH, or temperature. Press Enter. The following will appear. You will have to press the right arrow key several times to see all of the options displayed below:

```
FLOW RATE UNITS OF MEASURE
• GPS• •GPM• •GPH• •MGD• •CFS• •CFM• •CF-
```

Pressing the right arrow key several times will move other units onto the display:

```
FLOW RATE UNITS OF MEASURE
• CFH••CFD••LPS••M3S••M3M••M3H••M3D••AFD •>
```

NOT MEASURED will also appear if you keep moving with the right arrow key. This step establishes the units of measure the flow meter will use in all subsequent displays and calculations.

GPS	gallons per second
GPM	gallons per minute
GPH	gallons per hour
MGD	millions of gallons per day
CFS	cubic feet per second
CFM	cubic feet per minute
CFH	cubic feet per hour
CFD	cubic feet per day
LPS	liters per second
M3S	cubic meters per second
M3M	cubic meters per minute
M3H	cubic meters per hour
M3D	cubic meters per day
AFD	acre-feet per day.

```
TOTALIZED VOLUME UNITS
• GAL • • MGAL • • CF • • L • • M3 • • AF •
```

This step determines the units the flow meter will use to record the totalized flow that passes by.

GAL	gallons
MGAL	millions of gallons
CF	cubic feet
L	liters
M3	cubic meters
AF	acre-feet

For the next several substeps you must have the appropriate sensor attached to the flow

meter's Parameter Port or Rain Gauge Port (for the Rain Gauge or YSI 600 Sonde). You can only have D.O./temperature, pH/temperature or temperature alone on a given flow meter, unless you use the YSI 600 Sonde. The YSI 600 Sonde provides multiple outputs simultaneously. You can use the Rain Gauge with the YSI 600 sonde if you use a special Y-connect cable.

Remember that programming for either pH or D.O. will prevent the display of any references to the other in later program steps. All sensors but the rain gauge must be fully submerged in the flow stream. The pH and D.O. probes must be kept constantly wet.

The pH or D.O. probes cannot attach directly to the flow meter, as their output signals are low. You must also install the appropriate amplifier box between the probes and the flow meter.

☑ *Note*

The 270 D.O. module has been discontinued. Probes, service kits, and accessories are still available to maintain existing field units.

Their use in streams with intermittent flow (such as storm drainage) is not recommended. See Section 4 in the manual (Accessories) for more information about the pH, D.O. probes, and rain gauge. Note that the pH probe is a consumable item, and will eventually need replacement in any case.

```
RAIN GAUGE
• INCHES • • MM • • NOT MEASURED •
```

You must have an Isco 674 Rain Gauge connected to the flow meter through the Rain Gauge Port to sense rainfall. MM = millimeters. The rain gauge is factory-calibrated. If you do not want to use a rain gauge, you would select NOT MEASURED for this step.

☑ Note

If you choose NOT MEASURED, no more references to rainfall will appear in the rest of the program.

```
pH UNITS OF MEASURE
• pH • • NOT MEASURED •
```

pH measurement determines the relative acidity or alkalinity of a solution. You must have an Isco pH Probe (or approved equivalent) connected to the flow meter through the parameter port to sense pH. pH measurements range from 0 to 14 pH units, with solutions below 7 considered acidic and solutions above 7, alkaline. Pure water has a pH of 7. These devices require periodic calibration for accurate sensing of pH. See Section 4 (Accessories) in the manual for more information about the pH probe.

If you are not using a pH probe you would select NOT MEASURED.

- If you choose NOT MEASURED for pH, you will be unable to activate pH later in the program.

- If you select pH, you will be unable to activate and measure D.O. later in the program.
- If your situation requires the measurement of both parameters (pH and D.O.) at the same time, or if you also need to measure conductivity, use the YSI 600 Multi-Parameter Sonde.

If you select NOT MEASURED for pH and press Enter, the following will appear:

```
D. O. UNITS
• MG/L • • PPM • • NOT MEASURED •
```

Measurement of dissolved oxygen is conducted in studies of water quality in lakes and streams. Some dissolved oxygen is necessary for the survival of aquatic life in these waters.

You must have an Isco Dissolved Oxygen Probe to sense dissolved oxygen. The probe attaches to the module, which attaches to the Parameter Port. These devices require periodic calibration for accurate sensing. PPM = parts per million; MG/L = milligrams per liter. If you are not using the D.O. probe, you would select NOT MEASURED for this step.

☑ *Note*

Selection of NOT MEASURED will keep D.O. from appearing on subsequent programming menus.

Selection of PPM or MG/L will keep references to pH from showing up on subsequent menus.

```
TEMPERATURE UNITS
• DEG F • • DEG C • • (NOT MEASURED) •
```

This step sets up measurement of the temperature of the flow stream. You must have an Isco Temperature Probe attached to the flow meter's Parameter Port. The temperature probe contains a thermistor and needs no further calibration.

Measurement is in degrees Celsius or degrees Fahrenheit. If you are not using the temperature probe, select NOT MEASURED.

☑ Note

Selection of NOT MEASURED will keep TEMPERATURE from appearing in subsequent programming menus.

Note that if you are using either the pH or D.O. probe, temperature must be measured; the NOT MEASURED option will not even appear.

The following menus concern the use of the YSI 600 Multi-Parameter Sonde. This probe allows you to measure several different characteristics of a flow stream at the same time. The YSI 600 Sonde attaches to the Rain Gauge connector on the 4230 Flow Meter. Note that this connector must be a special, modified connector with nine pins.

☑ Note

The 4230 Flow meters with 4-pin Rain Gauge connectors cannot support the YSI 600. It is necessary to return the flow meter to the factory for modifications. In addition to the connector, there are significant internal modifications to the flow meter's electronics and software.

You can use both the YSI Sonde and a Rain Gauge on flow meters that support the YSI with a special Y-connect cable. Note that the YSI 600 Sonde differs from the previously-mentioned pH and D.O. probes. The YSI 600 can measure pH and D.O. at the same time, as well as temperature and conductivity.

If you are not using the YSI 600 sonde, select NO in the following display and the flow meter will advance to the next step. Otherwise, select YES.

```
YSI 600 CONNECTED
• YES • • NO •
```

☑ Note

If you select NO, you will be unable to activate the YSI Sonde later in the program.

If no communication has been confirmed, the following will appear:

```
YSI COMMUNICATIONS CHECK
• YES • • NO •
```

NO is the default. If you select YES, the following will appear:

```
WARNING! DO NOT DISCONNECT POWER
YSI COMMUNICATION CHECK. PLEASE WAIT...
```

⚠ CAUTION

Do not disconnect either the sonde or flow meter power during a communications check. The memory in the sonde can be damaged by a power failure occurring during an update.

If the communication check is bad, the following will appear:

```
COMMUNICATIONS CHECK FAILED
PRESS ENTER TO CONTINUE
```

☑ Note

The flow meter cannot communicate at 600 baud. If your sonde has been set up for 600 baud, you will get a communications failure. Consult the YSI 600 Manual for what to do in this case.

If the communications check is good, the following will appear:

```
COMMUNICATIONS RATE SET AT 2400 BAUD
PRESS ENTER TO CONTINUE
```

After you press ENTER, the flow meter will advance to the following display:

```
YSI 600 pH UNITS OF MEASURE
• pH • • NOT MEASURED •
```

☑ Note

Selection of NOT MEASURED from any of the YSI menus will keep you from activating that function later in the program.

If you wish to make use of the YSI 600 sonde's pH measurement capability, select pH. If you do not, select NOT MEASURED.

```
YSI 600 D.O. UNITS OF MEASURE
• MG/L • • NOT MEASURED •
```

If you wish to make use of the YSI 600 sonde's D.O. measurement capability, select MG/L. Otherwise, select NOT MEASURED.

```
YSI 600 CONDUCTIVITY PARAMETER
•YSI SP COND••YSI SALINITY••YSI CONDUCTIVITY•>
```

For any of the YSI CONDUCTIVITY options, if you press Enter, the following display will appear:

```
TEMPERATURE COEFFICIENT
1.91%
```

This value is provided because conductivity rises (~2% / °C) with temperature. The default setting is 1.91%. This value is the temperature coefficient for pure KCl (potassium chloride) in water. For other salts this value will be somewhat inaccurate, but it does provide a close approximation for solutions of many common salts, such as NaCl (sodium chloride), NH_4Cl (ammonium chloride) and sea water. If you use the value of 1.91, in most cases you will

be able to identify that gross changes are occurring in the ionic content of the stream.

If you move with the right arrow, the following options will appear on the display:

```
YSI 600 CONDUCTIVITY PARAMETER
• YSI T.D.S. • • NOT MEASURED •
```

T.D.S. stands for “total dissolved solids.” T.D.S. are measured in parts per thousand (ppt).

```
TDS SCALE FACTOR
0.75
```

Total dissolved solids are estimated by multiplying conductivity by an empirical factor. This factor can vary between 0.55 and 0.9 depending on the solubility of the ionic components in the water and its temperature.

```
YSI 600 TEMPERATURE UNITS
• °F • •°C • • NOT MEASURED •
```

Select the temperature units appropriate for your application.

