4120 Flow Logger

Installation and Operation Guide

TELEDYNE ISCO
A Teledyne Technologies Company

Part #60-3243-142 of Assembly #60-3244-073

Revision P, September 18, 2009

Foreword

This instruction manual is designed to help you gain a thorough understanding of the operation of the equipment. Teledyne Isco recommends that you read this manual completely before placing the equipment in service.

Although Teledyne Isco designs reliability into all equipment, there is always the possibility of a malfunction. This manual may help in diagnosing and repairing the malfunction.

If the problem persists, call or e-mail the Teledyne Isco Technical Service Department for assistance. Simple difficulties can often be diagnosed over the phone.

If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by the Customer Service Department, including the use of the **Return Authorization Number** specified. **Be sure to include a note describing the malfunction.** This will aid in the prompt repair and return of the equipment.

Teledyne Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

Teledyne Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.

Contact Information

Customer Service

Phone:	(800) 228-4373	(USA, Canada, Mexico)
	(402) 464-0231	(Outside North America)
Fax:	(402) 465-3022	
Email:	IscoCSR@teledyne.com	

Technical Support

Phone:	(800) 775-2965	(Analytical)
	(866) 298-6174	(Samplers and Flow Meters)
Email:	IscoService@teledyne.com	
Return equipment to:	4700 Superior Street, Lincoln, NE 68504-1398	

Other Correspondence

Mail to:	P.O. Box 82531, Lincoln, NE 68501-2531
Email:	IscoInfo@teledyne.com
Web site:	www.isco.com

Revised March 17, 2009

General Warnings

Before installing, operating, or maintaining this equipment, it is imperative that all hazards and preventive measures are fully understood. While specific hazards may vary according to location and application, take heed in the following general warnings:

⚠ WARNING

Avoid hazardous practices! If you use this instrument in any way not specified in this manual, the protection provided by the instrument may be impaired.

⚠ AVERTISSEMENT

Éviter les usages périlleux! Si vous utilisez cet instrument d'une manière autre que celles qui sont specifiées dans ce manuel, la protection fournie de l'instrument peut être affaiblie; cela augmentera votre risque de blessure.

Hazard Severity Levels

This manual applies *Hazard Severity Levels* to the safety alerts, These three levels are described in the sample alerts below.

⚠ CAUTION

Cautions identify a potential hazard, which if not avoided, may result in minor or moderate injury. This category can also warn you of unsafe practices, or conditions that may cause property damage.

⚠ WARNING

Warnings identify a potentially hazardous condition, which if not avoided, could result in death or serious injury.

⚠ DANGER

DANGER – limited to the most extreme situations to identify an imminent hazard, which if not avoided, will result in death or serious injury.

Hazard Symbols

The equipment and this manual use symbols used to warn of hazards. The symbols are explained below.

Hazard Symbols	
Warnings and Cautions	
	The exclamation point within the triangle is a warning sign alerting you of important instructions in the instrument's technical reference manual.
	The lightning flash and arrowhead within the triangle is a warning sign alerting you of "dangerous voltage" inside the product.
Symboles de sécurité	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
Warnungen und Vorsichtshinweise	
	Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.
	Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sei vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
Advertencias y Precauciones	
	Esta señal le advierte sobre la importancia de las instrucciones del manual que acompañan a este producto.
	Esta señal alerta sobre la presencia de alto voltaje en el interior del producto.

4120 Flow Logger

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4120 Flow Logger

Section 1 Introduction

The 4120 Flow Logger is a flow-monitoring instrument that measures the level and flow rate of an open-channel flow stream. The 4120 consists of a portable case to which the Isco Submerged Probe is connected. The probe, equipped with an internal pressure transducer, measures the level of a flow stream. A strap at the top of the case suspends the 4120 from a manhole ladder or other support.

The 4120 depends on an IBM-compatible computer running Flowlink, Isco's flow-data management software, for programming and calibration. To program the 4120, simply connect it to a computer running Flowlink and program the 4120 from the computer's keyboard. You can enter settings for sampler pacing and enable controls and set up the 4120's memory to store level, flow-rate, sampler, and rainfall data. Flowlink also retrieves stored data, transferring it from the 4120's memory to the computer. Stored data can also be downloaded for later viewing using Isco's hand-held 581 Rapid Transfer Device.

1.1 Features

Sampler controls – The 4120 paces samplers for flow-paced and trigger-paced sampling. It has a number of sampler-enable controls that start and stop the sampler when the 4120 detects programmed level, flow rate, or rainfall measurements.

Internal memory for data storage – The 4120 stores level, flow-rate, rainfall, and sample-event data in 230 kilobytes of non-volatile, battery-backed RAM (Random Access Memory).

Low power consumption – A fully-charged 12-volt alkaline battery will power a 4120 (programmed to take readings at 15-minute intervals) for approximately 6 months without recharging or replacement. You can expect to obtain a battery life of about 3 months with 947 Lead-Acid Batteries.

A variety of power sources – Power the 4120 with two 6-volt alkaline lantern batteries, an Isco 947 Lead-Acid Battery, the Isco 954 Solar Panel and an Isco 946 Lead-Acid Battery, or an Isco sampler.

Battery protection and battery-life monitoring – The 4120 monitors battery use for all battery types and reports the remaining battery life to Flowlink. A shut-down feature turns off the 4120 before a lead-acid battery discharges completely. This protects the battery as well as the integrity of your data.

Optional 4200T Modem – A factory-installed option, the 4200T Modem is a full duplex, auto-answer modem with dial-out capabilities and a speech synthesizer. It lets Flowlink program the logger to deliver voice messages to as many as five telephone numbers when it detects user-definable alarm conditions.

The 4200T works with standard voice-grade telephone lines. You must have a touch-tone line to use the its dial-out alarm feature. Additional information about dial-out alarms and the modem is in Flowlink's Help section.

> ☑ ***Note***
>
> The modem is disabled when an interrogator cable is connected to the flow logger's interrogator port. It cannot receive incoming calls, and the alarm dialout will be rendered inoperative, while this cable is connected. **Disconnect the interrogator cable in order to use the 4200T modem.**

Flash memory for easy software upgrades – As Isco adds software features to the 4120, upgrade your unit by connecting a computer and downloading the new software. For more information about software upgrades, see Section 4.7 *Updating the Flow Meter Software*.

Figure 1-1 4120 Flow Logger and Submerged Probe

1.2 Compatible Isco Equipment

The 4120 Flow Logger is compatible with:

- Isco 6700 Series Samplers
- Isco 3700 Series Samplers
- Isco 674 Rain Gauge
- Isco 581 Rapid Transfer Device

Teledyne Isco provides cables to connect the 4120 Flow Logger to samplers and the 674 Rain Gauge. See Connecting the 4120 to Samplers and Rain Gauges on page 2-15 and Appendix A, Accessories List.

1.3 What is in This Manual?

This manual is an installation and maintenance manual for the 4120 Flow Logger and the submerged probe. It contains:

- A brief description of the 4120's features
- Installation instructions for the 4120 and for the submerged probe
- Maintenance guidelines
- Technical specifications for the 4120 and the submerged probe.

To learn how to program and calibrate the 4120 Flow Logger, see the Flowlink Help section.

1.4 Repairing Your Flow Logger

The 4120 Flow Logger has no user-serviceable parts. If your flow logger requires repair, contact Teledyne Isco's Customer Service department for information on returning it to the factory. Contact information is located in the back of this manual.

1.5 Technical Specifications

The following tables contain technical specifications for the Isco 4120 Flow Logger and Submerged Probe.

Table 1-1 Technical Specifications for the 4120 Flow Logger

Dimensions	10.5 x 9.0 x 6.0 inches (26.7 x 22.9 x 15.2 cm)
Weight	8 lbs (3.6 kg), without batteries
Operating Temperature	0° to 140° F (-18° to 60° C)
Storage Temperature	-40° to 140° F (-40° to 60° C)
Enclosure	Self-certified NEMA 4X, 6
Power	Two 6-volt lantern batteries or one 12-volt Model 947 Flow Logger Lead-Acid Battery
Alkaline Battery Life	6 months with minimum reading intervals of 15 minutes

Table 1-2 Materials Used in the 4120 (see Figure 1-2)

1	Case and Battery Compartment Door	Polystyrene
2	Connector Panel	Noryl
3	Labels	Polyester (not shown)
4	Carrying Handle	Plastic
5	Handle Latches	Stainless Steel
6	Handle Latch Retainers	Stainless Steel
7	Connector Caps	Acetyl Plastic
8	Suspension Hook (not shown)	Stainless Steel

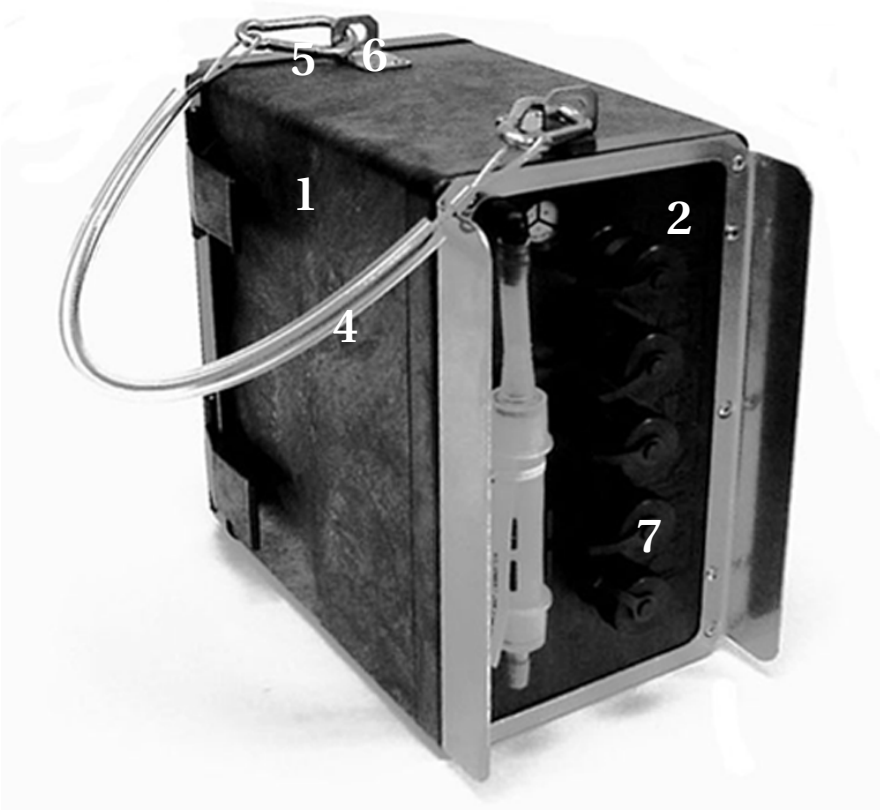


Figure 1-2 Materials Used in the 4120

Table 1-3 Technical Specifications for the Submerged Probe	
Operating Temperature	32° to 160° F (0° to 71° C)
Storage Temperature	-40° to 160° F (-40° to 71° C)
Level Measurement Method	Submerged pressure transducer mounted in the flow stream.
Transducer Type	Differential linear integrated circuit pressure transducer.
Level Measurement Range	0.1 ft to 10 ft (0.03 m to 3.05 m)
Maximum Allowable Level	20 ft (6.1 m)
Level Measurement Accuracy	0.033 to 5.0 ft: ±0.008 ft/ft (0.01 to 1.52 m: ±0.008 m/m) >5.0 ft: ±0.012 ft/ft (>1.52 m: ±0.012 m/m) @ 77° F (25° C). Includes non-linearity, repeatability, and hysteresis, but does not include temperature coefficient.
Compensated Temperature Range	32° to 100° F (0° to 38° C)
Temperature Coefficient	0.1 to 4.0 ft: ± 0.005 ft/°F (0.03 to 1.22 m: ± 0.0027 m/°C) 4.0 to 10.0 ft: ± 0.007 ft/°F (1.22 to 3.05 m: ± 0.0038 m/°C) Maximum error over compensated temperature range, per degree of temperature change.

Table 1-3 Technical Specifications for the Submerged Probe (Continued)	
Sensor Dimensions	Diameter: 0.875 inches (2.2 cm) Length: 5.5 inches (14.0 cm) without nose 9.5 inches (24.1 cm) with standard nose Frontal Area: 0.601 in^2 (3.88 cm^2)
Amplifier Box	Watertight enclosure
Cable Length:	25 feet (7.6 m) from sensor to amplifier box
Weight	3 lbs (1.4 kg) Entire probe and cable
Materials	Probe Body: CPVC Transducer Diaphragm: Type 316 stainless steel Cable: PVC

4120 Flow Logger

Section 2 Installation

2.1 The Basics

Basic installation requires the following:

- 4120 Flow Logger
- The Isco Submerged Probe probe measures depths as great as 10 feet and has a 25-foot cable.
- A power source; see About Power Sources on page 4-6.
- Mounting hardware for the probe (see *Circular Channels*, on page 2-7). You may also need a stud gun to attach the mounting hardware to the wall of the pipe or channel.

You may also need one or more of the following options:

- An Isco Submerged Probe Extension Cable (25 feet);
- A custom-length cable (to 1,000 feet) with an Isco Submerged Probe Quick Disconnect Box for the probe.

Programming and Calibration Require the Following:

- An IBM PC or compatible computer. You can use a desktop or laptop model.
- An Isco 9-pin or 25-pin Computer Connect Cable;
- Isco's Flowlink software.

2.1.1 Where Can You Install the 4120?

You can install the 4120 Flow Logger in nearly any location. A removable strap at the top of the 4120 case suspends the unit from a manhole ladder or other support. You can install the Submerged Probe in:

- Round pipes
- U-channel pipes
- Rectangular and trapezoidal channels
- Open-channel weirs and flumes; Any channel or device with a known level-to-flow relationship.

☑ *Note*

The Submerged Probe is unsuitable for flow streams with depths less than 0.875 inch (2.22 cm).

⚠ WARNING

The 4120 Flow Logger has not been approved for use in hazardous locations as defined by the National Electrical Code.
Before installing any device in a dangerous location, review safety precautions. (See General Safety Procedures on page D-1.) Check applicable guidelines, codes, and regulations of federal, state, city, and county agencies.

2.1.2 Installation Checklist

Before installing the 4120:

1. Check the condition of the desiccators. (Refer to page 4-2 for more information.)
2. Install a fresh battery. You can use:

- Two 6-volt alkaline lantern batteries. Lantern batteries are available from Teledyne Isco or local hardware stores.

☑ *Note*

Use only alkaline lantern batteries; non-alkaline batteries cannot produce sufficient power under load.

- Isco 947 Lead-Acid Battery. This battery, built especially for the flow logger, is available only from Teledyne Isco.
- Isco 946 Lead-Acid Battery recharged on-site with an Isco 954 Solar Panel.
- Power from an Isco sampler. The 4120 obtains power from the sampler through the cable connecting the 4120 to the sampler.
- A 12-volt DC marine battery can also be used as a power source for the 4120. These batteries require adapter cables and must be mounted outside the 4120's case.

⚠ CAUTION

Do not use external power sources that produce more than 13 volts. Excessive voltage will blow the internal fuses, and may cause more serious damage.

3. Connect a computer to the 4120 and use Flowlink to:
   a. Check the remaining battery life
   b. Set up the pacing and sampler-enable controls
   c. Enter the flow conversion for the site
   d. Set up the 4120's memory

2.1.3 At the Installation Site

Be sure you have the correct mounting hardware, including the probe carrier that mounts the probe on an Isco mounting ring.

Although your initial order will include mounting hardware, you may need additional mounting rings if you move the 4120 from site to site. You may also need a stud gun to attach the ring to the wall of the pipe or channel.

Physical Installation:

1. Install the probe upstream from the outflow of the pipe or invert. If you install the probe in a weir or flume, the probe's location varies with the device. Consult the device manufacturer for more information.
2. Use the strap and hook to suspend the 4120 from a manhole ladder or other support.
3. Connect the probe's cable to the 4120. With the standard cable, the 4120 must be within 25 feet of the probe. Two extension cables, in 25-foot or 50-foot lengths, are available should you need to locate the 4120 more than 25 feet from the probe. The combined length of the probe's cable and the extension cable should not exceed 75 feet.
4. Connect a rain gauge or a sampler, if desired.
5. Connect a laptop computer to the 4120 and calibrate the probe.

2.2 Submerged Probe Operation

The submerged probe consists of a cylindrical body, and a 25-foot (7.6-meter) cable. The probe itself has a removable nose section attached to the rear of body. The rear section contains a differential pressure transducer that senses the hydrostatic pressure produced by the liquid above the probe. The transducer converts pressure to analog signals and sends the signals to the 4120 through an amplifier box approximately 24 feet (7.3 meters) from the probe.

Because pressure is proportional to the level of the stream, the 4120 can convert the analog signals to level readings. The level readings, in turn, are converted to flow rates with level-to-flow-rate conversion formulas or tables characteristic of the primary device at the site.

2.2.1 How Does the Pressure Transducer Work?

The internal differential pressure transducer detects pressure with a small stainless steel diaphragm that transfers pressure to a small piezo-resistive disk. The outer face of the diaphragm is exposed to the flow stream through the ports around the outside of the probe. The inner face is exposed, or referenced, to the atmosphere through the internal vent tube that runs the full length of the probe's cable.

The outer face is subjected to the pressure exerted by both the liquid and the atmosphere while the inner face of the diaphragm is subjected only to atmospheric pressure. The difference between the pressures exerted on the diaphragm is the hydrostatic pressure.

2.2.2 Proper Installation Produces Reliable Readings.

The 4120 compares the hydrostatic pressure to atmospheric pressure. If the vent tube becomes blocked — because the cable is kinked or the tube fills with condensed water — the transducer is no longer exposed to atmospheric pressure and the pressure readings become unreliable.

Proper installation prevents the cable from kinking. A desiccant on the vent line helps prevent moisture from accumulating within the tube and blocking it. The flow logger connector contains a port to accept the vent tube at the end of the probe cable. A tube on the inside of the 4120 continues the vent to the desiccant tube on the 4120's exterior.

The following sections describe installation of the submerged probe. The first section presents general mounting considerations common to all submerged probe mounting techniques. The following sections describe probe installation using the two systems available for mounting the submerged probe in pipes or round-bottomed flow streams. For pipes up to 15 inches (38.1 cm) in diameter, spring stainless steel self-expanding mounting rings are available. For pipes larger than 15 inches in diameter, Teledyne Isco offers the **Scissors Ring**. For use in similarly-sized manhole inverts, you can use the **base** and **extension sections** of the Scissors Ring without the scissors section. The straps are held in place by studs installed in the wall of the flow stream using a power-activated stud gun. Submerged probes are also installed in primary measuring devices.

2.3 General Mounting Considerations

The location of the probe in the stream is usually dependent on the flow rate conversion used. For example, if you are using the probe with a primary measuring device (a weir or flume), there is a *specific location* for the probe with each primary device. The *Isco Open Channel Flow Measurement Handbook* provides much useful information in this regard.

If you want to measure flow using a gravity flow equation, such as the Manning equation, you will generally install the probe in the entrance (upstream) pipe of a manhole. If you want to measure flow by calibrating a manhole invert, you would probably locate the probe directly in the manhole invert.

In any case, you must determine the appropriate location of the probe, based on the hydraulic characteristics of the site and the method of level-to-flow rate conversion used.

You do not have to install the submerged probe at the bottom of the flow stream. Although the bottom is the normal position, the Parameter to Adjust step in the program allows you to mount the probe at any vertical location in the stream, and then adjust the indicated level to match the actual level. (The flow meter can indicate negative levels.)

A location other than the bottom of the flow stream may be useful for various reasons: to avoid heavy concentrations of silt, sand, or other solids; to make installation easier in tight locations; to maximize level resolution over a specific level range; to avoid hydraulic obstructions in the flow stream, etc.

The probe has several ports through which liquid enters the body to contact the pressure transducer. The only way for the probe to malfunction is for all the ports to be completely blocked. Most substances likely to cover the probe are somewhat porous, which still allows the hydrostatic pressure of the flow stream over the probe to reach the transducer.

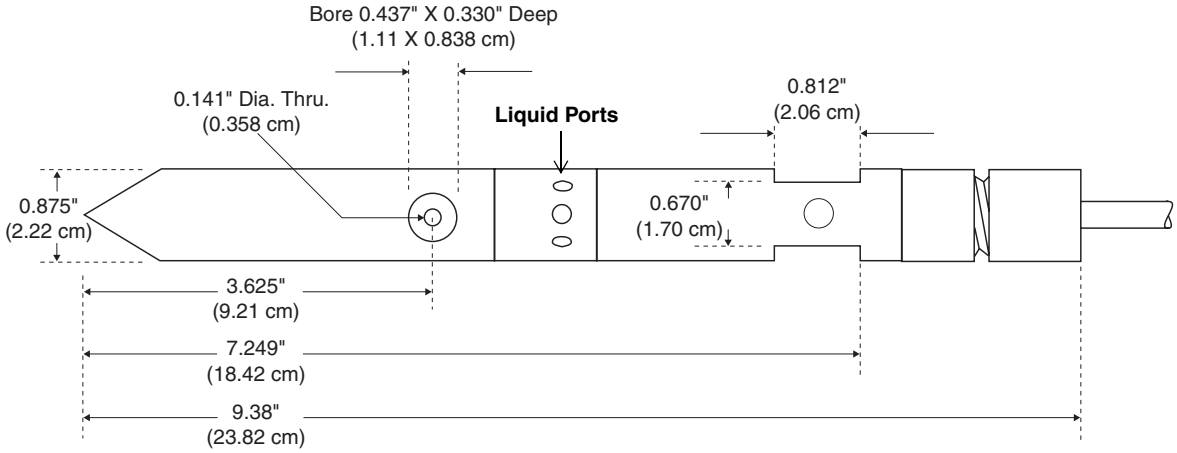


Figure 2-1 Submerged Probe Dimensions

2.3.1 Functionality Under Solids

Consequently, the probe will normally continue to function even when covered with several inches of silt or sand. Note however, that porous solids, such as wood chips or other organic material that may swell considerably when soaked in water, can interfere with the correct operation of the pressure transducer. In extreme cases, swelling material can put enough pressure on the diaphragm of the pressure transducer to deform it. This will ruin the submerged probe by introducing a permanent offset to the pressure transducer.

> ☑ ***Note***
>
> Always install the probe where it will be under water, even if only an inch or so. The probe cannot measure levels that fall below its location in the stream.

2.3.2 Minimum Reliable Detection Level

It is important to note that there is a practical minimum water level below which the submerged probe cannot reliably measure level. This minimum level is approximately equal to the height of the probe body, 0.1 ft. (1.3 in. or 0.030 m).

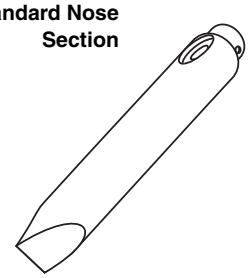
Liquid levels lower than this will be below the levels used to calibrate the sensor. The submerged probe level sensor will continue to measure levels less than 0.1 ft.; however, the accuracy of the measurement in this range is not guaranteed. Consequently, you should always use the submerged probe with caution in very low flow situations.

2.4 Submerged Probe Nose Sections

Teledyne Isco provides three nose sections, each designed for specific flow stream conditions.

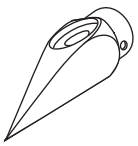
A complete list of nose sections and their part numbers can be found in Appendix B.

Standard Nose Section



Standard Nose Section – The standard nose section works in any flow stream and will be installed on your probe unless otherwise specified in your order. It is particularly well suited for flow streams with high velocities because its shape overcomes hydraulic problems that develop in these flow streams. At velocities exceeding 5 feet per second (1.5 meters per second), localized low-pressure areas form near the submerged probe, which can result in erroneous level readings. The length of the nose section (3.87 inches or 9.84 cm) minimizes low-pressure areas by allowing the flow stream to stabilize before it reaches the probe's entrance ports.

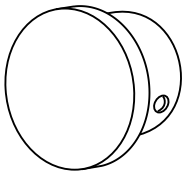
Slanted Nose Section



Slanted Nose Section – Under certain conditions - low flow rates in debris-laden small sewers, for example - the submerged probe may catch and retain the debris, obstructing the flow stream and causing erroneous level readings. To avoid this problem, use the slanted nose section. This nose section has a slanted leading edge that tends to shed debris more readily than the standard nose section.

Use the slanted nose section with caution, however, Under conditions of low flow and high velocity, the slanted nose section may induce a hydraulic "jump" in the flow stream that can cause erroneous level readings.

Flume Cap



Flume Cap – The flume cap is a small, blunt cap that replaces the nose section. Most flume manufacturers can supply flumes with a small cavity to accept an Isco probe. The probe cap protects the transducer while minimizing the total length.

2.4.1 Attaching the Nose Section

After cleaning, reinstall the nose section and tighten the screws. **The mounting hole must be aligned with the grounding point.**

Figure 2-2 Alignment of Grounding Point

2.5 Circular Channels

Consult your Isco Mounting Rings Installation and Operation Guide for detailed hardware information.

The following sections describe sensor installation using the two options available for mounting sensors in pipes or round-bottomed flow streams. For pipes up to 15" (38.1 cm) in diameter, **stainless steel self-expanding mounting rings** (**Spring Rings**) are available. For pipes larger than 15" in diameter, Teledyne Isco offers the **Scissors Rings (Universal Mounting Rings)**.

2.5.1 Spring Rings

To install a spring ring, you compress the ring, slip it inside the pipe, and then allow it to spring out to contact the inside diameter of the pipe. The inherent outward spring force of the ring firmly secures it in place. A typical self-expanding mounting ring (with a probe mounted on it) is shown in Figure 2-3.

These mounting rings are available for use in pipes with inside diameters of 6" (15.2 cm), 8" (20.3 cm), 10" (25.4 cm), 12" (30.5 cm), and 15" (38.1 cm). The Teledyne Isco part numbers for the various size mounting rings available are listed in Appendix B. These part numbers include not only the ring, but also the miscellaneous hardware necessary to mount the sensor on the ring.

⚠ CAUTION

Always wear leather gloves when handling the rings (either type). The metal is finished, but there is still a possibility of cutting your hands on the edges.

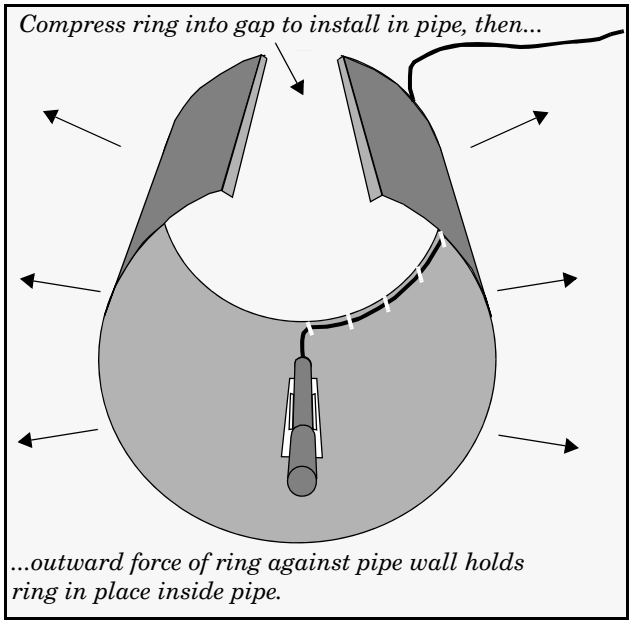


Figure 2-3 Sensor Installed on a Spring Ring

Attaching the Sensor to the Ring

Attach the probe to the ring either by using two 4-40 x 3/16" countersink screws or by snapping the optional probe carrier to the ring. This second method of attaching the sensor allows for easy removal in case service is needed later.

⚠ CAUTION

Make sure the slots on the probe carrier are completely pressed onto the tabs on the ring. This is particularly important where there is any possibility of reverse flows, or where flows are of high velocity. If the probe is not fully pressed onto the mounting ring tabs, it might come loose in the stream, and could possibly be damaged or lost.

To complete the sensor-spring ring assembly procedure, attach the sensor cable to the downstream edge of the ring. Follow the cable routing shown in Figure 2-3. Other routing directions may affect measurement accuracy. The cable can actually create a stilling well downstream from the sensor, causing the level to read low. Use the self-locking plastic ties supplied with the ring. Install the ring in the pipe by compressing it. Press inward on both sides and slide the ring into the pipe.

Route the sensor cable out of the stream and secure it in position by placing the ties through the holes in the mounting ring and then locking them around the cable, as shown. To prevent debris from catching on the cable, it is important to attach the cable to the mounting ring so it offers as little resistance to the flow as possible.

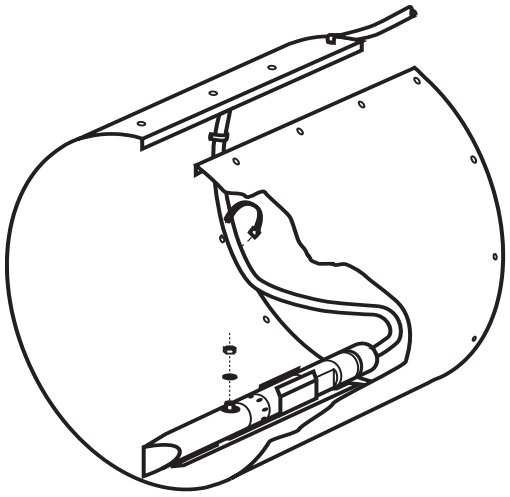


Figure 2-4 Spring Ring Preparation

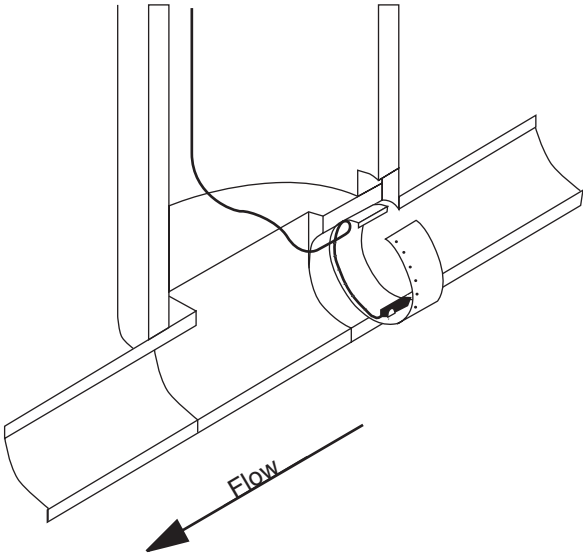


Figure 2-5 Mounting Ring in a Round Pipe

⚠ CAUTION

Make sure the sensor cable is securely fastened along the back (downstream) edge of the ring. Otherwise, the sensor may provide **inaccurate level readings** under conditions of high velocity.

Do not overtighten the plastic cable ties; they should be tightened just enough to secure the cable in place, without greatly indenting the cable. Overtightening the plastic ties may collapse the reference tube in the cable, blocking it.

The spring ring may need anchoring. Under conditions of high velocity (greater than 5 feet per second or 1.5 meters per second), the ring may not have sufficient outward spring force to maintain a tight fit inside the pipe. The ring may start to lift off the bottom of the pipe in a waving fashion, or may even be carried downstream.

This problem is more prevalent in the larger diameter pipes (10", 12", and 15", and in pipes with smooth inside surfaces, such as plastic pipes). If any of these conditions are present, or if movement of the mounting ring is detected or suspected, you must anchor the ring in place. You can do this by setting screws through the ring into the pipe, or by other appropriate means. If there is a problem with the smaller diameter rings, it may be sufficient to simply increase the outward spring force of the ring by bending it into a less round configuration.

2.5.2 Scissors Rings

For pipes larger than 15" in diameter, Teledyne Isco offers the adjustable Scissors Ring (also known as the Universal Mounting Ring). This device consists of two or more metal strips that lock together with tabs to form a single assembly. There is a base section where the sensors are mounted, one or more extension sections (usually), and a scissors section at the top that expands the entire assembly and tightens it inside the pipe. The scissors mechanism includes a long screw that increases the width as it is tightened.

The assembled rings fit pipe diameters from 16" to 80". Secure the unit in place by tightening the scissors mechanism with a 5/8" socket wrench or other suitable tool. Ring sections are .040" thick half-hard 301 stainless steel sheet. All other parts are also stainless steel, except for the plastic cable ties in the hardware kit.

Each extension, 1, 2, 3, and 4, adds 9.0", 21.5", 31.5", or 41.5", respectively, to the circumference of the ring. Used alone, the base section fits pipe that is approximately 16" to 18" in diameter. The 9.0" (the smallest) extension exists so that in larger pipe sizes, where large variations in circumference can occur, you can use one or two of these extensions to take up or remove slack, to bring the scissors mechanism into a position where it can be effectively tightened.

Mounting ring kits are available for different pipe sizes. A kit is also available for partial pipe applications (see your *Isco Mounting Rings Installation and Operation Guide*). For a listing of part numbers and ordering information, see Appendix B.

⚠ CAUTION

Do not overtighten the plastic cable ties; they should be tightened just enough to secure the cable in place, without greatly indenting the cable. Overtightening the plastic ties may collapse the reference tube in the cable, blocking it.

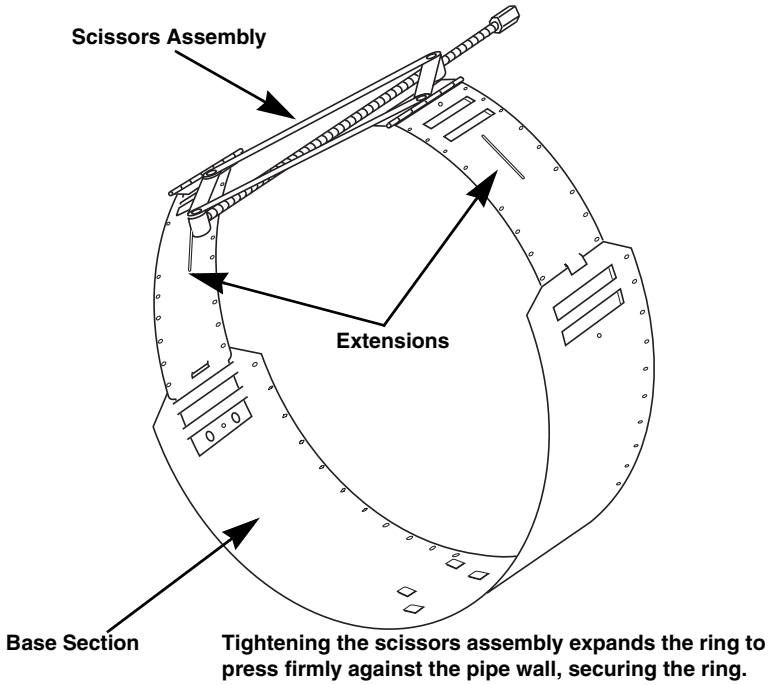


Figure 2-6 Universal Mounting Ring Adjustment

2.6 Other Mounting Techniques

Many installations require mounting methods other than mounting rings. Some alternative mounting methods are described below. Contact Teledyne Isco for assistance in determining your specific installation needs.