3.2 Step 2 - Flow Conversion

```
FLOW CONVERSION TYPE
•WEIR/FLUME• •EQUATION• •MANNING• •DATA POINTS•>
```

METERING INSERTS will also appear. WEIR/FLUME = weir or flume; EQUATION = equation; MANNING = Manning; DATA POINTS = data points.

If you select WEIR/FLUME, the following display will appear:

```
TYPE OF DEVICE:
• WEIR • • FLUME •
```

For detailed information on weirs and flumes, refer to the *Isco Flow Measurement Handbook*, available from Teledyne Isco. Consulting the manufacturer of the specific weir or flume is also worthwhile. Note that for weirs and flumes, there is a preferred location for installing the level measuring device. Proper mounting of the level measuring device and accurate measurement of the level in the flow stream at the calibration point are essential for accurate flow calculation.

If you select WEIR, the following display will appear:

```
SELECT TYPE OF WEIR:
• V-NOTCH • • RECTANGULAR • • CIPOLLETTI •
```

If you select V-NOTCH, the following will appear:

```
SELECT V-NOTCH WEIR ANGLE (IN DEGREES)
• 22.5 • • 30 • • 45 • • 60 • • 90 • • 120 •
```

If you select RECTANGULAR for weir, the following will appear:

```
END CONTRACTIONS ON RECTANGULAR WEIR:
• YES • • NO •
```

If you select YES, the following will appear:

```
RECTANGULAR WEIR WITH END CONTRACTIONS
ENTER CREST LENGTH XX.XXX FEET (or meters)
```

If you select CIPOLLETTI for weir, the following will appear:

```
CIPOLLETTI WEIR
ENTER CREST LENGTH XX.XXX FEET (or meters)
```

If you selected FLUME for the type of standard device, the following display will appear:

```
SELECT TYPE OF FLUME
• PARSHALL • • PALMER-BOWLUS • • LEOPOLD-LAGCO •
```

Also available with the arrow key:

```
SELECT TYPE OF FLUME
• HS • • H • • HL • • TRAPEZOIDAL •
```

If you select PARSHALL for flume, the following will appear:

```
SELECT PARSHALL SIZE:
•1"• •2"• •3"• •6"• •9"• •1.0'• •1.5'• •2.0'•
```

If you press the right arrow key several times, the sizes shown below will move onto the screen:

```
SELECT PARSHALL SIZE:
• 3' • • 4' • • 5' • • 6' • • 8' • • 10' • • 12' •
```

If you select PALMER-BOWLUS for flume, the following will appear:

```
SELECT PALMER-BOWLUS SIZE
•4"• •6"• •8"• •9"• •10"• •12"• •15"• •18"• •21"
```

If you press the right arrow key several times, the sizes shown below will move onto the screen:

```
SELECT PALMER-BOWLUS SIZE
• 24" • • 27" • • 30" • • 48" •
```

If you select LEOPOLD-LAGCO for flume, the following will appear:

```
LEOPOLD-LAGCO FLUME SIZE
• 4"• •6"• •8"• •10"• •12"• •15"• •18"• •21" •
```

If you press the right arrow key several times, the sizes shown below will move onto the screen:

```
LEOPOLD-LAGCO FLUME SIZE
• 24" • • 30" •
```

If you select HS for flume, the following display will appear:

```
HS FLUME SIZE
• 0.4' • • 0.5' • • 0.6' • • 0.8' • • 1.0' •
```

If you select H for the type of flume, the following will appear:

```
H FLUME SIZE
• 5'• •.75'• •1'• •2'• •2.5'• •3'• •4.5'•
```

If you select HL for the type of flume, the following will appear:

```
HL FLUME SIZE
• 2.0' • • 2.5' • • 3.0' • • 3.5' • • 4.0' •
```

If you select TRAPEZOIDAL for flume, the following will appear:

```
TRAPEZOIDAL SIZE
• LG 60 V • • 2" 45 WSC • • 12" 45 SRCRC •
```

(This completes the section on WEIR/FLUME flow conversions.)

Returning to step 2, SELECT FLOW CONVERSION.

If you select EQUATION the following display will appear:

```
ENTER EQUATION UNITS
Q = XXX.XXXH^X.XX + XXX.XXXH^X.XX
```

This step allows you to enter an equation that is appropriate for your flow situation. The equation is expressed in the general form of $Q = k1H^{P1} + k2H^{P2}$, where Q = flow rate, k1 = a constant, H = level or head, and ^{P1} is the power to which k1 and H are raised. k2 and ^{P2} are a second constant and power found in some equations. If your equation has only one term, you should enter 0 for the second constant.

Again returning to step 2, SELECT FLOW CONVERSION, if you select MANNING, the following display will appear:

```
SELECT MANNING TYPE
• ROUND PIPE • • U-CHANNEL • • RECTANGULAR • • T-
```

TRAPEZOIDAL is also available, if you move to the right with the right arrow key.

If you select ROUND PIPE for the Manning flow conversion, the following displays will appear:

```
MANNING ROUND PIPE
SLOPE = X.XXXXX ROUGH = X.XXXX
```

Slope is entered as a dimensionless quantity, delta Y/ delta X, not as percent slope. Or, as otherwise expressed:

$$\frac{\Delta X}{\Delta Y} = \frac{\text{Rise}}{\text{Run}} \quad \text{For example: } \frac{1}{100} = .01$$

Roughness coefficients are published in the *Isco Open Channel Flow Measurement Handbook*. You must know the material the pipe is made of. The roughness coefficients are published for all common materials in three grades: minimum, normal and maximum. Then:

```
MANNING ROUND PIPE
DIAMETER = X.XXX FEET (or meters)
```

If you select U-CHANNEL for the Manning flow conversion, the following displays will appear:

```
MANNING U-CHANNEL
SLOPE = X.XXXXX ROUGH = X.XXX
```

(Slope and roughness are entered as for ROUND PIPE previously.) Then:

```
MANNING U-CHANNEL
WIDTH = X.XXX FEET (or meters)
```

If you select RECTANGULAR for the Manning flow conversion, the following displays will appear:

```
MANNING RECTANGULAR
SLOPE = X.XXXXX ROUGH = X.XXX
```

(Slope and roughness are entered as for ROUND PIPE.) Then:

```
MANNING RECTANGULAR
WIDTH = X.XXX FEET (or meters)
```

If you select TRAPEZOID for the Manning flow conversion, the following displays will appear:

```
MANNING TRAPEZOID
SLOPE = X.XXXXX ROUGH = X.XXX
```

(Slope and roughness are entered as for ROUND PIPE.) Then:

```
MANNING TRAPEZOID
TOP WIDTH = X.XXX FEET (or meters)
```

Then:

```
MANNING TRAPEZOID
BOTTOM WIDTH = X.XXX FEET (or meters)
```

Returning to step 2, FLOW CONVERSION TYPE, if you select DATA POINTS, the following displays will appear:

```
SELECT DATA SET
• ONE • • TWO • • THREE • • FOUR • • (NONE) •
```

Then:

```
LEVEL UNITS FOR DATA POINT ENTRY
• FT • • IN • • M • • MM •
```

This allows you to enter data points that are in different units than you are using. Then:

```
FLOW RATE UNITS
• GPM• •GPS• •MGD• •CFS• •CFM• •M3S• •M3H• •M3D•
```

If you press the right arrow key a few times, the following units of measure will appear on the display:

```
FLOW RATE UNITS
• LPS• •CFD• •GPH• •AFD• •CFH• •CFM• •M3M•
```

GPM	gallons per minute
GPS	gallons per second
MGD	million gallons per day
CFS	cubic feet per second
CFM	cubic feet per minute
M3S	cubic meters per second
M3M	cubic meters per minute
M3H	cubic meters per hour
M3D	cubic meters per day
LPS	liters per second
CFD	cubic feet per day
GPH	gallons per hour
AFD	acre-feet per day
CFH	cubic feet per hour.

DATA POINT flow conversion allows you to enter measured level and flow rate values for a number of different points. The 4230 Flow Meter can accept as many as four sets of data points with each set containing up to fifty points.

The flow meter then performs a three-point interpolation to calculate a flow rate appropriate for the data entered. The common use of data point flow conversion is with unusual primary measuring devices, specifically devices that the 4230 Flow Meter does not support in its internal flow conversion set.

The level-to-flow rate data for such devices is usually available from the manufacturer. From this the flow meter can create a conversion based on the relationship between the level and flow rate.

After the FLOW RATE UNITS menu has appeared, the next menu is:

```
SET X (1-4): (0) POINTS ENTERED
• ADD POINT • • (UNITS) •
```

Then:

```
SET 1 DATA POINT 1
ENTER: 0.00 (level units) 0.000 (units of volume)
```

After you have entered the data set the following will appear:

```
SET X (1-4): XX (1-50) POINTS ENTERED
• (USE)• •EDIT POINT• •ADD POINT• •CLEAR• •PRINT•
```

UNITS, SAVE will also appear if you move the flashing cursor with the right arrow key. USE will only appear after four points have been entered. USE tells the flow meter that the set is complete and can be used for the flow rate calculation.

Select EDIT POINT if you need to change either the level or the flow value for a particular data point.

Select ADD POINT if you want to add another point to a data set.

CLEAR erases an entire set of data points from the memory.

PRINT will make the flow meter print out the entire data set.

UNITS allows you to set or change the units of measure used in the data set. Note that you can only set UNITS if the set is empty, or you have cleared it. You cannot change the units once you

have entered data points into a set unless you clear it and start over.

SAVE will save the data set as it is.

If you select either EDIT POINT or ADD POINT, the following will appear:

```
SET X (1-4) DATA POINT XX (1-50)
ENTER: XX.XX (level units) XXX.XXX (volume)
```

3.2.1 Flow Metering Inserts

There is one more possible flow conversion for the 4230 Bubbler Flow Meter. This option will appear as FLOW METERING INSERTS. These devices are metal inserts for 6", 8", 10", and 12" diameter round pipe sewers. The inserts form a primary measuring device inside the pipe when they are placed.

The inserts are installed from street level to a maximum depth of 16 feet with a handle made up of snap-fit extension pipes. The inserts are sealed into the upstream pipe by inflating a rubber bladder. Each insert is supplied with two circular weir plates that provide either a round orifice or V-notch opening. Once installed, the flow backs up behind the insert and a bubbler tube in the bottom of the insert measures level. The flow meter calculates flow based on this measured level. If you select METERING INSERTS for the FLOW CONVERSION mode, the following menu will appear:

```
SELECT WEIR/ORIFICE TYPE
• V-NOTCH • • ROUND •
```

Then:

```
SELECT FLOW INSERT SIZE
• 6" • • 8" • • 10" • • 12" •
```

3.2.2 Enter Maximum Head - All Models

Before advancing from step 2 (Flow Conversion) to step 3 (Adjust Ports), the flow meter will request that you enter a value for Maximum Head (Level) for the device or flow conversion you are using.

For most standard measuring devices this information is published or is available from the device manufacturer. Note, however that you should not arbitrarily use the largest value available. Instead, use the value that is the largest expected level for your actual situation, even if this is less than the published maximum.

The flow meter's internal resolution and its accuracy are based on the value you enter for Maximum Head. The flow meter will display:

```
FLOW RATE AT MAXIMUM HEAD
X.XXX CFS (or other units of measure)
```

3.2.3 Programming the 4-20 mA Outputs

If you turn on any of the 4-20 mA outputs (ANALOG OUTPUTS) in step 1- Setup, programming the actual operation of the output appears in step 2 - Select Flow Conversion.

☑ Note

If you do not turn on the 4-20 mA output(s) in step 1, the menus determining its (their) operation will not even appear later in the program. If you need this function and cannot find the appropriate menus in step 2, return to step 1, Setup and check to see that you have not inadvertently switched the option off.

For each 4-20 mA output port turned on, the flow meter will request entry of the type of data that will drive the output, along with minimum and maximum values. Here is an example of what you might see for programming analog output 1.

```
DATA TYPE FOR ANALOG OUTPUT 1
• (OFF)••(LEVEL)••(FLOW RATE)••(VELOCITY)••(pH)•
```

TEMPERATURE, DISSOLVED OXYGEN, CONDUCTIVITY, SPECIFIC CONDUCTANCE, SALINITY, and TOTAL DISSOLVED SOLIDS may also appear as driving conditions.

The actual choices available to you will depend on what ports you have turned on previously and what accessories (YSI, pH, DO probes, rain gauge, *etc*.) you are using with your flow meter. After you select one of the choices available to you, the flow meter will request that you enter minimum and maximum values for that choice:

```
ANALOG OUTPUT PORT 1
4 MA = X.X (units)
```

Note that 4 MA in the second line of the display could also be 0 MA if that is what you selected

for the current loop minimum in Setup. The units are the units of measure appropriate for the option you selected; for example, feet or meters for level, degrees F or C for temperature, mg./l for dissolved oxygen, *etc*. After you have set the minimum value for the port, the flow meter will request you to enter a value for full-scale, or 100%:

```
ANALOG OUTPUT PORT 1
20 MA = X.X (units)
```

This value causes the port to transmit 100% or 20 mA. For example if the data type selected for this output were level, and the unit is measuring level in a four-foot pipe, you would enter a full-scale value of four feet. If the actual level reading is currently two feet, the analog output would read 12 mA (50% if the 4-20mA current range is selected) or 10 mA (50% if the 0-20 mA current range is selected).

The flow meter will then request that you repeat the process of defining the data type and setting the minimum and maximum values for any of the other analog ports you activated previously in Setup.

3.3 Step 3 - Port to Adjust

This step lets you enter the measured level in the flow stream. It also lets you calibrate the pH (acidity or alkalinity), D.O. (dissolved oxygen) parameter sensors, and the YSI 600 Multiple Parameter Sonde. Note that there is no calibration step for the temperature sensor

because it doesn't need calibration. When you select step 3 the following will appear:

```
PORT TO ADJUST
• NONE• •(LEVEL)• •(pH)• •(D.O.)• •(YSI 600)•
```

LEVEL will not show up if you are using the flow meter only for parameter sensing. Likewise, pH and/or D.O. and YSI 600 will not show up on the display if you have locked them out by programming selections you made in step 1.

Remember that selection of either pH or D.O. in step 1 will keep the other from appearing on the display in this or subsequent programming steps. If the parameter you want does not appear in this menu, exit the program and return to Setup. Check to see that you have not accidentally locked out your choice with selections made in the early part of the program.

If you select NONE, the flow meter will advance to the next step. If you select LEVEL, the following will appear:

```
ENTER CURRENT LEVEL
X.XXX FEET (or other units of measure, as selected)
```

For this value, you must measure the level in the flow stream. This is usually done with a measuring stick. Generally, you should measure the level upstream from the bubble line outlet, or at the prescribed point in the primary measuring device. The bubbler should be installed in an area of stable flow.

You should remove the bubbler and mounting ring to measure the level if either of the following occur:

- If it is not possible to measure the level upstream when the bubbler is installed, (cramped quarters inside smaller pipes).
- If the bubbler and its mounting ring create a visible “jump” in the stream.

This “jump” would be any noticeable disturbance on the surface of the flow stream where it passes over the bubbler and mounting ring, and is typical of lower flows. See Section 3, *Installing the Bubble Line*, (in the instruction manual) for more information.

Enter this value with the number keys. Note that LEVEL ADJUST must be done at the job site, while most other programming can be done in the shop. Unless you have reliable information about the size of the channel, you should measure that, also.

☑ Note

It is very important to enter accurate measurements for both the level in the stream and the dimension(s) of the channel, as all calculations of flow will be based on these measurements. If the values entered are incorrect, even by relatively small amounts, all subsequent flow calculations will be incorrect also.

For example, an error of only $^1/_4$" for a 3" level and $^1/_4$" for a 10" diameter round pipe can result in a combined error of over 14%!

Errors in level measurement have a greater effect on flow calculations at low liquid levels. Dimensional errors are more significant at higher levels.

If you select pH for port to adjust, the following display will appear. (Note that pH will not appear as an option unless you have selected it in step 1.) If you want to measure pH and pH does not appear in this step, you must go back to step 1 and select pH instead of NOT MEASURED.

```
pH CALIBRATION
• pH 4 & 7 • • pH 7 & 10 • • pH 4, 7, & 10 •
```

You can perform a two- or three-point calibration for pH with the pH sensor. Select the calibration that best suits your stream's profile. If the pH in your stream in generally below 7, you would probably select pH 4 & 7. If the pH is generally above 7, you would probably select pH 7 & 10. If your stream's pH varies a great deal, say from 3 to 12, your best choice would be pH 4, 7, & 10. Then:

```
RINSE PROBE AND PLACE IN 4.0 pH SOLUTION
PRESS ENTER WHEN STABLE  X.XX pH
```

The flow meter will direct you to repeat this process with the other standard buffers (7 and/or 10) to calibrate the pH sensor. If the probe fails to provide the correct output with any of the buffer solutions you will receive the following message:

```
pH BUFFER/PROBE OUT OF RANGE
PRESS ENTER TO CONTINUE
```

If you select D.O. for port to adjust, the following will appear:

```
DISSOLVED OXYGEN CALIBRATION
• D.O. STANDARD • • ABS BAROMETRIC PRESSURE • >
```

ALTITUDE is just off screen to the right. If you select D.O. STANDARD for the calibration method, the following display will appear:

```
D.O. STANDARD
0.00 MG/L
```

If you select ABS (absolute) BAROMETRIC PRESSURE the following will appear:

```
ABS BAROMETRIC PRESSURE
X.XX mmHg
```

Note that absolute barometric pressure is barometric pressure not corrected to sea level. The barometric pressure published by the U.S. Weather Bureau is corrected to sea level. If you use their value, you must convert it to the absolute pressure for your altitude. You should use Weather Bureau barometric pressure only if you are at sea level, or are able to correct the Weather Bureau figure to absolute pressure at your location. Enter the value for atmospheric pressure.

```
WRAP D. O. PROBE IN MOIST CLOTH
PRESS ENTER WHEN STABLE: X.XX MS/CM:
```

Then the display will advance to the following:

```
CALIBRATING...
PLEASE WAIT...
```

If you select ALTITUDE for D.O., the following will appear:

```
UNITS FOR ALTITUDE ENTRY
• FT • • M •
```

Select the appropriate units and press Enter.

```
ALTITUDE
ALTITUDE = X.XX FT (or meters)
```

Enter the altitude for your location. Then:

```
WRAP D. O. PROBE IN MOIST CLOTH
PRESS ENTER WHEN STABLE: X.XXX MG/L
```

For more detailed information on the pH and D.O. probes, see Section 4 in the instruction manual.