2.6.1 Rectangular and Trapezoidal Channels

A flat, anchored mounting plate is a common mounting choice for installing sensors in rectangular or trapezoidal channels. You can also install the probe in rectangular channels by bending a mounting ring to fit the channel. Attach the ring to the channel wall with studs. Consult your *Isco Mounting Rings Installation and Operation Guide* for more information.

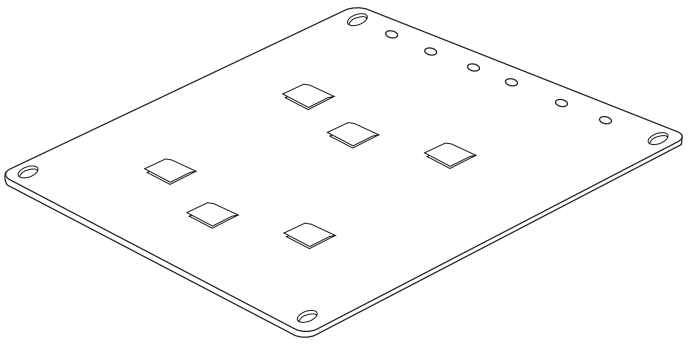


Figure 2-7 Isco Rectangular Mounting Plate

2.6.2 Stilling Wells or Streams with Very Low Velocity

In flow streams with a minimal flow velocity or in a stilling well, simply attach the probe to a weighted plate and submerge the plate in the stream or stilling well.

2.6.3 Securing Probe with a Weighted Plate

In situations with a minimal flow velocity (for example, in a stilling well), you can simply attach the probe to a weighted plate and submerge it in the flow.

2.6.4 Weirs and Flumes

The 4120 Flow Logger is generally used with some type of primary measuring device, such as a weir or flume. The placement of the submerged probe in the primary device is determined by the type of primary device. You can use one of Isco's mounting rings to install the probe in many weirs and flumes. If the mounting ring are not suitable, you must build your own mounting hardware. Figure 2-1 shows the dimensions of the probe for your reference when building your own hardware. Figure 2-8 shows the probe installed in several primary devices.

Certain flume manufacturers produce flumes with built-in cavities for Isco's submerged probe. Contact the flume manufacturer for details on the special flumes.

☑ Note

Always install the submerged probe pointing toward normal flow at the head-measuring point of the device. The location of the measuring point varies with each device. Refer to Table 2-1 and to the *Isco Open Channel Flow Measurement Handbook*.

Table 2-1 Locating the Head-Measuring Point

Device	Head-Measuring Point
Weirs	Upstream from the weir plate by at least 3 times the maximum head.
Parshall Flumes	1/3 of the way into the converging section.
Palmer-Bowlus Flumes	Upstream from the flume entrance by half the pipe diameter.

☑ Note

When installing the probe with custom hardware, remember to attach the probe securely to the side or bottom of the flow stream and tie the cable down so that it does not collect debris.

For many primary measuring device installations, the submerged probe mounting rings or base sections discussed previously may be used to mount the probe at the appropriate location. In many installations, though, the mounting rings or bases may not be suitable.

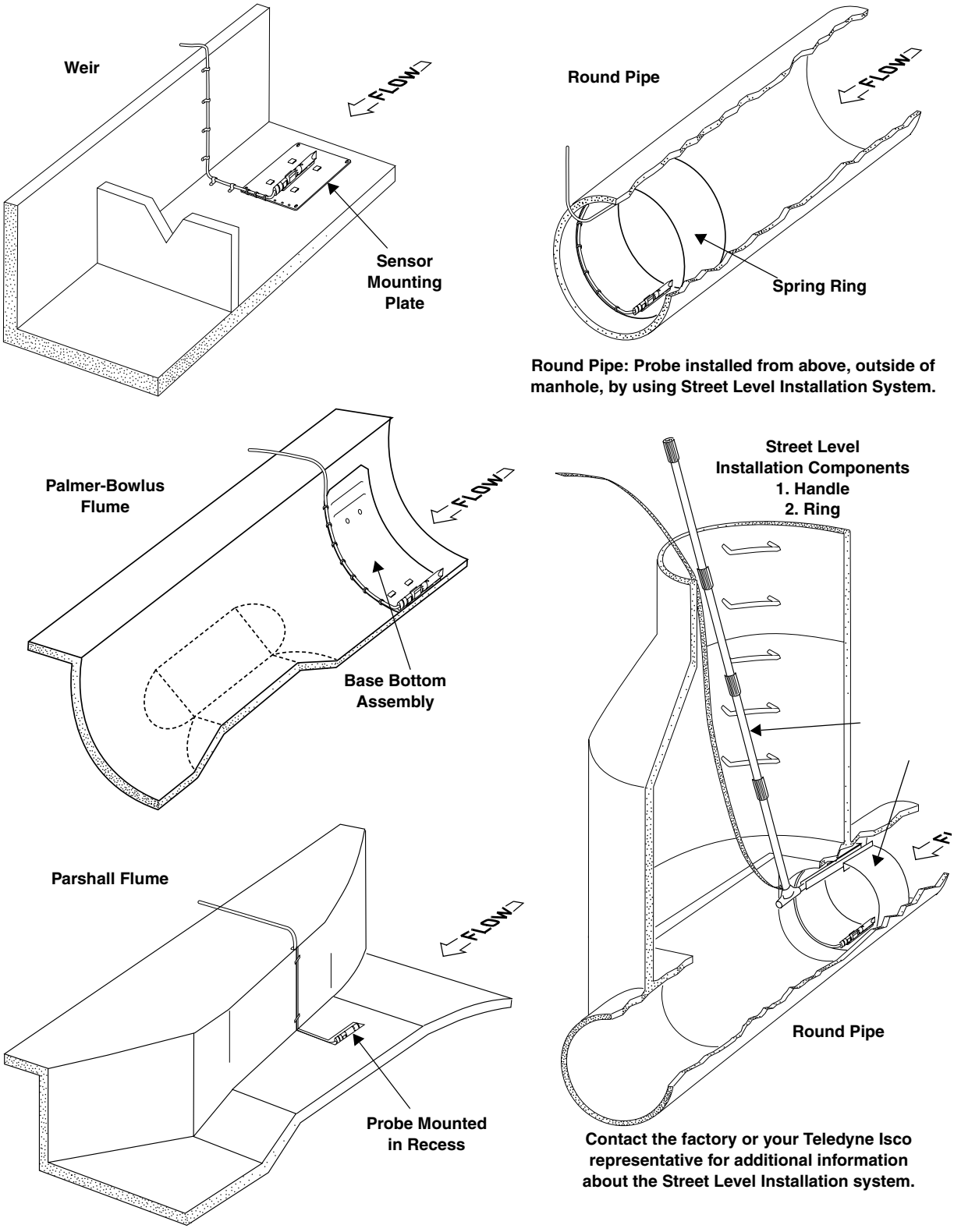


Figure 2-8 Typical Primary Device Installations

Mounting hardware may have to be fabricated locally to allow the level sensor to be mounted at the correct location in the primary device. The only requirements for custom mounting hardware are:

- The probe must be securely attached to the side or bottom of the flow stream.
- The cable must be tied down and led out of the flow stream in an orderly manner.
- The hardware be made from corrosion-resistant materials.

It should be noted that the mounting rings may be used to install the probe in rectangular channels by simply putting right angle bends in them at the appropriate locations. It should be noted that certain flume manufacturers produce flumes with built-in cavities designed specifically for use with Isco submerged probe level sensors. Typically, these are Parshall or Palmer-Bowlus flumes. Contact the manufacturer for details on these flumes.

2.7 Completing the Probe Installation

The submerged probe installation is finished by coiling any excess sensor cable and securing it using cable clamps or other means. The reference tube inside the cable can be restricted or blocked if the cable is kinked, sharply bent, or otherwise pinched. The probe cable should be handled and mounted with care. Also, if there is any appreciable distance between the point where the probe cable leaves the mounting apparatus and the location of the flow meter, be sure to attach the cable to the flow stream wall to prevent it from vibrating, moving around, tangling, or possibly collecting debris.

⚠ CAUTION

Under no circumstances should you leave any extra length of sensor cable dangling freely in the flow stream where it could trap debris or become tangled.

Use gloves and eye protection when assembling and installing the rings in a pipe. Though deburred, the edges of the stainless steel can cut if improperly handled. *Please read the information on how best to install this device.*

Observe general safety procedures when entering any manhole. See “General Safety Procedures” in the back of the manual for more information on general hazards and necessary precautions.

2.8 Connecting the 4120 to Samplers, Rain Gauges, and the RTD

The 4120 Flow Logger is compatible with the Isco 3700 and 6700 Series, 4700, and Avalanche samplers, the Isco Model 674 Rain Gauge, and the Isco 581 Rapid Transfer Device.

A number of cables are available to connect the 4120 to samplers and rain gauges. To connect the sampler to the 4120, attach the cable to the sampler's flow meter connector and the 4120's sampler connector. To select the right cable, refer to the diagram in Figure 2-16.

The 674 rain gauge comes with its own cable, attached to the base. Isco provides a cable to connect non-Isco rain gauges to 4100 Series flow loggers. See the Accessories List in Appendix A.

The Isco 581 RTD requires no cable. It plugs directly into the 4120's Interrogator port and automatically downloads all stored data. While the data is being downloaded, the RTD's green LED will flash steadily. It will stop flashing and remain constant when the download is complete. To save power, be sure to remove the RTD from the 4120 when the download is finished.

Later, the RTD can be connected to your PC for data transfer through the RTD's power cable.

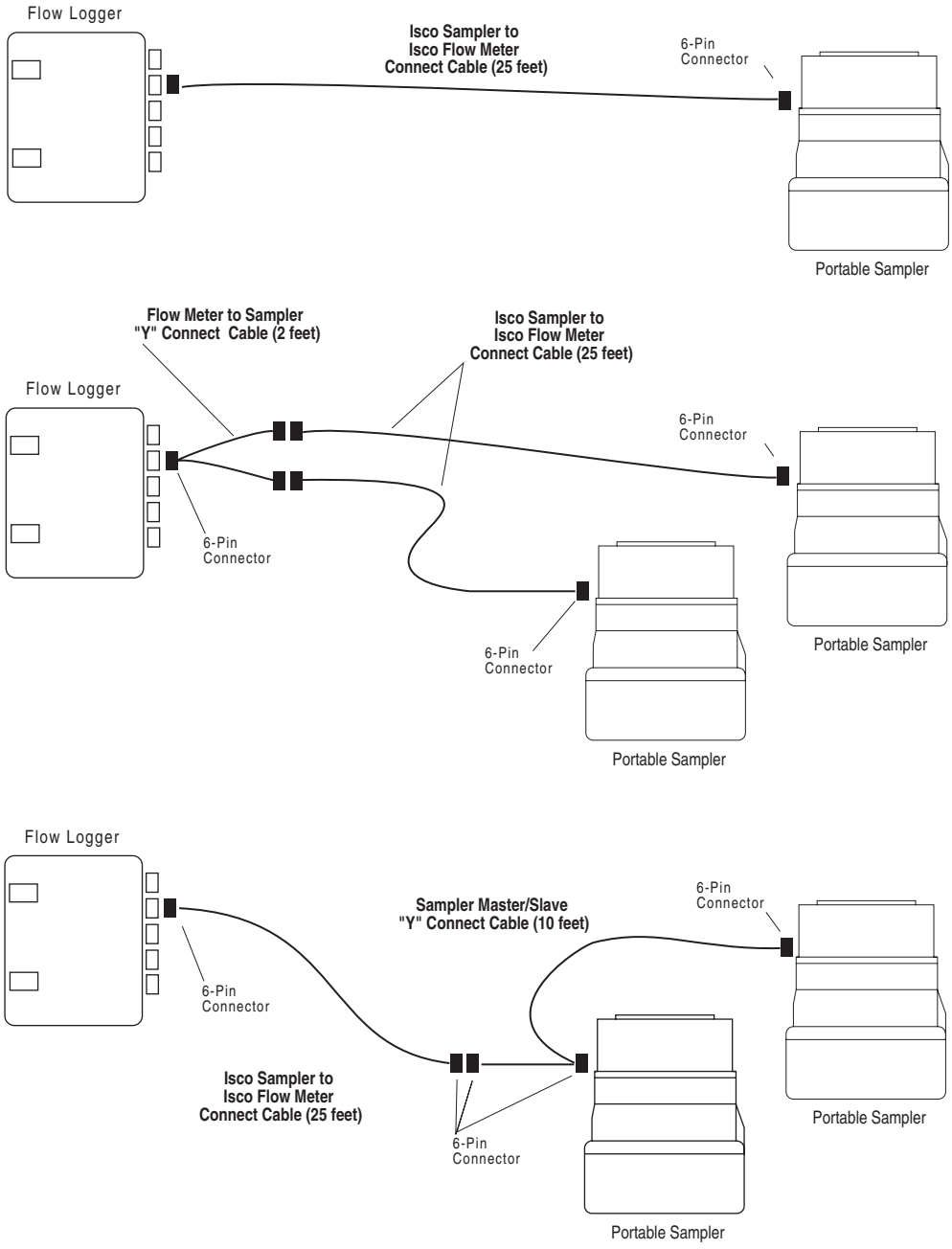


Figure 2-9 Connecting Samplers to the 4120

2.9 Quick Disconnect Box

Use the Quick Disconnect Box when you need to mount the 4120 more than 75 feet from the sensor. You can mount the Quick Disconnect Box as far as 1,000 feet (262 meters) from the 4120, but no more than 75 feet (20 meters) from the sensor's flow-stream installation. You can combine the sensor with the extension cables and Quick Disconnect Box as shown in Figure 2-10.

Use the disconnect box when you need to vent the sensor at another location than the 4120. For example, consider the following situation.

Although the primary device is in a manhole, the most convenient location for the 4120 is a nearby building. However, the building's air-handling system produces fluctuations in the air pressure. If the sensor is connected directly to the 4120 and therefore vented through the 4120, the fluctuating air pressure will distort the level and flow readings. Instead of using the 4120 to vent the sensor, mount the Quick Disconnect Box outside the building or in the manhole and vent the sensor through the box.

2.9.1 Connecting the Quick Disconnect Box to the 4120

The Quick Disconnect Box consists of a sealed Noryl® enclosure (NEMA 4x, 6) with a removable lid and a mounting bracket. The Quick Disconnect Box has a male 9-pin connector for attaching the sensor cable on one end of the box and a 1/2-inch (1.3-centimeter) NPT hole on the opposite side for custom-length cable.

Connect the Quick Disconnect Box to the 4120 with a custom-length cable that Teledyne Isco cuts to order for each customer. The cable can be as long as 1,000 feet and is supplied with a connector. This connector attaches the cable to the 4120's sensor connector.

The wires at the opposite end of the cable connect to the terminals inside the Quick Disconnect Box. If you use cable without conduit, use a cord-grip fitting to seal the box. Cord-grip fittings are available from Teledyne Isco. You can use these fittings with cable or with flexible conduit. See the Accessories List in Appendix A to select the right fitting for your cable. If you use rigid conduit, be sure to seal the box with a sealed, 1/2-inch conduit connector.

2.9.2 Mounting the Quick Disconnect Box

1. Locate the Quick Disconnect Box so that the sensor cable and its interior vent tube are not kinked or bent when connected to the box.
2. Mount the Quick Disconnect Box on a solid surface. The box has a mounting bracket with two keyholes on 3-inch (7.7-centimeter) centers.
3. Remove the top of the box.
4. Figure 2-12 shows you how to assemble the cord-grip fitting.
   Thread the cable through the fitting until there is enough lead wire to connect the cable to the barrier block noted in Figure 2-11. If you use conduit, thread the lead wires through the conduit before threading it through a compres-

sion fitting attached to the disconnect box. Be sure to seal the conduit and connector.

5. Attach the lead wires as shown in Figure 2-11.
6. Replace the top of the box.
7. Connect the sensor cable (or extension cable) to the box.