Returning to step 3, Parameter to adjust, the following will appear:

```
PARAMETER TO ADJUST
• NONE • • (LEVEL) • • (pH) • • (DO) • • (YSI 600) •
```

☑ *Note*

If you are using the YSI Sonde and YSI 600 does not appear on your display, return to step 1, Program, and make sure you have selected YES from the YSI CONNECTED menu.

If you select YSI 600, the following display will appear:

```
YSI 600 PARAMETER TO CALIBRATE
• NONE • • pH • • DO • • CONDUCTIVITY •
```

If you select pH for the parameter, the following will appear:

```
YSI 600 pH CALIBRATION
• pH 4 & 7 • • pH 7 & 10 • • pH 4, 7, & 10 •
```

You can perform a two- or three-point calibration for pH with the YSI sonde. The menus that follow are similar to those in the preceding section for the Isco pH sensor. Select the calibration that best suits your stream's profile. When you complete the pH calibration successfully, the following display will appear:

```
CALIBRATING...
PRESS ENTER TO CONTINUE
```

Returning to the YSI menu, if you select D.O:

```
YSI 600 DISSOLVED OXYGEN CALIBRATION
• D.O. STANDARD • • ABS BAROMETRIC PRESSURE •>
```

ALTITUDE is just off screen to the right. Programming for YSI 600 D.O. is essentially the same as that described for the Isco D.O. sensor on the preceding section, with the exception that you always place the sensor in a cup, rather than wrap a moist cloth around it as is done for the Isco D.O. sensor.

If you select CONDUCTIVITY for the parameter to calibrate, the following display will appear:

```
CONDUCTIVITY CALIBRATION UNITS
• MS/CM • • PPT •
```

MS/CM is milli-siemens per centimeter. The siemen is the S.I. (Système Internationale)

name for the unit of conductance, which is also the reciprocal of the ohm. The siemen was formerly called the mho (ohm spelled backwards), and that term is more familiar to some. PPT is parts per thousand. Select the standard most suitable for your application.

```
CONDUCTIVITY STANDARD
X.XX MS/CM
```

Then:

```
PLACE PROBE IN X.XX MS/CM
PRESS ENTER WHEN STABLE: X.XX MS/CM
```

Then:

```
CALIBRATING...
PLEASE WAIT...
```

If you select PPT for the conductivity standard:

```
CONDUCTIVITY STANDARD
X.XX PPT
```

Then:

```
PLACE PROBE IN X.XX PPT
PRESS ENTER WHEN STABLE: X.XX MS/CM
```

Then:

```
CALIBRATING...
PLEASE WAIT...
```

Note that there is no need to calibrate the YSI 600 temperature sensor, as it is self-calibrating.

3.4 Step 4 - Reset Totalizer

This step lets you reset the flow meter's internal flow totalizer. Note that there is the possibility of more than one totalizer. The 4230 Flow Meter can maintain a separate totalizer for the time the sampler is enabled through the sampler enabling feature (step 6).

If you select step 4, the following will appear: If you select NO, the flow meter will advance to the next step. If you select YES, the flow meter will reset the internal totalizer to zero.

```
RESET TOTALIZER
• YES • • NO •
```

Then, if you have sampler enabling turned on (step 6), the flow meter will ask you whether you want to reset the totalizer for the total flow during the time the sampler was enabled. (See step 6 for an explanation of sampler enabling.)

```
ENABLE TOTALIZER XX CF
PRESS 'ENTER
```

(Other units of measure may appear.) Then:

```
RESET SAMPLER ENABLE TOTALIZER
• YES • • NO •
```

3.5 Step 5 - Sampler Pacing

This step determines how the flow meter will signal an associated automatic wastewater sampler to take a sample. The flow meter and sampler must be connected together with a cable. The flow meter sends flow pulses to the sampler. The sampler uses these flow pulses as

counts. When an appropriate number of flow pulses has been received by the sampler, it will take a sample.

If you select step 5, the following will appear:

```
SAMPLER PACING
•DISABLE• •(VOLUME)• •(FLOWLINK)• •CONDITIONAL•
```

VOLUME will not appear if the flow meter is measuring level only, or is being used for parameter monitoring.

The FLOWLINK menu option will not appear unless Flowlink, Teledyne Isco's proprietary data acquisition and storage software, is installed and pacing has been downloaded from Flowlink.

If you select DISABLE for sampler pacing, the flow meter will be effectively disconnected from the sampler. The sampler will run its program as if the flow meter weren't there.

Selection of DISABLE will also cause the flow meter to advance to the next program step. If you select VOLUME for sampler pacing, the following will appear:

```
SAMPLER PACING
ENTER PACING VOLUME XX.XXXX (units)
```

(Range is from maximum flow ÷ 10 to max. flow × 10,000)

If FLOWLINK appears for sampler pacing, the operation of sampler pacing has been determined by choices made in Flowlink software. Flowlink controls the flow meter remotely, via phone lines and a modem, or

locally with a laptop computer and cable. In any event, if the sampler pacing definition is controlled by Flowlink, it can only be changed through Flowlink.

If you select CONDITIONAL, the following will appear:

```
CONDITION
•(LEVEL)••(FLOW RATE)••(RAINFALL)••(D.O.)••(pH)•
```

TEMPERATURE, YSI pH, YSI DO, YSI CONDUCTIVITY, and YSI TEMP may also appear. Note that all the conditions shown are in parentheses. Which ones actually appear depend on your previous programming selections. At least one of these menu options will be available to you.

Pressing the right arrow key may be necessary to bring all items onto the display, (provided they are available for use.)

LEVEL will only appear if the flow meter is set up to measure level or flow.

RAINFALL, D.O., pH, and TEMPERATURE measurement require the appropriate sensor probe be used with the flow meter. Remember that only one parameter condition (D.O. or pH) can be measured by the flow meter at a time.

RAINFALL can appear if you have a rain gauge attached to the flow meter.

TEMPERATURE can be measured alone, or with either parameter probe.

D.O. and/or pH may not appear on the menu, depending on selections made in step 1. If you do not see the item you need, return to step 1,

and recheck your programming. If you did not make the proper selections there, certain menu options will not appear here, as they would have been locked out.

The YSI 600 conditions of pH, D.O., CONDUCTIVITY, and TEMPERATURE will only appear on the menu if you have turned them on in steps 1 and 3.

For any of these conditions, you can set the point at which a change in the selected condition causes the flow meter to send a flow pulse to the sampler. The following menu will appear:

```
(Selected CONDITION)
• GREATER THAN • • LESS THAN • • RATE OF CHANGE •
```

If you select GREATER THAN, the flow meter will ask you to enter a maximum value for the selected condition, which if exceeded, will trigger the flow pulse.

If you select LESS THAN, the flow meter will ask you to enter a minimum value for the selected condition. If the condition falls below that value later, the flow meter will send a flow pulse to the sampler.

If you select RATE OF CHANGE, the flow meter will ask you to enter two values, one for the condition, and the other for a period of time over which the change occurs.

After you have determined what condition will signal the sampler and under what circumstances, the following menu will appear:

```
SELECT OPERATOR
• DONE • • OR • • AND •
```

SELECT OPERATOR allows you to trigger the sampler from a single condition or from two conditions. Suppose you wanted to trigger the sampler from only one condition and that condition was LEVEL. You would select level as the condition, and then identify what change in LEVEL would be the trigger. Then you would select DONE for the SELECT OPERATOR step. Selection of DONE will advance the flow meter to the next program step.

However, suppose you wanted to select two conditions, either of which would trigger the sampler. In such a case you would select OR for the SELECT OPERATOR step. The menu will return to the one listing the conditions. This will let you define the second condition. Now the flow meter will trigger the sampler when either condition changes.

Finally, suppose you had a situation where you wanted changes in two conditions to occur before you signalled the sampler. In that case you would select AND for the SELECT OPERATOR step. Then you would define the second condition. Now the flow meter will signal the sampler only after both conditions have changed.

The next screen on the flow meter (after you have established the conditions for sampler pacing) will request the following. (Entering 0 sends no pulses.):

```
CONDITION TRUE PACING INTERVAL
PACE EVERY X MINUTES
```

This option lets you send flow pulses periodically to the sampler when the conditions you established for sampler pacing are being met. Then:

```
CONDITION FALSE PACING INTERVAL
PACE EVERY X MINUTES
```

This option allow you to send flow pulses periodically to the sampler during the time the conditions you established for sampler pacing are not being met. Again, entering 0 sends no pulses.

3.6 Step 6 - Sampler Enable

The operation of step 6, Sampler Enable is similar to step 5, Sampler Pacing. The menus and options are similar. The difference is that where sampler pacing only causes the flow meter to send a momentary signal (flow pulse) to the sampler, sampler enabling actually controls an inhibit line to the sampler that can keep the sampler from running its program. Sampler enabling is useful where the sampler needs to remain idle for long periods of time, such as storm water runoff applications.

When you select or advance to step 6, the following display will appear:

```
SAMPLER ENABLE MODE
• DISABLE • • ENABLE • • CONDITIONAL • • (STORM) •
```

(FLOWLINK) may also appear. The FLOWLINK menu option will not appear unless Flowlink software has been installed.

DISABLE means that the sampler will be permanently inhibited by the flow meter. This condition will remain until you change it in this program step, or if you are using FLOWLINK, until it is overridden by a command from Flowlink.

Select the DISABLE option with care; it will make the sampler appear to be inoperative, and that could easily be misinterpreted as an equipment failure by someone not familiar with the programming of the flow meter.

ENABLE means that the sampler is permanently enabled, free to run its own program without any control from the flow meter. This condition will remain until you change this menu option, or until it is overridden by a command from Flowlink.

The STORM option will not appear unless you turned on rainfall measurement in step 1. STORM selection is what you use when you want to monitor storm water runoff.

STORM enabling is really a combination of conditions. First, enter a value for LEVEL in the flow stream. Second, enter a value for RAINFALL. Third, enter an amount of time

over which the rainfall occurs. Finally, you enter a time since the last rainfall. You must have an Isco Rain Gauge to measure rainfall. The following menus are the STORM sequence:

```
LEVEL
GREATER THAN X.XXX FT(Or other units, as selected.)
```

Then:

```
RAINFALL AMOUNT
X.XX INCHES (Or other units, as selected.)
```

Then:

```
RAINFALL TIME PERIOD
• 15 MIN • • 30 MIN • • 1 HR • • 2 HR • • 4 HR •
```

If you press the right arrow key several times, the following times will appear:

```
RAINFALL TIME PERIOD
•6 HR• •8 HR• •12 HR• •24 HR• •48 HR• •72 HR•
```

The intervals above are the periods of time over which the rainfall occurs. The amount of rain entered in the previous step and detected by the rain gauge must fall during the time interval chosen from this menu before the flow meter recognizes the event as a storm.

The next menu defines the interval that must pass between storm events.

```
TIME SINCE LAST RAINFALL
DAYS: X (allowable entry of 1-7)
```

If you select CONDITION from SAMPLER ENABLE, the following will appear:

```
CONDITION
• (LEVEL) • • (FLOW RATE) • • (D. O.) • • (pH) •
```

TEMPERATURE, RAINFALL, YSI pH, YSI D.O., YSI CONDUCTIVITY and YSI TEMP may also appear.

The above conditions are all shown in parentheses, because they may or may not be available to you by the time you reach this menu. The menus that do appear will depend on the flow meter type and programming selections made earlier in the program. At least one of the conditions will be available to you.

If you select LEVEL from CONDITION the following will appear:

```
LEVEL
• GREATER THAN • • LESS THAN • • RATE OF CHANGE •
```

After you select one of these options, the flow meter will request that you enter a value, for example if you selected GREATER THAN:

```
LEVEL
GREATER THAN X.XX FEET (Or other units.)
```

Enter a maximum value for the selected condition, which if exceeded, will enable the sampler.

If you select LESS THAN, the flow meter will ask you to enter a minimum value for the selected condition. If the condition falls below that value later, the flow meter will enable the sampler.

If you select RATE OF CHANGE, the flow meter will ask you to enter two values, one for the condition, and the other for a period of time over which the change occurs.

After you have determined what condition will signal the sampler and under what circumstances, the following menu will appear:

```
SELECT OPERATOR
• DONE • • OR • • AND •
```

This step allows you to trigger the sampler from a single condition or from two conditions. Suppose you wanted to trigger the sampler from only one condition and that condition was level. You would select level as the condition, and then identify what change in level would be the trigger. Then you would select DONE for the SELECT OPERATOR step. Selection of DONE will advance the flow meter to the next program step. Selection of OR or AND will allow you to select another condition, and then determine whether both conditions are necessary for enabling (AND) or whether either condition will enable the sampler (OR).

If you select FLOW RATE:

```
FLOW RATE
• GREATER THAN • • LESS THAN • • RATE OF CHANGE •
```

You would select one of these options, and then enter a value, as for LEVEL, previously.

The rest of the menus will appear the same as they did for LEVEL and FLOW RATE. D.O., pH, TEMPERATURE, and RAINFALL all

require activation in step 1 and use of the appropriate sensor. Only one parameter condition (pH, D.O.) can be measured by the flow meter at a time. pH and D.O. will not appear on the display at the same time.

It is possible to program the sampler enable option so that it operates in two different modes, latching and nonlatching. To explain this, in the nonlatching mode the sampler will be enabled only as long as the condition that caused the enabling remains outside of "normal." If the enabling condition returns to "normal," the sampler enable will turn off until the next time the condition goes outside of "normal."

In the latching mode, the sampler will be enabled the first time the condition goes outside of normal and it will remain enabled regardless of any subsequent changes in the enabling condition. If this is the case, the following menu will allow you to reset the sampler enable feature. Note that this menu will not appear unless the condition necessary to enable the sampler has been met and the sampler is currently enabled.

```
WHEN ENABLE CONDITION IS NO LONGER MET
• DISABLE SAMPLER • • KEEP ENABLED •
```

Or:

```
ENABLE CURRENTLY LATCHED, RESET
• NO • • YES •
```

Select YES to reset the sampler enable feature; select NO to leave the sampler enabled.

```
PRINTER ON/OFF WITH ENABLE
• YES • • NO •
```

This selection allows you to turn the flow meter's printer on or off when the sampler is enabled from the flow meter. This allows you to conserve battery power and print a chart only when the sampler is enabled. This feature is useful for monitoring storm water runoff.

3.7 Step 7 - Alarm Dialout Mode

This step lets you signal an alarm to a remote location from the flow meter. The conditions that can cause an alarm are the same as described previously for sampler enabling.

☑ *Note*

You must have the optional internal modem installed and connected to a telephone network to make use of this feature. This menu will not even appear if you do not have a modem. The flow meter will automatically advance to the next step.

More information about the modem can be found in Section 4 in the instruction manual. If you have the modem installed and select step 7, the following will appear:

```
ALARM DIAL OUT
• DISABLE • • CONDITIONAL • • STORM • • FLOWLINK •
```

If you select DISABLE, this option will be inactivated until you change the selection later. The program will advance to the next step. If you select STORM, the flow meter will request definitions similar to those for STORM in sampler enable. The following will appear:

```
LEVEL
GREATER THAN X.XXX FT (Or other units of measure.)
```

Followed by:

```
RAINFALL AMOUNT
X.XX INCHES (or other units of measure)
```

Then:

```
RAINFALL TIME PERIOD
• 15 MIN • • 30 MIN • • 1 HR • • 2 HR • • 4 HR •
```

If you press the right arrow key several times, the following times will appear:

```
RAINFALL TIME PERIOD
• 6 HR• •8 HR• •12 HR• •24 HR• •48 HR• •72 HR•
```

The intervals above are the periods of time over which the rainfall occurs. The amount of rain entered in the previous step and detected by the rain gauge must fall during the time interval chosen from this menu before the flow meter recognizes the event as a storm.

The next menu defines the interval that must pass between storm events.

```
TIME SINCE LAST RAINFALL
DAYS: X (allowable entry of 1-7)
```

If you select CONDITIONAL, the following will appear:

```
CONDITION
• (LEVEL) • • (FLOW RATE) • • (D. O.) • • (pH) •
```

TEMPERATURE, RAINFALL, YSI pH, YSI D.O., YSI CONDUCTIVITY, and YSI TEMP may also appear. As mentioned previously, some of these menu options may not appear depending on selections you made earlier in the program. At least one of the options will be available to you.

D.O., pH, TEMPERATURE, and RAINFALL all require activation in step 1 and connection of the appropriate sensor to the flow meter. D.O. and pH will never appear together, as only one can be used at a time.

When you have selected the condition you want, the display will advance to the following:

```
CONDITION
• GREATER THAN • • LESS THAN • • RATE OF CHANGE •
```

For these conditions, you enter an amount, which if exceeded (GREATER THAN), or if dropped below (LESS THAN), or if changed too quickly (RATE OF CHANGE), will activate the alarm dialout. For RATE OF CHANGE, you enter two values: amount and time interval over which change occurs. Then the display will advance to the following:

```
SELECT OPERATOR
• DONE • • OR • • AND •
```

As described previously for sampler enabling, this step allows you to combine conditions to produce an alarm dialout signal. Select DONE if you need only one condition to trigger the alarm.

If you want either of two conditions to trigger an alarm, select OR.

If you want both of two conditions to be met before signalling an alarm, select AND. Selection of DONE will advance you to the next display menu. Selection of OR or AND will return you to the CONDITION menu to select the other condition.

The flow meter will then request that you enter the telephone numbers for the remote alarms. Five numbers are possible, in decreasing order of importance. You can enter as many as eighteen digits for each phone, so the targets need not necessarily be local.

```
ALARM DIALOUT NUMBERS
• DONE• •NUM 1• •NUM 2• •NUM 3• •NUM 4• •NUM 5•
```

If you select DONE, the flow meter will advance to the next step. If you select one of the NUM entries, such as NUM 1, the following will appear:

```
FIRST PHONE NUMBER
XXXXXXXXXX
```

You can enter the phone numbers as straight multiple digit numbers, or you can use the +/– key to enter a dash as telephone numbers are

often written. Pressing the . (decimal) key inserts a , .