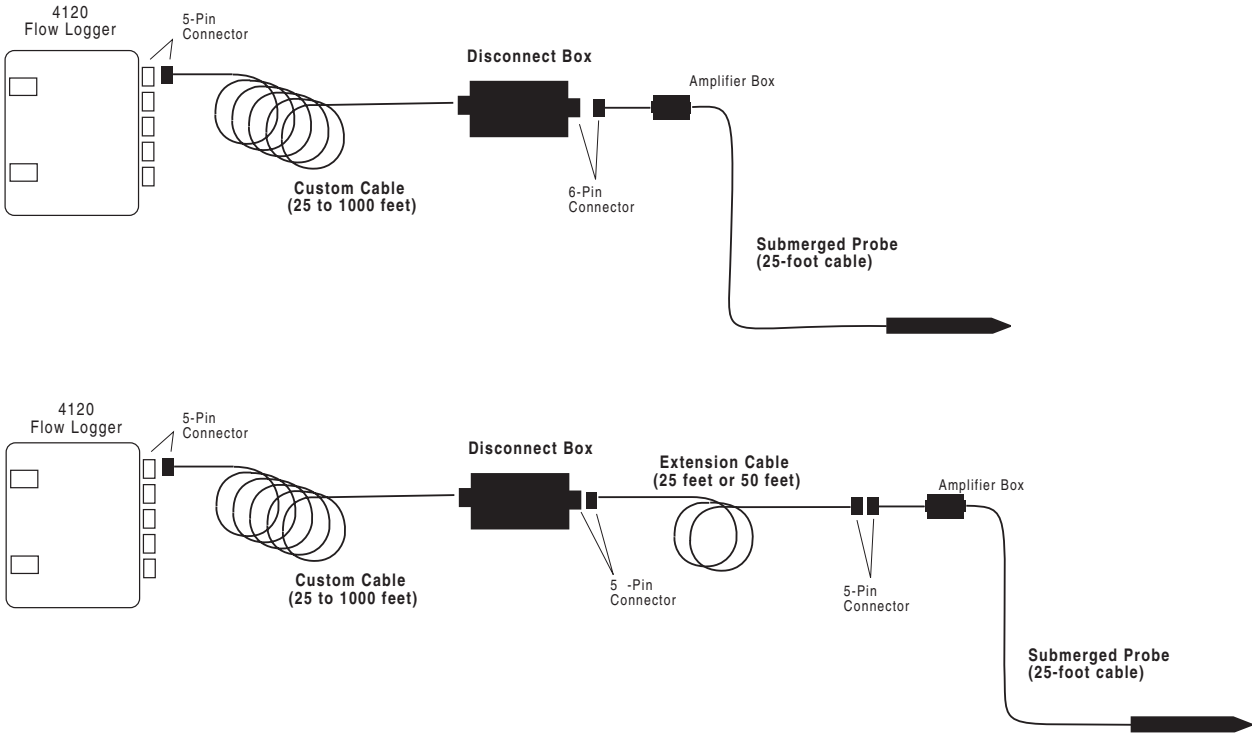


Figure 2-10 Cable Connections and the Quick Disconnect Box

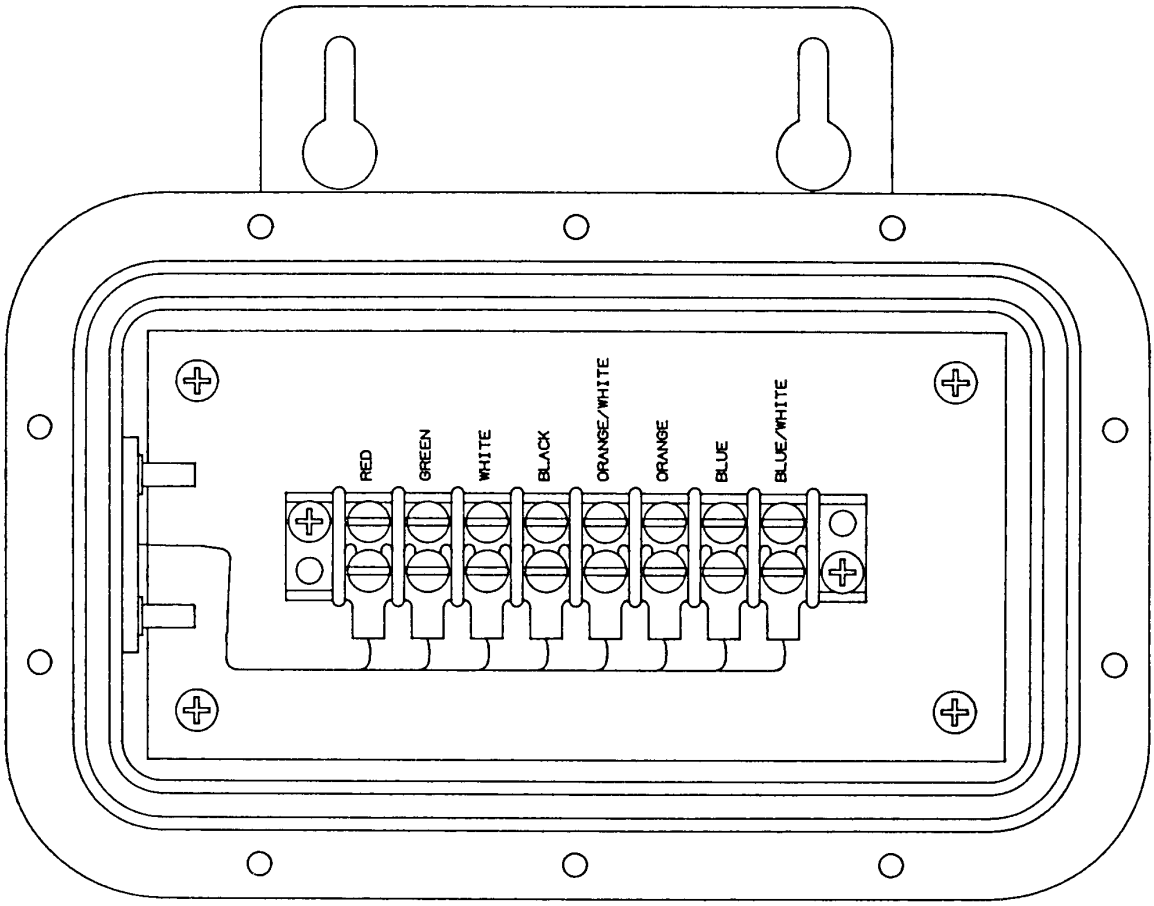


Figure 2-11 Connecting the Custom-Cable Leads to the Disconnect-Box Barrier Block

COLOR	BLOCK POSITION
Red	1
Green	2
White	3
Shield	4
Black	5

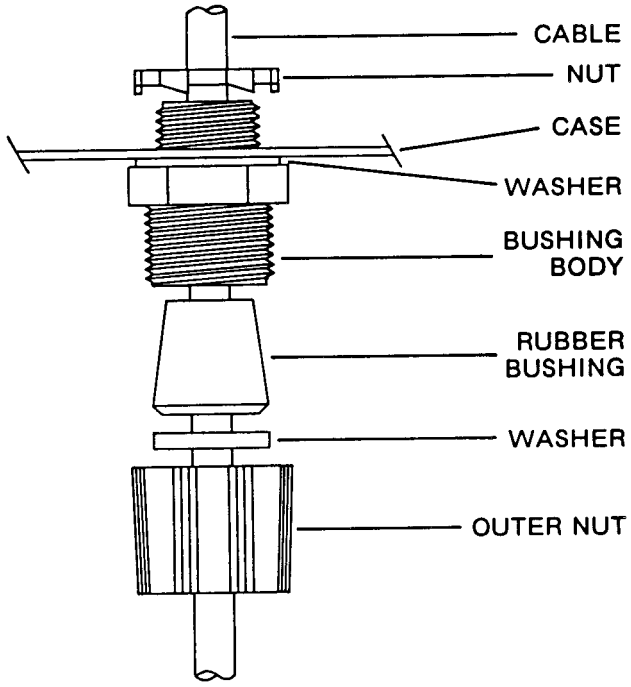


Figure 2-12 Cord-Grip Fitting

4120 Flow Logger

Section 3 Programming the 4120

To program the 4120, connect the 4120 to a computer and enter the 4120's program with Flowlink. Flowlink provides all programming instructions for the flow logger. For a summary of Flowlink's functions refer to Table 3-1. More information about programming the flow loggers is in Flowlink's Help section.

3.1 About the 4120's Memory

The 4120's memory contains 230 KB of nonvolatile, battery-backed RAM (Random Access Memory) which Flowlink divides into storage areas called partitions. Although the amount of data stored in each partition varies according to the type of data and the partition size, a 230 KB divided into three, equally sized partitions stores:

- More than 400 days of level, flow-rate, or rainfall data at 15-minute intervals;
- 5,000 sample-event readings.

3.2 Sampler Enabling and Sampler Pacing

The 4120 offers two types of sampler control: sampler enable and sampler pacing. A 4120 programmed to enable or disable a sampler compares level, flow, time, or rainfall measurements to a set point, usually the reading measurement at which the 4120 is to enable or disable the sampler. Thus, a set point can be:

- At a specific time and date
- When the flow stream's level or flow rate passes a set point (for example, a level measurement of 0.3 foot)
- When the amount of rainfall exceeds a set point (1 inch of rain collected in 30 minutes)

Although you can program the 4120 to enable the sampler on a single data type's set point, you can also combine most data types with three logical operators: AND, OR, and NOT. Refer to Table 3-2. Using the operators, a flow logger can enable a sampler when reading two set points (level AND rainfall) or either set point (level OR rainfall).

The second type of sampler control, sampler pacing, determines how often the sampler will take a sample. The flow logger offers both flow-pacing and trigger-pacing.

To learn more about flow logger memory, sampler enabling, and sampler pacing, refer to Flowlink's Help section.

Table 3-1 Flowlink Tasks

Programming Instructions	Status Information	Data Management
• Sampler pacing • Sampler enable controls • Memory setup: number of partitions type of data interval between readings • Level calibration • Level-to-flow conversion	• Battery life • Flow-stream status: totalized flow current level flow rate • Sampler enabled or disabled • Memory status • 4120 clock • 4120 software version	• Data retrieval • Reports • Graphs • Data editing • Import/export data in ASCII format

Table 3-2 Sampler-Enable Data Types and Logical Operators

Data Type or Condition	Set Point	Logical Commands
Always ON	None (The Flow Logger will use this condition unless you specify otherwise.)	No
Always OFF	None	No
Level	Level reading	Yes
Flow	Flow rate	Yes
Time	Start time	Yes
Rainfall	Total rainfall measured in a specific period	Yes

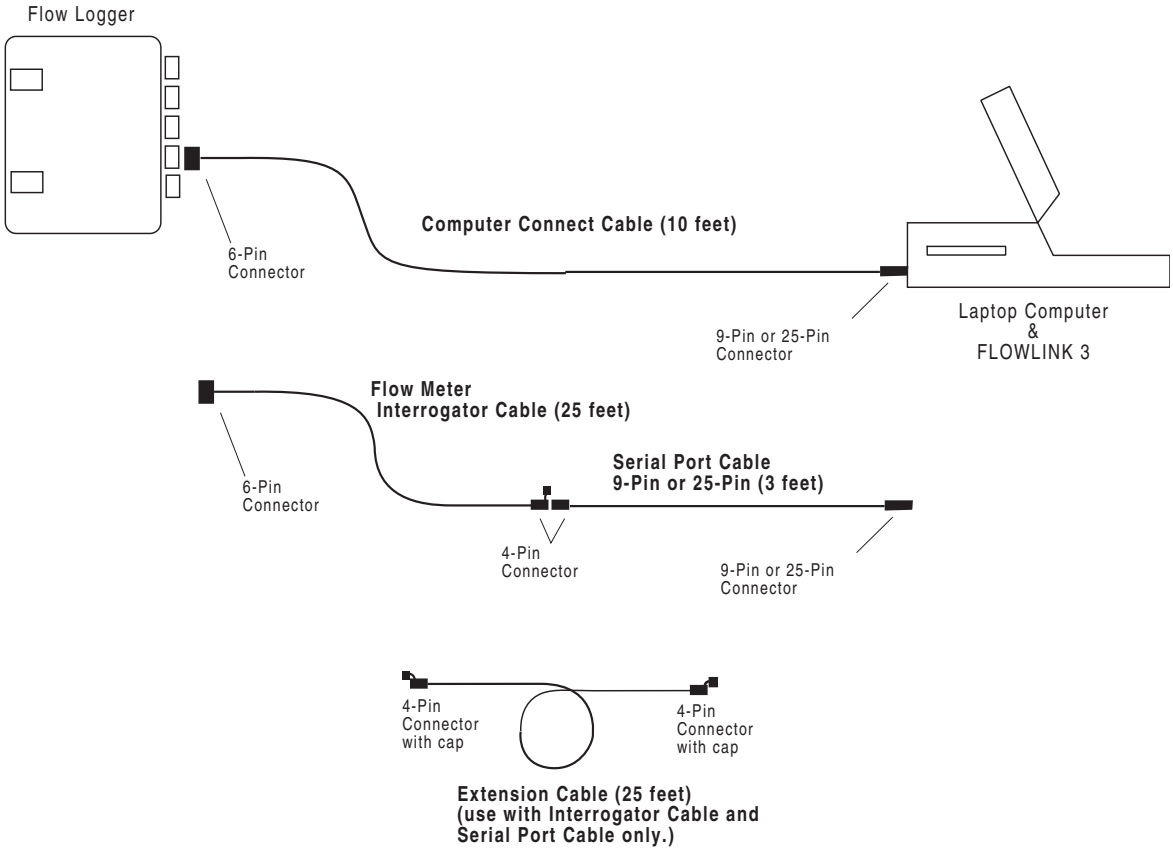


Figure 3-1 Connecting the 4120 for Programming

4120 Flow Logger

Section 4 Maintenance

To keep the 4120 in operating condition, observe the following:

- Keep all unused connectors capped. This prevents moisture and the chemicals found in harsh environments from damaging the pins in the connectors.
- Clean the flow logger and the submerged probe regularly.
- Check the condition of the desiccant regularly, and regenerate the desiccant when necessary. (See Recharging and Replacing the Desiccant on page 4-2.)
- Inspect the paper humidity indicator. If it is pink in color, return the unit to Teledyne Isco. There may be a problem with the case.
- Replace or recharge the batteries as required. (See About Power Sources on page 4-6. For information on recharging Isco batteries, refer to the Isco Power Products Guide.)

4.1 Cleaning the Submerged Probe

The Submerged Probe requires occasional cleaning. (The amplifier box requires no maintenance.) Because the probe body offers a streamlined profile to the flow, solid materials rarely collect on the probe. However, remove debris from the flow stream near the probe periodically to maintain the hydrostatic conditions on which the level-to-flow rate conversion is based.

The probe functions even when covered with silt, sand, or other solid materials. Occasionally, however, organic materials such as saw dust, wood chips, or snails may become jammed inside the probe. This material expands and exerts pressure on the diaphragm. This can damage the diaphragm, permanently disabling the probe. If all liquid ports in the probe become blocked, or if the diaphragm cavity is packed with material, clean the probe. This not only protects the probe from damage, but ensures that the probe responds to the hydrostatic pressure above the probe instead of the pressure created by the swollen material inside the probe.

⚠ CAUTION

The stainless-steel diaphragm on the face of the probe's pressure transducer is extremely vulnerable to pressure. Damage to the diaphragm permanently disables the probe. A small warning disk in front of the transducer protects the diaphragm. DO NOT remove the disk.

To clean the probe:

1. Remove the probe and its mounting ring from the flow stream.
2. Scrape any accumulated solids off the exterior of the probe. Use a brush and flowing water. Gently flush the cavities of the probe with water.

If the ports are thoroughly blocked or if you need to clean the probe for storage:

1. Remove the probe nose section by unscrewing the two flat-head screws which hold the nose section in place and pull the nose section straight out of the probe body.
2. Gently flush the probe cavity with water to remove any solid materials. Do not remove the warning disk when cleaning the probe's cavity.
3. Reinstall the nose section and tighten the two screws. Align the large mounting hole with the grounding point (Figure 4-1).

Warning Disk Inside Probe

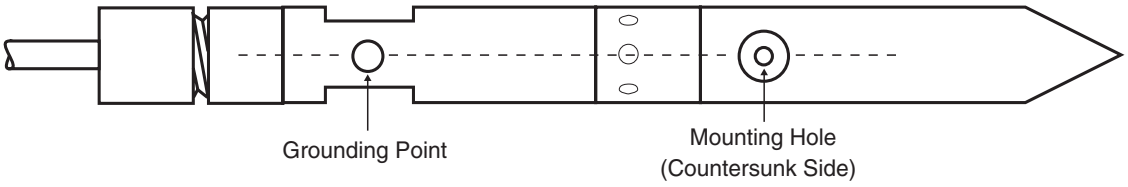


Figure 4-1 Grounding Point on Submerged Probe

4.2 Recharging and Replacing the Desiccant

Because it is frequently installed in humid environments, the 4120 Flow Logger uses desiccators to prevent moisture damage to its components. A desiccant bag protects the electronics compartment. A desiccant cartridge is located inside the battery compartment. A desiccant tube on the exterior of the case dries the probe's vent tube to prevent condensed moisture from blocking the tube.

4.2.1 Recharging the Desiccant Bag

A paper humidity indicator on the side of the case, labeled "INTERNAL CASE HUMIDITY," shows the relative humidity in the compartment. The desiccant should be recharged when the area marked "30" turns pink.