If you want to signal more than one remote number at a time, the numbers are arranged in decreasing priority. NUM 1 carries the highest priority, followed by NUM 2 and so on.

After you have entered the numbers, the flow meter will request:

```
DELAY BETWEEN DIALOUTS
XX MINUTES
```

This is the time delay between calling the first number and calling the second, *etc*. This option gives you time to respond to an alarm before the flow meter dials the next number. Select a value between 1 and 99 minutes. Then the display will advance to the following:

```
CALLBACK TO DISABLE ALARM
• YES • • NO •
```

Select YES if you want to be able to acknowledge the alarm condition in the flow meter by calling back. No message is spoken on this callback.

When the flow meter's modem detects the ring, it will answer and automatically reset the alarm. If there is no one available to answer an alarm, you can have the flow meter dial a paging service and then someone with a pager can call back to acknowledge the alarm.

To acknowledge an alarm from a touch tone phone; wait for the spoken message to

complete; then press *-X-X-X. The X-X-X are the three digits of the site ID number.

3.8 Step 8 - Printer

This step sets up the operation of the flow meter's internal printer. This printer also functions as a plotter. Note that the printer/plotter is capable of printing alphanumeric information (words and numbers), and at the same time, plotting linear data like flow, level, pH, *etc*.

The unit can print as many as three different data lines while it regularly records other printed information supplied from the flow meter. Program selections made in this step will determine the appearance of the printer/printer's chart.

The first menu will request the speed of the chart.

```
ENTER PRINTER SPEED
• OFF • • 1/2"/HR • • 1"/HR • • 2"/HR • • 4"/HR •
```

If you select OFF, the printer will be disabled. No data will be printed on the chart. The flow meter will, however, still print reports if you activate that function in step 9. The choice made from the other speeds depends on the amount of data you need to record on the chart.

If you are recording from a relatively stable situation, are using only one data line, and you want to achieve maximum longevity for the chart paper roll, select a lower speed for chart advance. On the other hand, if there is a great

deal of activity in your installation, and you must use all three data lines, selection of a faster chart speed will probably produce a chart more easily read and interpreted.

After you select the printer speed, the flow meter will ask you to define what input you want depicted by printer LINE A. (The printer can print as many as three separate data lines at the same time.) The following display will appear:

```
INPUT FOR PRINTER LINE A
• (LEVEL)• •(D.O.)• •(FLOW RATE)• •(pH)• •OFF•
```

TEMPERATURE, D.O., YSI pH, YSI D.O., YSI CONDUCTIVITY, and YSI TEMP can also appear. Remember that menus in parentheses may or may not appear due to previous program selections. Either pH or D.O. may appear, but not both. The various YSI options will only appear if you have enabled the YSI 600 option in step 1, previously. You must have the appropriate probes to sense these conditions for the flow meter. Select OFF, if you do not wish to use this line.

If you select pH, D.O., TEMPERATURE, or any of the YSI options the flow meter will request that you set limits that will serve as the bottom of the chart and the chart full-scale.

```
PRINTER LINE A BOTTOM SCALE
X.XX pH(or other condition, as selected previously)
```

You would enter here the lowest pH value you expect to see in your flow stream:

```
PRINTER LINE A FULL SCALE
X.XX pH(or other condition, as selected previously)
```

Enter here the highest pH value (or other condition) you expect to see in your stream. Note that selection depends on the range that you would normally expect to see. If your stream varies from 6 to 8 pH units, you would not want to enter 0 and 14 as limits. The chart resolution would be poor. You could enter 5 and 9 pH and still have good resolution if there were sharp deviations because of the availability of over-ranges in the flow meter.

Selection of OFF from the INPUT FOR PRINTER LINE menu will cause the printer to leave this line blank. Selection of conditions other than pH, D.O., TEMPERATURE, or YSI-functions will result in a request that you enter the full-scale value for the condition being plotted. For example, if you selected LEVEL as a condition, the following would appear:

```
PRINTER LINE A FULL SCALE
X.XXXX FEET(or other units of measure, as selected)
```

The flow meter will automatically go into over-range if the data goes higher than the full-scale value you have selected. You can easily recognize over-range operation by the plotted line running off the right side of the chart and then immediately reappearing on the left.

Because of the over-range feature, you can set a full-scale value that gives you good resolution on the chart. At the same time, the automatic over-range will prevent the loss of data if the plotted line rises past the full-scale point. For the other conditions, the full-scale units will be appropriate for what is being measured (D.O., pH, temperature, *etc.*) Note that the flow meter is capable of multiple over-ranges.

```
INPUT FOR PRINTER LINE B
• (LEVEL)• •(FLOW RATE)• •(D.O.)• •(pH)• •OFF•
```

TEMPERATURE, YSI pH, YSI D.O., YSI CONDUCTIVITY, and YSI TEMP may also appear. Again, as for line A, you can select another condition to plot. The flow meter will request a full-scale value, or bottom and full-scale values. These values can differ from that entered for line A.

```
INPUT FOR PRINTER LINE C
• (LEVEL)• •(FLOW RATE)• •(D. O.)• •(pH)• •OFF•
```

TEMPERATURE, YSI pH, YSI D.O., YSI CONDUCTIVITY, and YSI TEMP may also appear. For line C, you can select yet another condition to plot on the chart. The flow meter will also request entry of a full-scale, or bottom and full-scale values, as for the previous two lines.

```
PLOT RAINFALL ON CHART?
• NO • • YES •
```

You must have an Isco Rain Gauge connected to the flow meter to measure rainfall. Output is recorded in either inches or millimeters. Note that there is only one over-range for rainfall.

3.9 Step 9 - Reports/History

This step lets you set up the flow meter to print periodic reports. The typical report contains such information as the period of time covered in the report, maximum and minimum levels, and when they occurred. You can define two different reports in this step. For example, this is used to provide weekly and monthly reports. You can choose the content of the reports by working through the menus in step 1.

When you go to step 9, the following display will appear:

```
REPORT GENERATOR A
• ON • • OFF • • (PRINT) •
```

If you select OFF, the program will advance to the next step, and no report A will be generated. If you select YES, the following will appear:

```
REPORT A DURATION TO BE IN
• HOURS • • DAYS • • MONTHS •
```

After you select the units of time, the following will appear:

```
ENTER REPORT A DURATION
XX HOURS
```

DAYS or MONTHS could also appear depending on what you selected for the previous step. The time selected becomes the time interval that will be covered in the report. Then the flow meter will ask you when you want the first report printed:

```
PRINT REPORT A AT
YR: XXXX MONTH: XX DAY: XX HR: XX MIN: XX
```

Then:

```
REPORT GENERATOR B
• ON • • OFF • • (PRINT) •
```

The second report generator lets you program the flow meter to print two independent reports at different intervals, for example. This is useful for those who need both a weekly and a monthly summary of activity on the flow meter. If you select OFF for this step, the program will advance to the next step, and there will be no report B generated. If you select YES, the following will appear:

```
REPORT B DURATION TO BE IN
• HOURS • • DAYS • • MONTHS •
```

Select the appropriate interval for this second report. After you select the units of time the following will appear:

```
ENTER REPORT B DURATION
XX HOURS
```

DAYS or MONTHS could also appear depending on what you selected for the previous step. The time selected becomes the

time interval that will be covered in the report. Then the flow meter will ask you when you want the first report printed:

```
PRINT REPORT A AT
YR: XXXX MONTH: XX DAY: XX HR: XX MIN: XX
```

After you have entered the desired date for the first report, the program will advance to the following:

```
PRINT FLOW METER HISTORY
• YES • • NO •
```

The final step on the flow meter is HISTORY. This step presents a record of the programming activity on the flow meter that you can have printed on the printer. The flow meter keeps a record of certain programming changes and prints them out. If you select YES, the following will appear:

```
PRINT FLOW METER HISTORY
• PRINT SINCE LAST • • PRINT ALL •
```

If you press PRINT SINCE LAST, the flow meter will only print the changes that have occurred since the last print request. If there were no changes, there will be no print. If you select PRINT ALL, the flow meter will print all the changes it has in memory, as far back as 50 entries. If you selected NO from PRINT FLOW METER HISTORY, the flow meter will advance to CLEAR HISTORY - • YES • • NO • If you select NO again, the flow meter will exit programming and return to the normal display. If you clear the memory, previous programming

changes will be erased, but the flow meter will again begin keeping track of changes the next time you change the program.

Flow Meter History Contents –

```
D.O. ADJUSTED              REPORT B TURNED ON
pH ADJUSTED                REPORT A TURNED OFF
LEVEL ADJUSTED             REPORT B TURNED OFF
FLOW CONVERSION CHANGED    TOTALIZER RESET
PLOTTER SPEED CHANGED      INTERROGATED
PLOTTER TURNED ON          SAMPLER ENABLED
PLOTTER TURNED OFF         SAMPLER DISABLED
TIME CHANGE FROM           ALARM ACKED BY #X
TIME CHANGE TO             ALARM NOT ACKNOWLEDGED
REPORT A CHANGED           YSI pH ADJUSTED
REPORT B CHANGED           YSI D.O. ADJUSTED
REPORT A TURNED ON         YSI CONDUCTIVITY ADJ.
```

4230 Bubbler Flow Meter

Section 4 Maintenance

Depending on where you install the flow meter, relatively little needs to be done to keep the 4230 Flow Meter in good condition. Following the simple procedures outlined in the following sections will ensure a long, trouble-free life for the flow meter.