☑ Note

Teledyne Isco does not recommend recharging the desiccant bag yourself because you must open the case, breaking the NEMA 6 seal that prevents moisture and corrosive atmospheres from destroying the circuitry. Instead, if you think the desiccant bag requires recharging, contact Customer Service for assistance. Excessive humidity in the case may indicate that the case or case seal requires repair.

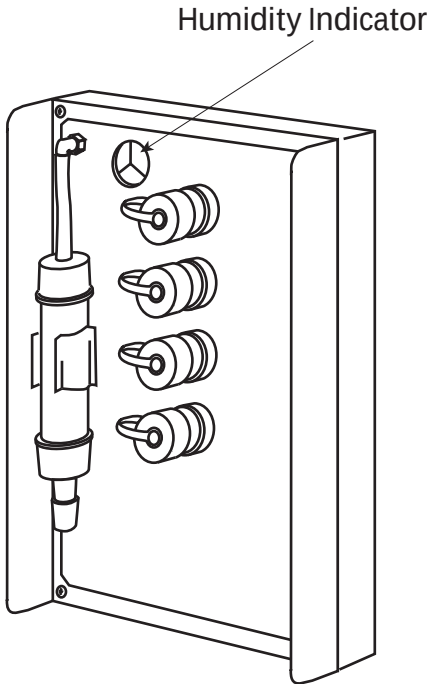


Figure 4-2 Location of Humidity Indicator Window

☑ Note

Anhydrous calcium sulfate and silica gel are both regenerated with heat but require different temperatures. Calcium sulfate requires temperatures of 400• to 450• F; silica gel requires temperatures of 212• to 350• F.

⚠ WARNING

Desiccant may produce irritating fumes when heated. (Material Safety Data Sheets for both chemicals are in Appendix C.) Leave the room while heating the desiccant.

Important Guidelines to Follow:

- Always use a vented, circulating forced air, convection oven in a well-ventilated room.
- DO NOT use a microwave oven to recharge the desiccant cartridge. Heating the metal cartridge case in a microwave oven will damage the oven.
- Use the recommended temperature. Avoid heating the desiccant at higher than recommended temperatures.
- Avoid heating the desiccant longer than necessary.

4.2.2 When to Recharge the Desiccant Cartridge

The metal desiccant cartridge, located in the battery compartment, has an inspection window that shows the silica gel desiccant inside. The desiccant is blue or yellow when dry. Recharge the desiccant cartridge when the particles turn pink or green.

The desiccant cartridge requires periodic recharging to dry it after it becomes saturated with moisture. After repeated recharging, it eventually requires replacement. Table 4-1 shows you how to recharge the desiccant cartridge and when to replace it.

4.2.3 When to Recharge the Desiccant in the Tubes

Both the 4120 Flow Logger and the Quick Disconnect Box dry the probe's vent tube with a desiccant tube. Inspect the desiccant tube frequently. Constantly exposed to humid air, the desiccant will become saturated quickly. If the desiccant is unable to dry the vent tube and the tube becomes blocked with moisture, the level readings will be unreliable. Prolonged interior moisture can permanently damage the 4120 and the probe.

Two types of desiccant may be used in the tubes: anhydrous calcium sulfate ($CaSO_4$) and silica gel (SiO_2).

Calcium sulfate looks like rough chips of tinted plaster and changes from blue when dry to rose-red when saturated. Regenerate the calcium sulfate desiccant before all the desiccant in the tube turns rose-red.

Isco uses two types of silica gel:

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

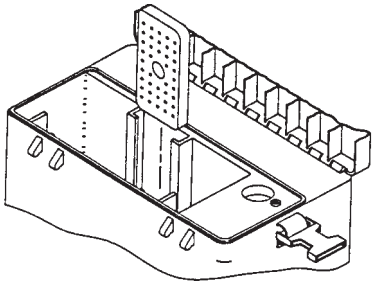
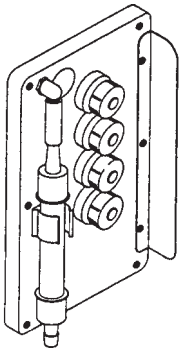
Regenerate silica gel before all the desiccant in the tube turns pink or green.

The desiccant in the tube requires periodic recharging to dry it after it becomes saturated with moisture. After repeated recharging, it eventually requires replacement. Table 4-1 shows you how to recharge the desiccant in the tube and when to replace it.

Do not put the plastic tube in the oven. It will melt.

The filters in the ends of the desiccant tube prevent desiccant particles from entering the vent line. When they become soiled, wash with dish soap and water, then allow them to dry.

Table 4-1 How to Recharge Desiccators

	Desiccant Cartridge	Desiccant Tube
Location of desiccant		
How to remove desiccator	Open compartment door and slide cartridge from slot	Snap the desiccant tube from mounting clip and disconnect it.
When to recharge	Desiccant behind inspection window turns PINK or GREEN.	Anhydrous Calcium Sulfate: Before all desiccant in the tube turns ROSE-RED. Silica Gel: Before all desiccant in the tube turns PINK or GREEN
How to recharge	Heat cartridge in a vented, circulating forced air, convection oven in a well-ventilated room.	Pour desiccant particles into shallow pan. Heat particles in a vented, circulating forced air, convection oven in a well-ventilated room.
Oven temperature	300° F (150° C)	Anhydrous Calcium Sulfate: 400° - 450° F (204° - 232° C) Silica Gel: 300° F (150° C)
How long to heat	3 hours	Anhydrous Calcium Sulfate: 1 to 2 hours Silica Gel: 3 hours
When desiccant is recharged	Desiccant behind the inspection window turns BLUE or YELLOW	Desiccant particles turn BLUE or YELLOW
When to replace	The desiccant particles no longer turn blue when recharged.	The desiccant particles no longer turn blue or yellow when recharged.

4.3 About Power Sources

The 4120 Flow Logger requires a 12-volt DC power source. A number of power sources, two shown in Figure 4-3 and Figure 4-4, are available:

- Two 6-volt lantern batteries. Use only alkaline lantern batteries or the flow logger will not work correctly. Lantern batteries are available from Teledyne Isco or local hardware stores.

> ☑ ***Note***
>
> When discarding disposable alkaline batteries or any type of recyclable batteries, please dispose of them safely, observing all local environmental regulations.

- Isco Model 947 Lead-Acid Battery. This battery, built especially for the flow logger, is available only from Teledyne Isco.
- Isco Model 946 Lead-Acid Battery recharged on-site with an Isco Model 954 Solar Panel. The battery mounts on the solar panel; it does not fit in the 4120's battery compartment. (See Figure 4-6 and Figure 4-7.)
- Power from an Isco sampler. The 4120 obtains power form the sampler through the cable connecting the 4120 and the sampler.

A 12-volt DC marine battery can also be used as a power source for the 4120. These batteries require adaptor cables and must be mounted outside the 4120's case.

The 4120's battery compartment has a 3-pin connector for the Isco Model 947 Lead-Acid Battery. Install it as shown in Figure 4-3. The three brass contact plates on the back of the compartment fit the positive and negative contacts of alkaline batteries regardless of the batteries' orientation.

A silicon band seals the battery compartment door when the door is securely latched. Seals around the battery connectors prevent moisture from entering the electronics compartment through the connectors. a desiccant cartridge keeps the battery connectors and contact plates dry when you latch the compartment door.

4.3.1 Battery Protection and Battery Life

Lead-Acid Batteries – Lead-acid batteries can be severely damaged or destroyed if completely discharged. The 4120 protects the battery (and itself) by monitoring the voltage level of the battery. It shuts down when the voltage declines to low levels. This protects not only the battery and the 4120, but, because readings can become unreliable at low voltages, it also preserves the integrity of your data. The 4120 monitors the battery capacity and reports the remaining battery life via Flowlink.

> ☑ ***Note***
>
> For information about charging Isco batteries, refer to the *Isco Power Products Guide*.

The 4120 will not lose any data if it shuts down. Readings stored in RAM are protected by a lithium battery that provides power to the RAM when the 4120 is without power; for example, when the 4120 shuts down or when you replace the battery. The lithium battery also maintains the 4120's clock so that you do not have to reset it after battery changes.

Figure 4-3 Installing the Model 947 Lead-Acid Battery

Alkaline Batteries – Place an alkaline battery at each end of the battery compartment, so that the springs contact the brass contact plates at the bottom of the compartment. To complete the circuit, the plates extend form one end of the compartment to the other. A short section of nonconductive tape insulates the plates at the center of the compartment, preventing the batteries form touching the wrong contact plate and creating a short circuit.

If the insulating tape becomes damaged, have it replaced immediately A short circuit in the compartment can severely damage the flow logger's case.

Figure 4-4 Installing Alkaline Batteries

4.3.2 Low Power Consumption

The 4120 Flow Logger consumes very little power. Although the actual power consumed by a flow logger depends on many variables, one is most significant: the frequency of readings.

The frequency of readings determines power consumption because the 4120 shuts down between readings. If you have programmed the flow logger to take frequent readings - at intervals of 5 minutes, for example - you can expect the flow logger to consume about six times more power than a flow logger programmed to take readings every 30 minutes.

Under most conditions, two fully charged, 6-volt alkaline batteries will power the 4120 for as long as 6 months without recharging or replacement when readings are taken at 15-minute intervals. the Model 947 Lead-Acid Battery has about one third that capacity. You can also power the 4120 for longer periods with a lead-acid battery that is recharged daily by a solar panel.

Even though you can expect a battery life of 6 months, you should check the remaining battery life regularly. The flow logger reports battery use when connected to a computer running Flowlink. You can use this information to prevent lost readings by scheduling a battery replacement before the current battery becomes completely drained.

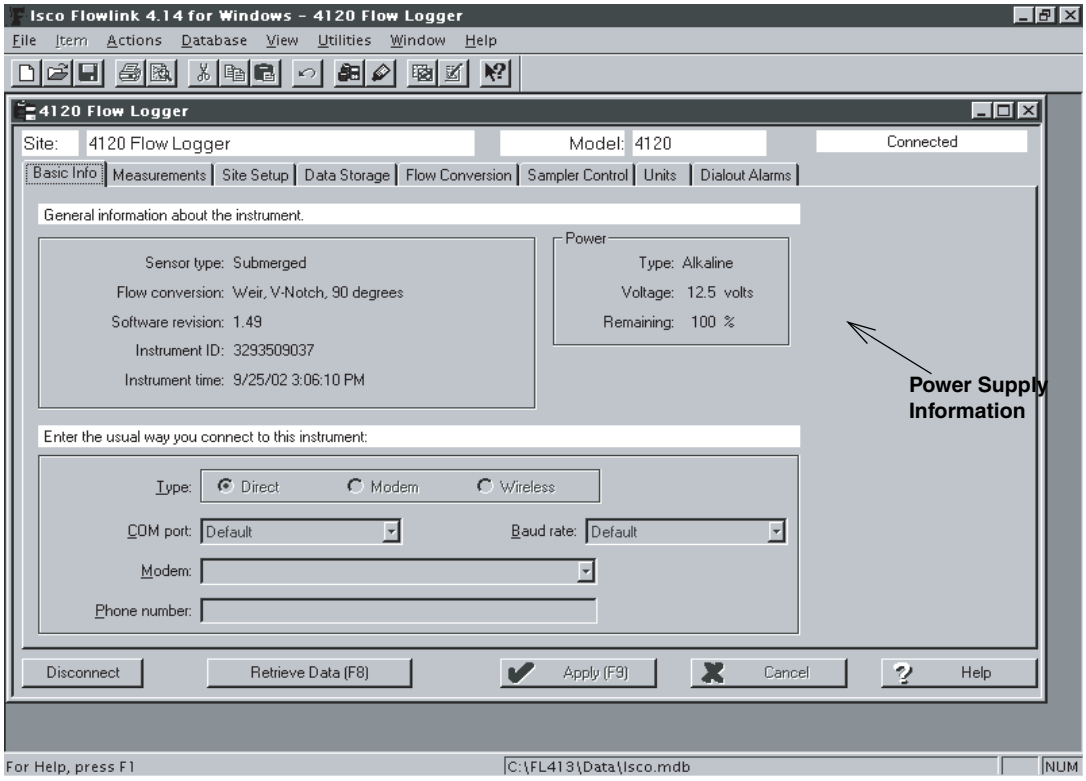


Figure 4-5 Remaining Battery Life Reported in Flowlink

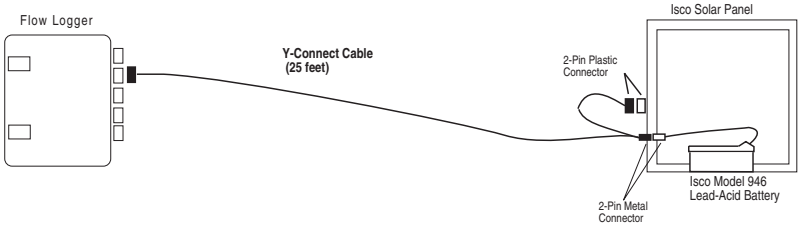


Figure 4-6 Connecting Solar Panels to the 4120

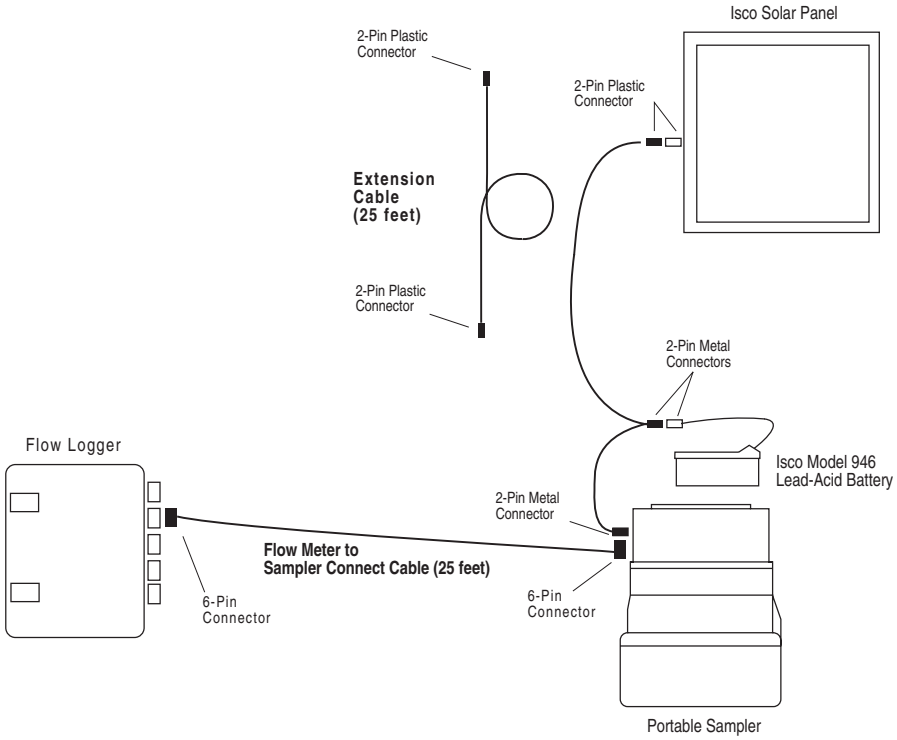


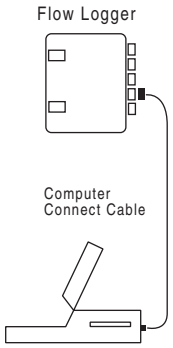
Figure 4-7 Connecting a Solar Panel and a Sampler to the 4120

Flowlink reports the type of battery, the current voltage, and the remaining battery capacity in the Power box. When the flow logger obtains power from an external source, Flowlink reports the battery type as “external.”

4.4 How does the Flow Logger Conserve Power?

The 4120 conserves power by providing power to the circuitry only under certain conditions. These conditions occur when the 4120 must:

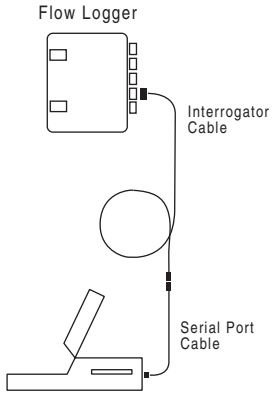
- **Respond to a signal from a tipping-bucket rain gauge.** The 4120 responds to a rain gauge signal only when programmed to store rainfall data or to monitor rainfall readings fro sampler-enable controls.
- **Take a reading.** Flowlink determines the interval between readings (1, 2, 5, 10, 15, 30, 60, or 120 minutes) as part of the 4120’s program.



- **Send a pacing pulse (an electronic signal) to a sampler.** When flow-pacing a sampler, a pulse represents a certain volume of water: 100 gallons; 5,000 cubic feet; or other volume setting entered with Flowlink. When trigger-pacing a sampler, however, a pulse represents one of two possible time intervals.
  To conserve power, the 4120 must do as many tasks as possible when powered. So, it sends pulses while taking readings. If the 4120 has measured a large volume of water or if the trigger pacing interval is shorter than the reading interval, it may send several flow pulses at once.

☑ Note

For more information about flow pacing and trigger pacing, see the Flowlink Help section.



- **Respond to a computer.** The 4120 responds to a computer when it detects a completed circuit created by connecting a Computer Connect Cable to the flow logger's Interrogator connector. Leaving the cable connected to the flow logger drains power unnecessarily. Teledyne Isco also supplies a pair of cables, the flow Meter Interrogator Cable and the Serial Port Cable, to interrogate flow meters. These cables are compatible with the flow logger. The computer-detecting circuit is in the 4-pin connectors that attach the cables to each other.

☑ Note

Leaving the Serial Port Cable and the Interrogator Cable attached to each other while the interrogator cable is attached to the flow logger will drain the battery.

- **Respond to Event Marks from a Sampler.** An event mark is an electronic signal sent by the sampler indicating that a sample has been completed.
  The 4120 responds to an event mark only when programmed to store sample-event data. When it receives an event signal, the 4120 records the time of the event mark and the bottle receiving the sample.

4.5 Adaptor Cables for Alternative Power Sources

Teledyne Isco provides three power source adaptor cables. The first connects an Isco Model 947 Lead-Acid Battery to the Isco 965 Five Station Battery Charger. Because the Model 947 Lead-Acid Batteries use a different connector than the Isco batteries the charger was originally designed for, use the adaptor to connect the lead-acid batteries to the charger.

The second cable connects the AC Power Pack to the 4120. It attached to the flow logger's sampler connector.

The last cable, the External 12-Volt DC Source Connect Cable, connects the 4120 to a 12-volt, deep-cycle marine battery. The cable has a connector at one end that attaches to the 4120's sampler connector. The opposite end of the cable has one red and

one black wire, each attached to a battery clip. Attach the clip at the end of the red wire to the positive terminal of the battery and the clip at the end of the black wire to the negative terminal.

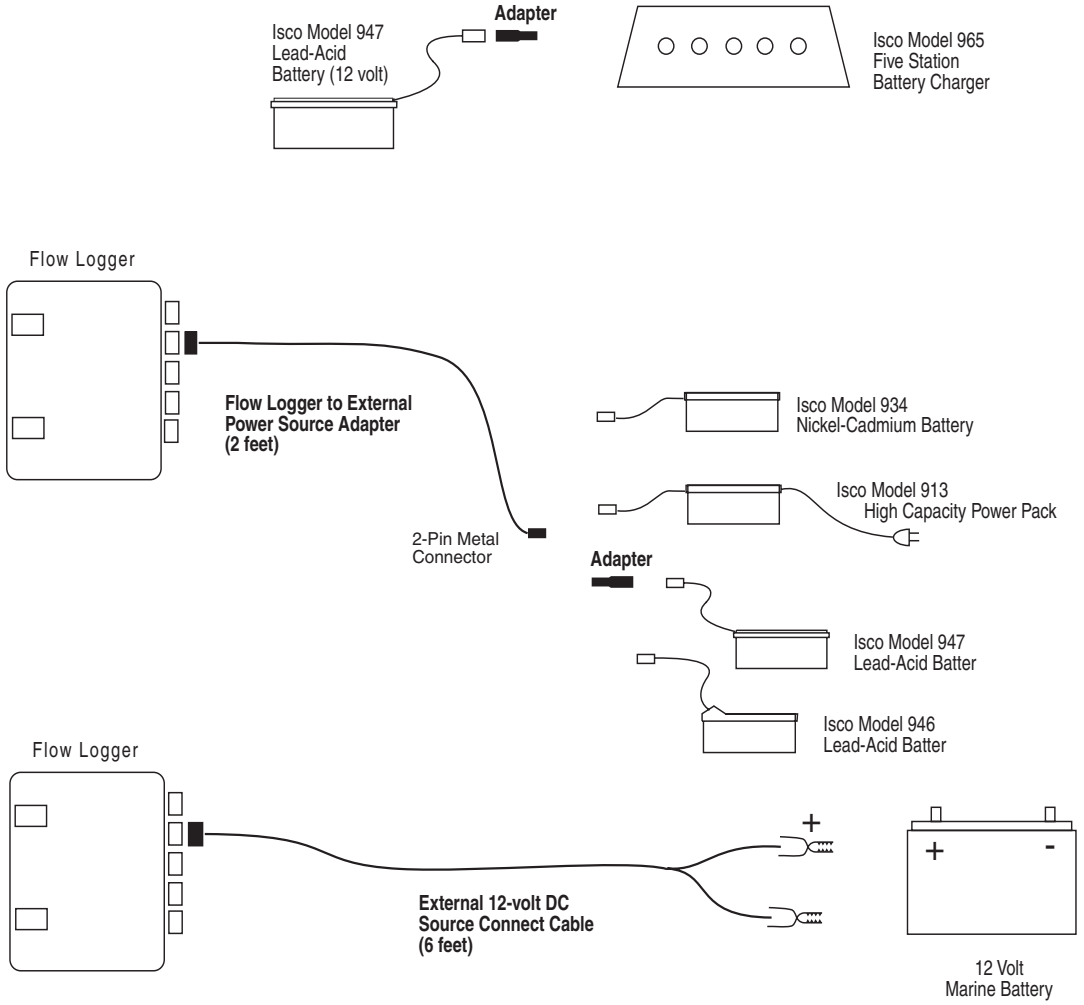


Figure 4-8 Adaptors for Alternative Power Sources

4.6 Fuses

If your flow logger does not seem to be operating correctly, it may have one or two bad fuses, or its circuit board may need repair. The power fuse may be open if the 4120 does not respond when you try to connect through Flowlink. If the other fuse is open, you will still be able to connect and download flow data; however, no rainfall will be logged, and you will not be able to download using an RTD.

> ☑ ***Note***
>
> Teledyne Isco does not recommend replacing fuses yourself because you must open the case, breaking the NEMA 6 seal that prevents moisture and corrosive atmospheres from destroying the circuitry. Instead, if your flow logger requires repair, contact Customer service for information on returning it to the factory.

Teledyne Isco, Inc.
P.O. Box 82531
Lincoln, NE 68501
Email: IscoInfo@teledyne.com
Telephone Within USA: Toll free: (800) 228-4373
Outside USA: (402) 464-0231
Fax: (402) 465-3022
Technical Service: (866) 298-6174

4.7 Updating the Flow Meter Software

The flow meter should be powered and turned on.

Connect your computer to the flow meter using the Computer Connect Cable (Interrogator Cable) and start the program Update Isco Instrument Software.

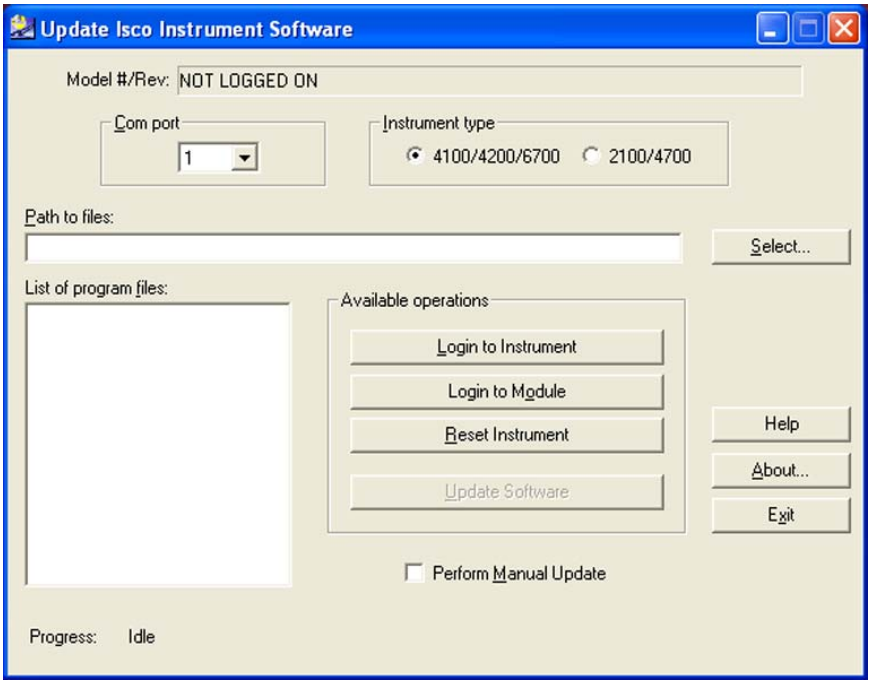


Figure 4-9 Open the software update program

Click the Help button and follow the steps listed under Update Instrument Software. Do not disturb the connection or stop the update while the file transfer is taking place. When the transfer is complete, the program displays an “Operation successful” message. Click OK and close the program.

Your flow meter’s software is now updated and ready for operation.

4120 Flow Logger

Appendix A Accessories List

Accessories can be purchased by contacting Teledyne Isco's Customer Service Department.

Teledyne Isco, Inc.
Customer Service Department
P.O. Box 82531
Lincoln, NE 68501 USA

Phone: (800) 228-4373
(402) 464-0231
FAX:(402) 465-3022

E-mail:IscoCSR@teledyne.com.

Basic Equipment and Accessories

Instruction Manual	60-3243-142
Dri-Can Desiccant	099-0012-00
Flow Data Handbook	60-3003-041
Standard Nose Section	60-2503-086
Slanted Nose Section	60-2503-097
Flume Probe Cap	60-2503-105
4120 Flow Logger only	60-3124-001
Submerged Probe, 10' Range (with 25-foot cable)	60-3224-002
25' Extension Cable for the Submerged Probe	60-3224-004
50' Extension Cable for the Submerged Probe	60-3224-005
Submerged Probe Quick Disconnect Box	60-3224-003
Submerged Probe Carrier Assembly *(Use with Isco Mounting Rings)*	60-3204-005
Flowlink 5.1 Software	68-2540-200

Optional Equipment

Spreader Bar	60-3004-110
4-20 mA Output Interface	60-1784-039
674 Rain Gauge 0.01" tip	60-3284-001
674 Rain Gauge 0.1 mm tip	60-3284-006
Rain Gauge Connect Cable For Non-Isco Rain Gauges	60-3004-149
4200T Modem	factory-installed

(Contact your sales representative or Teledyne Isco Customer Service.)

Power Sources and Battery Chargers

6-Volt Alkaline Battery, Disposable, 6 volts; 2 required per flow logger 340-2006-02

Flow Logger Lead-Acid Battery, Rechargeable, 12 volts; 1 required per flow logger. Requires one of the battery chargers listed below. 60-3114-011

(Also requires Flow Logger lead-acid battery charging adapter, part #68-3114-015)

Lead-Acid Battery Pack 60-3004-106

Battery Backed Power Pack (120 VAC), AC power converter/battery charger with built-in battery 60-3004-130

Battery Backed Power Pack (240 VAC) 60-3004-160

High Capacity Power Pack (120 VAC) 60-1684-088

Battery Charger, 120 volts AC, 50/60 Hz 60-3004-059

Model 965 Five-Station Battery Charger, 120/240 V, with 120 V power cord. 68-3000-965

Model 965 Five-Station Battery Charger, 120/240 V, with 240 V power cord. 68-3000-966

Solar Panel Battery Charger, 5 watts 60-5314-478

Solar Panel Battery Charger, 40 watts 60-5314-347

Solar Panel Battery Charger, 110 watts 60-5314-629

Connect Cables

Interrogator Cable, 9 pin 60-2544-044

Interrogator Cable, 25 pin 60-2544-040

Standard Y Cable for Isco Samplers 60-3704-081

Special Y Cable without diodes 60-5314-278

Flow Logger External 12-Volt DC Source Connect Cable 60-3114-016

(Connects flow logger to external 12-volt DC source. Terminates in heavy-duty battery clips.)

Flow Logger External Power Connect Cable 60-3114-002

Lead-Acid Battery Charging Adapter 60-3114-002

Flow Logger to External Power and Sampler “Y” Connect Cable 60-3114-001

(Connects a single flow logger to two Isco sampler-to-flow meter connect cables and to an external power source.)

Isco Sampler to Flow Meter Connect Cable, 25-foot 60-3004-107

Spring Rings

Probe Mounting Ring for 6" pipe 68-3200-007

Probe Mounting Ring for 8" pipe 68-3200-008

Probe Mounting Ring for 10" pipe 68-3200-009

Probe Mounting Ring for 12" pipe 68-3200-010

Probe Mounting Ring for 15" pipe 68-3200-011

Universal Mounting Ring (Scissors Ring) (for Pipes 16" diameter and larger)

Base Section (with tabs for mounting up to five probes) 60-3004-171

Scissors Assembly 60-3004-170

Extension 1 (9.0") 60-3004-172

Extension 2 (21.5") 60-3004-173

Extension 3 (31.5") 60-3004-174
Extension 4 (41.5") 60-3004-175

Scissors Ring Assemblies will require a base and scissors section for all sizes. Sizes from 21" to 80" will also require two or more extension sections.

Street Level Installation System

Multi-Section Pole 60-3204-012

(Includes instruction manual. To complete the system, you must also order a Street Level Mounting Ring.)

Street Level Mounting Ring for 6" dia. pipe 60-3204-014
Street Level Mounting Ring for 8" dia. pipe 60-3204-015
Street Level Mounting Ring for 10" dia. pipe 60-3204-016
Street Level Mounting Ring for 12" dia. pipe 60-3204-017
Street Level Mounting Ring for 15" dia. pipe 60-3204-018
Sensor Mounting Plate 68-3000-051

(Includes plastic ties and instructions)

Submerged Probe Qick Disconnect

Quick Disconnect Box 60-3224-003
Watertight Cord-Grip (0.19" - 0.20" dia. cable) 209-0076-05
Watertight Cord-Grip (0.25" - 0.31" dia. cable) 209-0076-04
Watertight Cord-Grip (0.31" - 0.37" dia. cable) 209-0076-03
Watertight Cord-Grip (0.37" - 0.44" dia. cable) 209-0076-06
Watertight Cord-Grip (0.44" - 0.50" dia. cable) 209-0076-07
Watertight Cord-Grip (0.50" - 0.56" dia. cable) 209-0076-08

4120 Flow Logger

Appendix B General Safety Procedures

In field installations of Isco wastewater samplers and associated equipment, the safety of the personnel involved should be the foremost consideration. The following sections provide safety procedures for working in and around manholes and sewers. the first section offers general safety advice. The second section deals with the special problem of hazardous gases found in sewers.

⚠ WARNING

The 4120 has not been approved for use in hazardous locations as defined by the National Electrical Code.

⚠ CAUTION

Before any sampler is installed, the proper safety precautions must be taken. The following discussions of safety procedures are only general guidelines. Each situation in which you install a flow meter varies. You must take into account the individual circumstances you are in. Additional safety considerations, other than those discussed here, may be required.

B.1 Practical Safety Precautions

The following procedures are those used by Black & Veatch, a respected consulting firm, and are published here by permission.

Field personnel must keep safety uppermost in their minds at all times. When working above ground, rules of common sense and safety prevail. However, when entering manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

B.1.1 Hazards

There are many hazards connected with entering manholes. Some of the most common hazards are:

Adverse Atmosphere – The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. orced ventilation may be necessary.

Deteriorated Rungs – Manhole steps may be corroded and not strong enough to support a man. It may be difficult to inspect the rungs because of poor lighting.

Traffic – Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.

Falling Objects – Items placed near the manhole opening may fall and injure a worker in the manhole.

Sharp Edges – Sharp edges of items in or near a manhole may cause cuts or bruises.

Lifting Injuries – Unless proper tools are used to remove manhole covers, back injuries or injuries to hands or feet may result.

B.1.2 Planning

Advance planning should include arrangements for test equipment, tools, ventilating equipment, protective clothing, traffic warning devices, ladders, safety harness, and adequate number of personnel. Hasty actions may result in serious injuries. Time spent in the manhole should be kept to a minimum.

B.1.3 Adverse Atmospheres

[Refer to Table B-1, Hazardous Gases, at the end of this appendix.] Before workers enter a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Combustible or toxic vapors may be heavier than air, so the tests on the atmosphere must be run at least 3/4 of the way down the manhole.

Whenever adverse atmosphere is encountered, forced ventilation must be used to create safe conditions. After the ventilating equipment has been operated for a few minutes, the atmosphere in the manhole should be retested before anyone enters the manhole.

When explosive conditions are encountered, the ventilating blower should be placed upwind to prevent igniting any gas that is emerging from the opening. When a gasoline engine blower is used, it must be located so that exhaust fumes cannot enter the manhole.

If testing equipment is not available, the manhole should be assumed to contain an unsafe atmosphere and forced ventilation must be provided. It should never be assumed that a manhole is safe just because there is no odor or the manhole has been entered previously.

B.1.4 Entering Manholes

Since the top of the manhole is usually flush with the surrounding surface, there may not be anything for the person who is entering the manhole to grab on to steady himself. Persons who are entering manholes should not be permitted to carry anything in their hands as they enter the manhole, to ensure that their hands will be free to hold on or grab if they slip. A good method for entering a manhole is to sit on the surface facing the manhole steps or ladder, with the feet in the hole and the arms straddling the opening for support. As the body slides forward and downward, the feet can engage a rung, and the back can rest against the opposite side of the opening. If there is any doubt about the soundness of the manhole steps, a portable ladder should be used.