4.1 Care of the Flow Meter Case

If the lid is tightly latched, and all the M/S connectors on the side of the case are tightly capped, you can clean the case by spraying it with a hose or washing it with soapy water. Do not use a hose with a nozzle or a high pressure hose-and-wand as used at car washes. Do not immerse the flow meter in a tank of water to wash it. While designed to withstand accidental submersion in water, if that should happen, the flow meter is not intended to be submerged.

⚠ CAUTION

Use only soap and water to clean the flow meter. Do not attempt to use petroleum-based cleaning

solvents (such as gasoline) or halogenated cleaning solvents (contain chlorine), that could attack the plastic used in the case or cause the permanent fogging of the window.

4.1.1 Care of the Case Seal

Periodically inspect the case seal and clean it if necessary. The ridge extending around the edge of the flow meter cabinet forms a seal with the groove in the cabinet door. It should be free of dirt, sand, *etc*. If it is not, clean it carefully with a damp cloth.

The rubber gasket in the lid should also be clean; if not, you may clean it with a small brush and a damp cloth. If you do any cleaning while the case is open, be careful not to allow any dirt or debris to fall inside the flow meter case. It is best to work on the flow meter with the case standing upright. If you don't maintain the seals properly, they may leak, causing damage and eventual failure of the components inside.

4.1.2 Preventing Moisture Damage

To prevent moisture damage to internal components, keep the lid tightly latched at all times, except when you are changing the program or the paper roll for the printer. Do not operate the flow meter with the case open; this will expose the internal components to dirt and moisture. It will also cause the desiccant canister to fail quickly.

Keep the external connectors clean by keeping the mating connectors or the protective caps on unused connectors tightly screwed on. Under severe operating conditions you may spray the threads only of the connectors with a cleaner/lubricant (such as Jif or WD-40) to prevent corrosion. Be careful not to spray any of the conductive terminals (pins or jacks) inside the connectors; residue from the sprays can cause intermittent or failed contacts.

4.2 Changing the Printer Paper and Ribbon

The internal printer needs little maintenance beyond changing the chart roll and the ink ribbon. Refer to the pictures on the label inside the case.

To change the chart paper you will need:

- a new roll of paper
- a knife or a pair of scissors
- a small piece of tape

The printer will shut down when the paper runs out. The roll is nearly empty when a 1-inch wide pink band appears on the left side of the chart. To change the roll:

1. Locate the handle on the left side of the take-up roll.
2. Pull straight out on this handle until the take-up roll slips off the printer.
3. Remove the paper roll from the take-up spool by holding the handle in one hand

with your thumb pressed against one of the slots in the white end cap.

4. Snap the white end cap free from the two black catches on the end of the spool.
5. Pull the paper roll off the spool with your other hand.
6. Remove the feed spool by pulling on the handle extending from the right side of the printer.
7. Snap off the other white end cap as described previously. Save the white end caps; you will reuse them.
8. Remove the empty roll from the spool by holding the handle in one hand and pulling the roll from the spool with the other.

4.2.1 Installing the New Roll of Paper

After you remove the empty roll:

1. Slide the new roll onto the feed spool so it unrolls from the back side - facing away from you.
2. Line up the slots in the cardboard tube with the raised guides on the spool.
3. Reattach the white end cap by wedging the two catches on the end of the spool into the two slots on the white end cap.
4. Peel the paper back gently so it will unroll freely. Using the knife or scissors, cut off the end of the roll if it is torn.

5. Fold the paper over on itself so the end is straight and stiffer than a single layer of paper would be.
6. Unroll a few inches of the paper and set the roll on top of the cabinet.
7. Use your fingers to feed the paper down the back of the internal printer to where it touches the roller. Make sure the paper gets past the lever for the paper sensing switch.
8. Then press the Chart Advance key and hold it until the paper comes through the printer mechanism.

Rethreading the Paper –

9. When the paper comes through, reinstall the feed spool with the new roll on it by snapping it into the printer assembly.
10. Run a few inches through the printer, using the Chart Advance key; then unfold the end.
11. Put the cardboard tube from the empty roll on the take-up spindle and reattach the white end cap by wedging the catches on the end of the spool into the two slots on the white end cap.
12. Use the piece of tape to attach the end of the new paper to the cardboard tube from the old roll.
13. Roll some of the paper onto the spool so that it will wind clockwise, facing away from you. Then reinstall the take-up roll into the top of the printer.

14. Be careful to push it all the way back in, so that the take-up gear on the end of the spool assembly will reengage.
15. When the take-up spool is back in place, again push the Paper Reroll key to remove any slackness in the paper.

4.2.2 Ink Ribbon Replacement

Ribbon life varies greatly from one installation to another depending on how often the printer has to print. When the characters on the chart become difficult to read, you should replace the ribbon. If possible, try to replace the ribbon at the same time you change the paper roll, as it is easier to replace the ribbon when the roll of paper is out of the way. To replace the ribbon, first turn the unit off.

If there is paper in the unit, remove the take-up spool and unroll enough paper to get it out of the way, so you can clearly see the two ribbon spools. Each spool has a ribbon-detecting lever pressing against the ribbon. Note the direction the ribbon leaves the left spool and how it winds onto the right spool.

1. Take hold of one of the spools and rotate it slightly, loosening the ribbon.
2. Lift gently until the spool comes free from its shaft. Do the same with the other spool.
3. Lift the chart and take-up spool out of the way and remove the ink ribbon from the printer mechanism, noting how it threads through the unit.

4. Thread the new ribbon through the printer mechanism.
5. Locate the three pins on each spool and turn the spools so the pins face the gears on the two ribbon shafts.
6. Replace the two spools on their respective shafts, pushing the detector levers out of the way so the spools will easily re-engage their gears.
7. Gently rotate each spool to tighten the ink ribbon. Reinstall the paper take-up roll if necessary.

4.3 Maintenance of the Bubble Line

Periodically inspect the bubble line on the 4230 Flow Meter to make sure that it is not kinked, frayed, cut, nicked, clogged, or otherwise damaged. If you find the bubble line damaged, you should replace it. A leaky or obstructed line will cause erroneous level readings and/or decreased battery life as a result of the pump having to run too often. If you need to replace the bubble line, you can install a new line by referring to the instruction manual, Section 3.

Inspect the outlet of the bubble line periodically to make sure it has not become clogged with sludge or algae. If the line is clogged, either clean it, or just cut the tip off. If clogging proves to be a continuing problem, you may find it helpful to use a bubble line with a larger inside diameter. Consult the factory for specific

recommendations regarding the size of the line, special connectors required, *etc*. However, it is usually better to increase the frequency of the automatic purge operation (see the following) to increasing the size of the bubble line. Algae problems may be reduced with the use of copper bubble line extensions.

4.3.1 Automatic Air Purge

The 4230 Flow Meter is equipped with an automatic purge feature to periodically clear the bubble line with a blast of air from the pump. The program allows you to set the time between purge cycles, with intervals ranging from five minutes to one hour. The purge button on the keypad also allows you to purge the bubble line anytime. You don't have to wait until the next programmed purge cycle occurs. You can tell when the purge is running from the sound of the pump running inside the flow meter; the pump will continue to run for as long as the button is pressed, and for a short while after release. The letter P will appear on the display during a purge cycle.

4.4 Maintenance of the Batteries

If your flow meter installation is battery-powered, you will have to recharge the battery, unless you are using a solar panel battery charger. You may use an Isco Nickel-Cadmium Battery, Lead-Acid Battery, or an external lead-acid battery, such as a deep-cycle R-V or marine battery. The charging

requirements and operating characteristics of lead-acid and nickel-cadmium batteries are different from each other, and it is important to cycle and charge these batteries correctly. This will maintain reliable service from the flow meter and achieve maximum life from the batteries. The following sections cover nickel-cadmium batteries first, then lead-acid batteries.

4.4.1 Charging the Nickel-Cadmium Battery

Charge the nickel-cadmium battery either with an Isco Power Supply, Isco Battery Charger, or Isco Five Station Battery Charger. All supply the proper DC charging current. Chargers designed for lead-acid batteries are usually not satisfactory because their voltage is generally too low to fully charge a nickel cadmium battery; consequently they are not recommended. To charge a nickel-cadmium battery, connect the plug on the battery cable to the mating receptacle on the power pack or to the connector on the battery charger.

4.4.2 Five Station Battery Charger

If you have several flow meters or samplers and must maintain a number of batteries, Teledyne Isco offers a five station battery charger. You can charge five nickel-cadmium batteries or five lead-acid batteries at the same time with this charger. The Five Station Battery Charger operates from the 120 VAC line and provides

five separate 400 mA current-limited outputs to charge the batteries.

Because the nickel-cadmium battery shows an almost-constant output voltage regardless of charge, voltage measurements are of no value. Teledyne Isco recommends you charge the battery for 15 to 18 hours. While charging, the battery will stay cool to the touch. When charged, it will feel warm, as the charging current turns into heat. Discontinue charging when the battery feels warm. You can achieve the 15 to 18 hour charging period by putting the batteries on charge at 5:00 PM and removing them at 8:00 AM the next morning.