A person should never enter a manhole unless he is wearing personal safety equipment, including a safety harness and a hard hat. Two persons should be stationed at the surface continuously while anyone is working inside a manhole, to lift him out if he is

overcome or injured. One man cannot lift an unconscious man out of a manhole. The persons stationed at the surface should also function as guards to keep people and vehicles away from the manhole opening. To avoid a serious injury, a person should not be lifted out of a manhole by his arm unless it is a dire emergency.

When more than one person must enter a manhole, the first person should reach the bottom and step off the ladder before the next one starts down. When two men climb at the same time, the upper one can cause the lower one to fall by slipping or stepping on his fingers.

B.1.5 Traffic Protection

In addition to traffic cones, markers, warning signs, and barricades, a vehicle or a heavy piece of equipment should be placed between the working area and oncoming traffic. Flashing warning signals should be used to alert drivers and pedestrians. Orange safety vests should be worn by personnel stationed at the surface when the manhole is located in a vehicular traffic area.

B.1.6 Falling Objects

All loose items should be kept away from the manhole opening. This applies to hand tools as well as stones, gravel and other objects.

B.1.7 Removing the Covers

Manhole covers should be removed with a properly designed hook. Use of a pick ax, screwdriver, or small pry bar may result in injury. A suitable tool can be made from $^{3}/_{4}$-inch round or hex stock. Two inches of one end should be bent at a right angle and the other end should be formed into a D-handle wide enough to accommodate both hands. Even with this tool, care must be exercised to prevent the cover from being dropped on the toes. The 2-inch projection should be inserted into one of the holes in the cover, the handle grasped with both hands, and the cover lifted by straightening the legs which have been slightly bent at the knees.

B.1.8 Other Precautions

Other precautions which should be taken when entering a manhole are:

- Wear a hard hat.
- Wear coveralls or removable outer garment that can be readily removed when the work is completed.
- Wear boots or nonsparking safety shoes.
- Wear rubberized or waterproof gloves.
- Wear a safety harness with a stout rope attached.
- Do not smoke.
- Avoid touching yourself above the collar until you have cleaned your hands.

B.1.9 Emergencies

Every member of the crew should be instructed on procedures to be followed in cases of an emergency. It is the duty of each crew chief to have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

B.1.10 Field Equipment

The following equipment will be available for use:

Blowers	Gloves	Traffic cones
Breathing apparatus	Hard Hats	Coveralls
Harnesses	First aid kits	Manhole irons
Emergency flashers	Pick axes	Flashlights
Rain slickers	Mirrors	Ropes
Gas detectors	Safety vests	Gas masks
Waders”		

B.2 Lethal Atmospheres in Sewers

The following is an article written by Dr. Richard D. Pomeroy, and published in the October 1980 issue of ***Deeds & Data*** of the WPCF. Dr. Pomeroy is particularly well known for his studies, over a period of nearly 50 years, in the field of the control of hydrogen sulfide and other odors in sewers and treatment plants. He has personally worked in a great many functioning sewers. In the earlier years he did so, he admits, with little knowledge of the grave hazards to which he exposed himself.

It is gratifying that the subject of hazards to people working in sewers is receiving much more attention than in past years, and good safety procedures are prescribed in various publications on this subject. It is essential that people know and use correct procedures.

It is less important to know just what the hazardous components of sewer atmospheres are, as safety precautions should in general be broadly applicable, but there should be a reasonable understanding of this subject. It is disturbing to see statements in print that do not reflect true conditions.

One of the most common errors is the assumption that people have died from a lack of oxygen. The human body is able to function very well with substantially reduced oxygen concentrations. No one worries about going to Santa Fe, New Mexico, (elev. 2,100 meters), where the partial pressure of oxygen is equal to 16.2% (a normal atmosphere is about 21%) oxygen. When first going there, a person may experience a little ‘shortness of breath’ following exercise. People in good health are not afraid to drive over the high passes in the Rocky Mountains. At Loveland Pass, oxygen pressure is 13.2% of a normal atmosphere. At the top of Mt. Whitney, oxygen is equal to 12.2%t. Many hikers go there, and to higher peaks as well. After adequate acclimation, they may climb to the top of Mt. Everest, where oxygen is equal to only 6.7%.

The lowest oxygen concentrations that I have observed in a sewer atmosphere was 13 percent. It was in a sealed chamber, near sea level, upstream from an inverted siphon on a metropolitan trunk. A man would be foolish to enter the chamber. Without ventilation, he might die, but not from lack of oxygen.

It seems unlikely that anyone has ever died in a sewer from suffocation, that is, a lack of oxygen. Deaths have often been attributed to 'asphyxiation.' This is a word which, according to the dictionary, is used to mean death from an atmosphere that does not support life. The word has sometimes been misinterpreted as meaning suffocation, which is only one kind of asphyxiation.

In nearly all cases of death in sewers, the real killer is hydrogen sulfide. It is important that this fact be recognized. Many cities diligently test for explosive gases, which is very important, and they may measure the oxygen concentration which usually is unimportant, but they rarely measure H_2S. Death has occurred where it is unlikely that there was any measurable reduction in the oxygen concentration. Waste water containing 2 mg per liter of dissolved sulfide, and at a pH of 7.0, can produce, in a chamber with high turbulence, a concentration of 300 PPM H_2S, in the air. This is considered to be a lethal concentration. Many people have died from H_2S, not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from H_2S poisoning before the people were ready to admit that H_2S is not a therapeutic agent. Hardly a year passes in the U.S. without a sewer fatality from H_2S as well as deaths elsewhere in the world.

The presence of H_2S in a sewer atmosphere is easily determined. A bellows-and-ampoule type of tester is very satisfactory for the purpose, even though it is only crudely quantitative. When using a tester of this type, do not bring the air to the ampoule by way of a tube, as this may change the H_2S concentration. Hang the ampoule in the air to be tested, with a suction tube to the bulb or bellows.

Lead acetate paper is very useful as a qualitative indicator. It cannot be used to estimate the amount of sulfide, but it will quickly turn black in an atmosphere containing only a tenth of a lethal concentration.

Electrodes or other similar electrical indicating devices for H_2S in air have been marketed. Some of them are known to be unreliable, and we know of none that have proved dependable. Do not use one unless you check it at frequent intervals against air containing known H_2S concentrations. A supposed safety device that is unreliable is worse than none at all.

Remember that the nose fails, too, when it comes to sensing dangerous concentrations of H_2S.

Various other toxic gases have been mentioned in some publications. It is unlikely that any person has been asphyxiated in a sewer by any of those other gases, except possibly chlorine. The vapor of gasoline and other hydrocarbons is sometimes present in

amounts that could cause discomfort and illness, but under that condition, the explosion hazard would be far more serious. The explosimeter tests, as well as the sense of smell, would warn of the danger. Pipelines in chemical plants might contain any number of harmful vapors. They, too, are sensed by smell and explosimeter tests if they get into the public sewer. Such occurrences are rare.

The attempt to instill a sense of urgency about real hazards is diluted if a man is told to give attention to a long list of things that in fact are irrelevant.

Be very careful to avoid high H_2S concentrations, flammable atmospheres, and hazards of physical injuries. Remember that much H_2S may be released by the stirring up of sludge in the bottom of a structure. Obey your senses in respect to irritating gases, such as chlorine (unconsciousness comes suddenly from breathing too much). Be cautious about strange odors. Do not determine percent oxygen in the air. There is a danger that the result will influence a man's thinking about the seriousness of the real hazards. Most important, use ample ventilation, and do not enter a potentially hazardous structure except in a good safety harness with two men at the top who can lift you out."

B.3 Hazardous Gases

The following table contains information on the properties of hazardous gases.

Table B-1 Hazardous Gases

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Ammonia	NH_3	Irritant and poisonous. Colorless with characteristic odor.	0.60	Causes throat and eye irritation at 0.05%, coughing at 0.17%. Short exposure at 0.5% to 1% fatal.	300 to 500	85	16 25	Near top. Concentrates in closed upper spaces	Sewers, chemical feed rooms.	Detectable odor at low concentrations
Benzene	C_6H_6	Irritant, colorless anesthetic	2.77	Slight symptoms after several hours exposure at 0.16% to 0.32%. 2% rapidly fatal.	3,000 to 5,000	25	1.3 7.1	At bottom.	Industrial wastes, varnish, solvents.	Combustible gas indicator
Carbon Bisulfide	CS_2	Nearly odorless when pure, colorless, anesthetic. Poisonous.	2.64	Very poisonous, irritating, vomiting, convulsions, psychic disturbance.	—	15	1.3 44.0	At bottom	An insecticide	Combustible gas indicator

Table B-1 Hazardous Gases (Continued)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Carbon Dioxide	CO_2	Asphyxiant, Colorless, odorless. When breathed in large quantities, may cause acid taste. Non-flammable. Not generally present in dangerous amounts unless an oxygen deficiency exists.	1.53	Cannot be endured at 10% more than a few minutes, even if subject is at rest and oxygen content is normal. Acts on respiratory nerves.	40,000 to 60,000	5,000	— —	At bottom; when heated may stratify at points above bottom.	Products of combustion, sewer gas, sludge. Also issues from carbonaceous strata.	Oxygen deficiency indicator
Carbon Monoxide	CO	Chemical asphyxiant. Colorless, odorless, tasteless. Flammable. Poisonous.	0.97	Combines with hemoglobin of blood. Unconsciousness in 30 min. at 0.2% to 0.25%. Fatal in 4 hours at 0.1%. Headache in few hours at 0.02%.	400	50	12.5 74.0	Near top, especially if present with illuminating gas.	Manufactured gas, flue gas, products of combustion, motor exhausts. Fires of almost any kind.	CO ampoules.
Carbon Tetra-Chloride	CCl_4	Heavy, ethereal odor.	5.3	Intestinal upset, loss of consciousness, possible renal damage, respiratory failure.	1,000 to 1,500	100	— —	At bottom.	Industrial wastes, solvent, cleaning	Detectable odor at low concentrations.
Chlorine	Cl_2	Irritant. Yellow-green color. Choking odor detectable in very low concentrations. Non-flammable.	2.49	Irritates respiratory tract. Kills most animals in a very short time at 0.1%.	4	1	— —	At bottom.	Chlorine cylinder and feed line leaks.	Detectable odor at low concentrations.
Formaldehyde	CH_2O	Colorless, pungent suffocating odor.	1.07	Irritating to the nose.	—	10	7.0 73.0	Near bottom.	Incomplete combustion of organics. Common air pollutant, fungicide.	Detectable odor.
Gasoline	C_5H_{12} to C_9H_{20}	Volatile solvent. Colorless. Odor noticeable at 0.03%. Flammable.	3.0 to 4.0	Anesthetic effects when inhaled. Rapidly fatal at 2.4%. Dangerous for short exposure at 1.1 to 2.2%.	4,000 to 7,000	1,000	1.3 6.0	At bottom.	Service stations, garages, storage tanks, houses.	1. Combustible gas indicator. 2. Oxygen deficiency indicator.**
Hydrogen	H_2	Simple asphyxiant. Colorless, odorless, tasteless. Flammable	0.07	Acts mechanically to deprive tissues of oxygen. Does not support life.	—	—	4.0 74.0	At top.	Manufactured gas, sludge digestion tank gas, electrolysis of water. Rarely from rock strata.	Combustible gas indicator.
Hydrogen Cyanide	HCN	Faint odor of bitter almonds. Colorless gas	0.93	Slight symptoms appear upon exposure to 0.002% to 0.004%. 0.3% rapidly fatal.	—	10	6.0 40.0	Near top.	Insecticide and rodenticide.	Detector tube

Table B-1 Hazardous Gases (Continued)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air = 1	Physiological Effect*	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Hydrogen Sulfide	H_2S	Irritant and poisonous volatile compound. Rotten egg odor in small concentrations. Exposure for 2 to 15 min. at 0.01% impairs sense of smell. Odor not evident at high concentrations. Colorless. Flammable.	1.19	Impairs sense of smell, rapidly as concentration increases. Death in few minutes at 0.2%. Exposure to 0.07 to 0.1% rapidly causes acute poisoning. Paralyzes respiratory center.	200 to 300	20	4.3 45.0	Near bottom, but may be above bottom if air is heated and highly humid.	Coal gas, petroleum, sewer gas. Fumes from blasting under some conditions. Sludge gas.	1. H_2S Ampoule. 2. 5% by weight lead acetate solution.
Methane	CH_4	Simple asphyxiant. Colorless, odorless, tasteless, flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit, provided oxygen percentage is sufficient for life.	—	5.0 15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.	1. Combustible gas indicator 2. Oxygen deficiency indicator.
Nitrogen	N_2	Simple asphyxiant. Colorless, tasteless. Non-flammable. Principal constituent of air. (about 79%).	0.97	Physiologically inert.	—	—	— —	Near top, but may be found near bottom.	Sewer gas. sludge gas. Also issues from some rock strata.	Oxygen deficiency indicator.
Nitrogen Oxides	NO N_2O NO_2	Colorless Colorless, sweet odor. Reddish-brown. Irritating odor. Deadly poison	1.04 1.53 1.58	60 to 150 ppm cause irritation and coughing. Asphyxiant. 100 ppm dangerous. 200 ppm fatal.	50	10	— —	Near bottom.	Industrial wastes. Common air pollutant.	NO_2 detector tube.
Oxygen	O_2	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.8% of O_2. Man can tolerate down to 12%. Minimum safe 8 hour exposure, 14 to 16%. Below 10%, dangerous to life. Below 5 to 7% probably fatal.	—	—	— —	Variable at different levels.	Oxygen depletion from poor ventilation and absorption, or chemical consumption of oxygen.	Oxygen deficiency indicator.
Ozone	O_3	Irritant and poisonous. Strong electrical odor. Strong oxidizer. Colorless. At 1 ppm, strong sulfur-like odor.	1.66	Max. naturally occurring level is 0.04 ppm. 0.05 ppm causes irritation of eyes and nose. 1 to 10 ppm causes headache, nausea; can cause coma. Symptoms similar to radiation damage.	0.08	0.04	— —	Near bottom.	Where ozone is used for disinfection.	Detectable odor at 0.015 ppm.

Table B-1 Hazardous Gases (Continued)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Sludge Gas	—***	Mostly a simple asphyxiant. May be practically odorless, tasteless.	Variable	Will not support life.	No data. Would vary widely with composition.		5.3 19.3	Near top of structure.	From digestion of sludge.	See components.
Sulfur Dioxide	SO_2	Colorless, pungent odor. Suffocating, corrosive, poisonous, non-flammable.	2.26	Inflammation of the eyes. 400 to 500 ppm immediately fatal.	50 to 100	10	— —	At bottom, can combine with water to form sulfurous acid.	Industrial waste, combustion, common air pollutant.	Detectable taste and odor at low concentration.
Toluene	C_5H_{12} to C_9H_{20}	Colorless, benzene-like odor.	3.14	At 200-500 ppm, headache, nausea, bad taste, lassitude.	200	100	1.27 7.0	At bottom.	Solvent.	Combustible gas indicator.
Turpentine	$C_{10}H_{16}$	Colorless, Characteristic odor.	4.84	Eye irritation. Headache, dizziness, nausea, irritation of the kidneys.	—	100		At bottom.	Solvent, used in paint.	1. Detectable odor at low concentrations. 2.Combustible gas indicator.
Xylene	C_8H_{10}	Colorless, flammable	3.66	Narcotic in high concentrations. less toxic than benzene.	—	100	1.1 7.0	At bottom.	Solvent	Combustible gas indicator.

* Percentages shown represent volume of gas in air.
** For concentration over 0.3%.
***Mostly methane and carbon dioxide with small amounts of hydrogen, nitrogen, hydrogen sulfide, and oxygen; occasionally traces of carbon monoxide.

4120 Flow Logger

Appendix C Material Safety Data Sheets

This appendix provides Material Safety Data sheets for the internal desiccants used in the 4120 Flow Logger.

Specific questions regarding the use and handling of these products should be directed to the manufacturer listed in the MSDS.

101 Christine Drive
Belen, New Mexico 87002
Phone: (505) 864-6691
Fax: (505) 861-2355

SÜD-CHEMIE
Performance Packaging

ISO 9002

MATERIAL SAFETY DATA SHEET -- September 28, 1998
SORB-IT®
Packaged Desiccant

SECTION I -- PRODUCT IDENTIFICATION

Trade Name and Synonyms:	Silica Gel, Synthetic Amorphous Silica, Silicon, Dioxide
Chemical Family:	Synthetic Amorphous Silica
Formula:	$SiO_2.x\ H_2O$

SECTION II -- HAZARDOUS INGREDIENTS

Components in the Solid Mixture

COMPONENT	CAS No	%	ACGIH/TLV (PPM)	OSHA-(PEL)
Amorphous Silica	63231-67-4	>99	PEL - 20 (RESPIRABLE), TLV – 5	LIMIT – NONE, HAZARD - IRRITANT ˝

Synthetic amorphous silica is not to be confused with crystalline silica such as quartz, cristobalite or tridymite or with diatomaceous earth or other naturally occurring forms of amorphous silica that frequently contain crystalline forms.

This product is in granular form and packed in bags for use as a desiccant. Therefore, no exposure to the product is anticipated under normal use of this product. Avoid inhaling desiccant dust.

SECTION III -- PHYSICAL DATA

Appearance and Odor:	White granules; odorless.
Melting Point:	>1600 Deg C; >2900 Deg F
Solubility in Water:	Insoluble.
Bulk Density:	>40 lbs./cu. ft.
Percent Volatile by Weight @ 1750 Deg F:	<10%.

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SORB-IT®
Packaged Desiccant

SECTION IV -- FIRE EXPLOSION DATA

Fire and Explosion Hazard - Negligible fire and explosion hazard when exposed to heat or flame by reaction with incompatible substances.

Flash Point - Nonflammable.

Firefighting Media - Dry chemical, water spray, or foam. For larger fires, use water spray fog or foam.

Firefighting - Nonflammable solids, liquids, or gases: Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire in enclosed area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of the tank due to fire.

SECTION V -- HEALTH HAZARD DATA

Health hazards may arise from inhalation, ingestion, and/or contact with the skin and/or eyes. Ingestion may result in damage to throat and esophagus and/or gastrointestinal disorders. Inhalation may cause burning to the upper respiratory tract and/or temporary or permanent lung damage. Prolonged or repeated contact with the skin, in absence of proper hygiene, may cause dryness, irritation, and/or dermatitis. Contact with eye tissue may result in irritation, burns, or conjunctivitis.

First Aid (Inhalation) - Remove to fresh air immediately. If breathing has stopped, give artificial respiration. Keep affected person warm and at rest. Get medical attention immediately.

First Aid (Ingestion) - If large amounts have been ingested, give emetics to cause vomiting. Stomach siphon may be applied as well. Milk and fatty acids should be avoided. Get medical attention immediately.

First Aid (Eyes) - Wash eyes immediately and carefully for 30 minutes with running water.

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Packaged Desiccant

NOTE TO PHYSICIAN: This product is a desiccant and generates heat as it adsorbs water. The used product can contain material of hazardous nature. Identify that material and treat accordingly.

SECTION VI -- REACTIVITY DATA

Reactivity - Silica gel is stable under normal temperatures and pressures in sealed containers. Moisture can cause a rise in temperature which may result in a burn.

SECTION VII --SPILL OR LEAK PROCEDURES

Notify safety personnel of spills or leaks. Clean-up personnel need protection against inhalation of dusts or fumes. Eye protection is required. Vacuuming and/or wet methods of cleanup are preferred. Place in appropriate containers for disposal, keeping airborne particulates at a minimum.

SECTION VIII -- SPECIAL PROTECTION INFORMATION

Respiratory Protection - Provide a NIOSH/MSHA jointly approved respirator in the absence of proper environmental control. Contact your safety equipment supplier for proper mask type.

Ventilation - Provide general and/or local exhaust ventilation to keep exposures below the TLV. Ventilation used must be designed to prevent spots of dust accumulation or recycling of dusts.

Protective Clothing - Wear protective clothing, including long sleeves and gloves, to prevent repeated or prolonged skin contact.

Eye Protection - Chemical splash goggles designed in compliance with OSHA regulations are recommended. Consult your safety equipment supplier.

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Packaged Desiccant

SECTION IX -- SPECIAL PRECAUTIONS

Avoid breathing dust and prolonged contact with skin. Silica gel dust causes eye irritation and breathing dust may be harmful.

* No Information Available

HMIS (Hazardous Materials Identification System) for this product is as follows:

Health Hazard	0
Flammability	0
Reactivity	0
Personal Protection	HMIS assigns choice of personal protective equipment to the customer, as the raw material supplier is unfamiliar with the condition of use.

Material Safety Data Sheet

Indicating Silica Gel

Identity (Trade Name as Used on Label)

Manufacturer :	MULTISORB TECHNOLOGIES, INC. (formerly Multiform Desiccants, Inc.)	MSDS Number* :	M75
Address:	325 Harlem Road Buffalo, NY 14224	CAS Number* :	
Phone Number (For Information):	716/824-8900	Date Prepared:	July 6, 2000
Emergency Phone Number:	716/824-8900	Prepared By* :	G.E. McKedy

Section 1 - Material Identification and Information

Components - Chemical Name & Common Names (Hazardous Components 1% or greater; Carcinogens 0.1% or greater)	%*	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED
Silica Gel SiO_2	98.0	6mg/m^3 (total dust)	10mg/m^3 (total dust)	
Cobalt Chloride	>2.0	0.05mg/m^3 (TWA cobalt metal dust & fume)	.05mg/m^3 (Cobalt, TWA)	
Non-Hazardous Ingredients				
TOTAL	100			

Section 2 - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_20 = 1)	2.1
Vapor Pressure (mm Hg and Temperature	N/A	Melting Point	N/A
Vapor Density (Air =1)	N/A	Evaporation Rate (_____=1)	N/A
Solubility in Water	Insoluble, but will adsorb moisture.	Water Reactive	Not reactive, but will adsorb moisture.
Appearance and Odor	Purple crystals, no odor.		

Section 3 - Fire and Explosion Hazard Data

Flash Point and Methods Used	N/A	Auto-Ignition Temperature	N/A	Flammability Limits in Air % by Volume	N/A	LEL	UEL
Extinguisher Media	Dry chemical, carbon dioxide and foam can be used.						
Special Fire Fighting Procedures	Water will generate heat due to the silica gel which will adsorb water and liberate heat.						
Unusual Fire and Explosion Hazards	When exposed to water, the silica gel can get hot enough to reach the boiling point of water. Flooding with water will reduce the temperature to safe limits.						

Section 4 - Reactivity Hazard Data

STABILITY ☐**Stable** ☐**Unstable**	Conditions To Avoid	Moisture and high humidity environments.
Incompatibility (Materials to Avoid)	Water.	
Hazardous Decomposition Products	Carbon dioxide, carbon monoxide, water	
HAZARDOUS POLYMERIZATION ☐May Occur	Conditions To Avoid	None.

*Optional

Section 5 - Health Hazard Data

PRIMARY ROUTES OF ENTRY	☐Inhalation ☐Skin Absorption	☐Ingestion ☐Not Hazardous	**CARCINOGEN LISTED IN**	☐NTP ☐IARC Monograph	☐OSHA ☐Not Listed
HEALTH HAZARDS	Acute	May cause eye, skin and mucous membrane irritation.			
	Chronic	Prolonged inhalation may cause lung damage.			
Signs and Symptoms of Exposure	Drying and irritation.				
Medical Conditions Generally Aggravated by Exposure	Asthma.				
EMERGENCY FIRST AID PROCEDURES - Seek medical assistance for further treatment, observation and support if necessary.					
Eye Contact	Flush with water for at least 15 minutes.				
Skin Contact	Wash affected area with soap and water.				
Inhalation	Remove affected person to fresh air.				
Ingestion	Drink at least 2 glasses of water.				

Section 6 - Control and Protective Measures

Respiratory Protection (Specify Type)	Use NIOSH approved dust mask or respirator.		
Protective Gloves	Light cotton gloves.	Eye Protection	Safety glasses.
VENTILATION TO BE USED	☐ Local Exhaust	☐Mechanical (General)	☐Special
	☐Other (Specify)		
Other Protective Clothing and Equipment	None.		
Hygienic Work Practices	Avoid raising dust. Avoid contact with skin, eyes and clothing.		

Section 7 - Precautions for Safe Handling and Use/Leak Procedures

Steps to be Taken if Material Is Spilled Or Released	Sweep or vacuum up and place the spilled material in a waste disposal container. Avoid raising dust.
Waste Disposal Methods	Dispose in an approved landfill according to federal, state and local regulations.
Precautions to be Taken In Handling and Storage	Cover promptly to avoid blowing dust. Wash after handling.
Other Precautions and/or Special Hazards	Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

*Optional Indicating Silica Gel

MULTISORB
Multisorb Technologies Inc.

MATERIAL SAFETY DATA SHEET

Effective Date March 8, 2005
MSDS Number M163

Section 1 – Product and Company Information

Product Name: **Silica gel, indicating, yellow**

Product Use: Desiccant, absorbent
Grades: Silica gel, indicating
Synonyms: Amorphous silica gel, SiO_2, silicon dioxide (amorphous)

Company; Multisorb Technologies, Inc.
Street Address: 325 Harlem Road
City, State, Zip, Country: Buffalo, NY 14224-1893 USA

Telephone Number: (716) 824 8900 [USA] Monday - Friday (8:00 - 5:00 EDT)
Fax Number: (716) 824 4091 [USA]
Website / E-Mail : multisorb.com

Section 2 – Composition / Information on Ingredients

Component Name	CAS Number	% by Weight
Synthetic amorphous silica gel (SiO_2)	112926-00-8	100
Phenolphthalein	77-09-08	100 ppm

While this material is not classified, this MSDS contains valuable information critical to the safe handling and proper use of this product. This MSDS should be retained and available for employees and other users of this product.

Section 3 – Hazard Identification

Emergency Overview: A yellow bead or granular material that poses little or no immediate hazard. This material is not combustible.

Potential Health Effects:

Eyes: Dust and or product may cause eye discomfort and irritation seen as tearing and reddening.

Skin: The product dust may cause drying of the skin. Silica gel may get hot enough to burn skin when it adsorbs moisture rapidly. Use an excess of water to cool the silica gel.

Ingestion: Material is not toxic and will pass through the body normally.

Inhalation: Slight irritation is possible but none is expected.

Medical Effects Generally Aggravated by Exposure: Respiratory ailments.

Chronic Effects/Carcinogenity: May cause eye, skin and mucous membrane irritation and drying.

Section 4 – First Aid Measures

Eyes: Rinse the eyes well with water while lifting the eye lids. If irritation persists, consult a physician.

Skin: Wash affected area with soap and water.

Ingestion: Ingestion is unlikely, this material will pass through the body normally.

Inhalation: Remove the affected person to fresh air and get medical attention if necessary.

Notes to Physician: Not applicable

Section 5 – Fire Fighting Measures

Flammable Properties: Not flammable

Flash Point: Not applicable **Method:** Not applicable

Flammable Limits: Not flammable

Lower Flammability Limit: Not applicable

Upper Flammability Limit: Not applicable

Autoignition Temperature: Not applicable

Hazardous Combustion Products: Not applicable

Extinguishing Media: Use extinguishing media that is appropriate for the surrounding fire. Silica gel is not combustible.

Fire Fighting Instructions: Not combustible

Unusual Fire and Explosion Hazards: None

Section 6 – Accidental Release Measures

Spill: Sweep or vacuum up and place the spilled material in a waste disposal container. Avoid raising dust. Wash with soap and water after handling.

Section 7 – Handling and Storage

Handling: Avoid raising dust and minimize the contact between worker and the material. Practice good hygienic work practices.

Storage: Store in a cool, dry location. Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

Section 8 – Exposure Controls/Personal Protection

Engineering Controls: Use exhaust ventilation to keep the airborne concentrations below the exposure limits.

Respiratory Protection: Use NIOSH approved respirator when the air quality levels exceed the TLV's.

Skin Protection: Light gloves will protect against abrasion and drying of the skin.

Eye Protection: Safety glasses.

Component Name	Exposure Limits		
	OSHA PEL	**ACGIH TLV**	**Other Recommended Limits**
Silica gel	TWA 20 mppcf (80 mg / m^3 % SiO_2)	TWA 10 mg / m^3	NIOSH REL TWA 6 mg / m^3 IDLH 3000 mg / m^3
Phenolphthalein	Not Applicable	Not Applicable	Not Applicable

Section 9 – Physical and Chemical Properties

Appearance: Yellow beads or granules

Odor: None

Physical State: Solid bead

PH: Not applicable

Vapor Pressure: Not applicable

Vapor Density: Not applicable

Boiling Point: 4046° F (2230° C)

Melting Point: 3110° F (1710° C)

Solubility: Insoluble in water

Specific Gravity: 2.1

Section 10 – Stability and Reactivity

Stability: Stable

Conditions to avoid: Moisture and high humidity environments.

Incompatibility: Water, fluorine, oxygen difluoride, chlorine trifluoride

Hazardous Decomposition Products: None

Hazardous Polymerization: Will not occur

Section 11 – Toxicological Information

This product and its components are not listed on the NTP or OSHA Carcinogen lists.

Animal Toxicology Tests for DOT Hazard classification
(Tests Conducted on finely ground silica gel)

1 - hour LC_{50} (rat) > 2 mg / l
48 - hour oral LD_{50} (rat) est. > 31,600 mg / kg
48 - hour dermal LD_{50} (rabbit) est. > 2,000 mg / kg
Considered an ocular irritant

Human Toxicology Silica gel is a synthetic amorphous silica not to be confused with crystalline silica. Epidemiological studies indicate low potential for adverse health effects. In the activated form, silica gel acts as a desiccant and can cause a drying irritation of the mucous membranes and skin in cases of severe exposure. Multisorb Technologies Inc. knows of no medical conditions that are abnormally aggravated by exposure to silica gel. The primary route of entry is inhalation of dust.

Section 12 – Ecological Information

Not known to have any adverse effect on the aquatic environment. Silica gel is insoluble and non-toxic.

Section 13 – Disposal Information

Disposal Information If this product as supplied becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Materials of a hazardous nature that contact the product during normal use may be retained on the product. The user of the product must identify the hazards associated with the retained material in order to assess the waste disposal options. Dispose according to federal, state and local regulations.

Section 14 – Transportation Information

U.S. Department of Transportation Shipping Name: Not classified as a hazardous material. Not regulated.

Section 15 – Regulatory Information (Not meant to be all inclusive - selected regulations represented)

TSCA Listed: Yes

DSL/NDSL (Canadian) Listed: Yes

OSHA: TWA 20 mppcf (80 mg / m^3 % SiO_2) for Silica gel

NIOSH: REL TWA 6 mg / m^3 IDLH 3,000 mg / m^3 for silica gel
Animal tests conducted in 1976 - 1978. 18 month exposure at 15 mg / m^3 showed silica deposition in respiratory macrophages and lymph nodes, minimum lung impairment, no silicosis.

ACGIH: TLV - 10 mg / m^3 for Silica gel

DOT: Not classified as a hazardous material.

SECTION 16 – Other Information

HMIS – Hazardous Materials Identification System

HMIS Rating	
Health	0
Flammability	0
Reactivity	0

0 - minimal hazard, 1 - slight hazard, 2 - moderate hazard, 3 - serious hazard, 4 - severe hazard

This MSDS was prepared by: George E. Mckedy
Senior Applications Development Specialist
Multisorb Technologies, Inc.

This data and recommendations presented in this data sheet concerning the use of our product and the materials contained therein are believed to be correct but does not purport to be all inclusive and shall be used only as a guide. However, the customer should determine the suitability of such materials for his purpose before adopting them on a commercial scale. Since the use of our products is beyond our control, no guarantee, expressed or implied, is made and no responsibility assumed for the use of this material or the results to be obtained therefrom. Information on this form is furnished for the purpose of compliance with Government Health and Safety Regulations and shall not be used for any other purposes. Moreover, the recommendations contained in this data sheet are not to be construed as a license to operate under, or a recommendation to infringe, any existing patents, nor should they be confused with state, municipal or insurance requirements, or with national safety codes.

4120 Flow Logger

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*Teledyne Isco One Year Limited Factory Service Warranty **

Teledyne Isco warrants covered products against failure due to faulty parts or workmanship for a period of one year (365 days) from their shipping date, or from the date of installation by an authorized Teledyne Isco Service Engineer, as may be appropriate.

During the warranty period, repairs, replacements, and labor shall be provided at no charge. Teledyne Isco's liability is strictly limited to repair and/or replacement, at Teledyne Isco's sole discretion.

Failure of expendable items (e.g., charts, ribbon, tubing, lamps, glassware, seals, filters, fittings, and wetted parts of valves), or from normal wear, accident, misuse, corrosion, or lack of proper maintenance, is not covered. Teledyne Isco assumes no liability for any consequential damages.

This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

This warranty applies only to products sold under the Teledyne Isco trademark and is made in lieu of any other warranty, written or expressed.

No items may be returned for warranty service without a return authorization number issued from Teledyne Isco.

The warrantor is Teledyne Isco, Inc.
4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to the USA and countries where Teledyne Isco Inc. does not have an authorized dealer. Custo mers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Is co dealer for warranty service.**

In the event of instrument problems, always contact the Teledyne Isco Service Department, as problems can often be diagnosed and corrected without requiring an on-site visit. In the U.S.A., contact Teledyne Isco Service at the numbers listed below. International customers should contact their local Teledyne Isco agent or Teledyne Isco International Customer Service.

Return Authorization

A return authorization number must be issued prior to shipping. Following authorization, Teledyne Isco will pay for surface transportation (excluding packing/crating) both ways for 30 days from the beginning of the warranty period. After 30 days, expense for warranty shipments will be the responsibility of the customer.

Shipping Address: Teledyne Isco, Inc. - Attention Repair Service
4700 Superior Street
Lincoln NE 68504 USA

Mailing address: Teledyne Isco, Inc.
PO Box 82531
Lincoln NE 68501 USA

Phone: Technical Support (800)775-2965 (lab instruments)
(866)298-6174 (samplers & flow meters)
Sales & General Information: (800)228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: iscoservice@teledyne.com **Web site:** www.isco.com

March 17, 2009 P/N 60-1002-040 Rev D

TELEDYNE ISCO
A Teledyne Technologies Company