4.4.3 Self-Discharge Characteristic

After you recharge a nickel-cadmium battery, return it to service as quickly as possible (one to two weeks maximum) to ensure you have a fully-charged battery. These batteries have higher self-discharge characteristics than others. Unlike non-rechargeable “primary” batteries (such as alkalines or lithium) that hold most of their charge for several years, a fully-charged nickel-cadmium battery will discharge itself completely in a matter of months. This does not affect the life of the batteries, and does not mean the battery is defective. (Lead-acid batteries also lose their charge, but over a much longer time; typically 50% in one year at room temperature. However, lead acid batteries are usually ruined if they are allowed to self-discharge completely.)

The charge on the nickel-cadmium battery will not last as long as expected if you delay using it for several weeks. The self-discharge characteristic increases as the temperature increases—always store the batteries in a cool area. It also gets worse as the batteries age. Self-discharge should not be a problem if you have only one flow meter and two batteries. If you have several instruments and many batteries to maintain, consider numbering them and keeping a log. Then cycle the batteries in order after charging. Or, if you are in doubt about the charge, just recharge the battery again for a few hours before using it.

4.4.4 Hazards of Overcharging

Overcharging the battery causes it to overheat, deteriorating the separator material inside the battery. Repeated overcharging will reduce the useable life of the battery, and should be avoided.

4.4.5 Charging from Another Source

Teledyne Isco does not recommend chargers for the nickel-cadmium battery other than those listed, as you could damage the batteries or the charger if they are incompatible. Chargers delivering too much current to the batteries may overheat them. This could cause them to vent, releasing irreplaceable electrolyte, causing premature failure. Chargers providing too little current to the battery may never charge it completely. Do not try to use any other

charger without an accurate meter to monitor the charging current. This should not exceed 450 mA. Be sure of proper polarity before connecting any other equipment. If an Isco Power Pack is used, you can overcharge the battery occasionally with little risk. However, avoid repeated overcharging.

4.4.6 Memory Effects Temporary

Previously, it was widely believed nickel-cadmium batteries had memory, and that a complete charge/discharge cycle (exercising the battery) was necessary to maintain battery capacity. It is now known that the memory effect is not a problem under normal operating conditions, and if it occurs, it is temporary and may be reversed by a deep discharge and charge. If the battery is discharged to random depths, charged for random amounts of time, and subjected to various duty cycles, the memory effects will not be present.

4.4.7 Internal Fuse

To prevent risk of fire and burns in case of a short-circuit, the nickel-cadmium battery is internally fused at approximately 50 amperes. Refer to the *Power Products Guide* for information on changing the fuse.

⚠ CAUTION

Do not test nickel-cadmium batteries for charge by "sparking" the output, and be very careful in putting

voltmeter probes into the output connector. Any accidents resulting in a shorted output will damage the battery in less than three seconds.

4.4.8 Using the Lead-Acid Battery

Teledyne Isco also offers a lead-acid battery. Made with a gelled-electrolyte lead-acid battery, this power source differs significantly from the nickel-cadmium battery in behavior and charging requirements. Please note carefully the following:

- Do not let the battery discharge completely before recharging; total discharge of gelled-electrolyte batteries may lead to internal cell reversal. This will ruin the battery.
- Recharge the battery promptly. Batteries left discharged too long may not recharge to full capacity, and eventually will not take or hold a charge at all, due to sulfation of the plates. Again, this will ruin the battery.
- Avoid using the battery in subfreezing environments. A discharged battery may freeze in a cold environment, which will also ruin it.
- Gelled-electrolyte batteries are easily damaged by overcharging, which forces them to vent water. They require charging by equipment designed for them.

The use of other types of battery chargers, even those intended for wet cell lead-acid batteries, may seriously overcharge these batteries, ruining them. Proper charging is accomplished by a constant voltage—tapered current technique, rather than by the constant current method used by nickel-cadmium battery chargers. You cannot rely on the battery feeling warm as an indicator of charge condition. If it feels warm, it may already be overcharged. If you use an Isco Power Supply, you may use the charging table printed on the side of the battery or monitor the charging voltage with a reliable digital voltmeter and discontinue charging when the meter reads 14.5 VDC. In remote locations, the Solar Panel Battery Charger can be used to maintain the charge on a Lead-Acid Battery.

4.4.9 Using Other Types of Batteries

A deep-cycle marine/RV battery is suitable for powering the flow meter. However, you will have to mount this type of battery externally, as it is too large to mount on the flow meter. Teledyne Isco offers a special optional cable to connect the flow meter to an external battery.

Mount the battery securely, in an upright position, so it will not inadvertently tip over. Do not check the charge condition of lead-acid batteries by “sparking” the output cables (momentarily shorting the wires together). These batteries, when fully charged, can deliver enormous current into a short-circuit,

particularly if the short is near the battery. Unlike nickel-cadmium batteries, as a general rule lead-acid batteries (gelled or wet cells) are not internally fused.

4.4.10 Attaching the Battery

To use these batteries, plug the M/S connector on the Isco battery cable into the +12 VDC connector of the flow meter. Connect the leads on the other end of the cable to the positive and negative terminals of the battery. The positive lead on the cable has a red heat-shrink tubing on the clip. Use corrosion-preventing washers on the battery terminals to slow the battery acid attacking the connections and damaging the connect cable. (These washers are available from any auto parts supply house.)

⚠ WARNING

Fire and toxic gas hazard! Do not short the battery. Cables shorted momentarily can weld together, causing heavy current flow until the wires melt through, or the battery fails. The insulation will also melt and burn, particularly if it is thermoplastic. Fire, severe burns to your hands, and the release of dangerous fumes are all possible from such an accident.

⚠ CAUTION

Be sure of proper polarity before attaching clips to the battery. NEVER attach the flow meter to a source of unknown polarity or voltage. If in doubt, check with a reliable DC voltmeter. NEVER attach

the flow meter directly to an AC power source of any voltage under any circumstances. Failure to observe this warning may result in serious damage to the electronic components of the flow meter.

4.5 Regenerating the Desiccators

The 4230 Flow Meter has a reuseable desiccant canister inside the case and a desiccant cartridge mounted on top of the case. The canister contains silica gel that takes up moisture inside the case when closed, keeping the unit dry during shipment, storage and use. If you leave the case open, the canister will take up moisture from the air. It will become saturated and will no longer protect the flow meter.

The external desiccant cartridge vents the reference port on the pressure transducer and dehydrates the air intake for the pump. If the desiccant particles are blue or yellow, the cartridge is active. As the desiccant absorbs moisture, the particles will turn from blue to pink, or from yellow to green. When pink or green, the desiccant will need regeneration.

4.5.1 Regenerating the Internal Case Desiccant

Look at the desiccant canister whenever the case is opened. The canister has a mica window on its side that shows blue or yellow when the desiccant is in good condition. As the canister absorbs moisture, the window will look pink or green. When pink or green, the desiccant needs

regenerating, or replace it with the spare canister in the accessory package. Remove the canister by loosening the two thumbscrews which secure the mounting bracket. Remove the canister and heat it in a vented oven at 300°F (150°C) for about three hours, or until the blue or yellow color returns. Do not use a microwave oven. After cooling, reinstall the canister in the flow meter. Make sure the window on the side of the canister remains visible.

⚠ CAUTION

Regeneration of the desiccators is very important. The flow meter may operate for an extended period of time with saturated desiccators. However, moisture will gradually be drawn inside the unit.

In cold environments, moisture that makes its way inside the air pump can form ice, which will jam the pump and ruin it.

Gases present in most sewers, when combined with moisture, form acids. These acids will attack both mechanical and electronic components inside the flow meter, eventually ruining it. For maximum equipment life and reliability, inspect and regenerate the desiccators regularly.

4.5.2 Regenerating the External Desiccant Cartridges

Teledyne Isco uses two types of silica gel:

- One chemical looks like small beads or pellets that are blue-black when dry, pale pink to transparent when saturated.
- The other chemical looks like coarse sand, yellow when dry, dark green when saturated.

Regenerate desiccant by heating at 212° to 350°F (100° to 175°C). To regenerate the cartridges, snap them out of the brackets on the flow meter. Then detach the silicone tubing from the top of each cartridge. Pull one of the end caps off each cartridge and pour the spent desiccant into a small metal pan or some other heat-resistant container.

Identify the desiccant as described above and regenerate it at the proper temperature two to three hours or until the blue or yellow color returns. Do not attempt to regenerate the desiccant inside the cartridge. The cartridge is plastic and will melt. Do not attempt to use a microwave oven to regenerate the cartridge. Refill the cartridge with the regenerated desiccant or the extra desiccant provided with the accessory package and replace the end caps. Note the filters in the end caps; they prevent small pieces of the desiccant falling out of the cartridge. Clean these filters periodically using ordinary dish soap and water, and allow to dry.

⚠ CAUTION

There have been reports of fumes coming out of the desiccant during regeneration. While we have been unable to verify this, just to be sure, we urge you to take no chances. Use a vented oven in a well-ventilated room. Do not remain in the room while the regeneration is taking place.