Flow Metering Inserts

Installation and Operation Guide

TELEDYNE ISCO
A Teledyne Technologies Company

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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

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Flow Metering Inserts

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Flow Metering Inserts

Section 1 Introduction

This section of the Flow Metering Inserts instruction manual provides a general introduction to the inserts. It consists of a brief discussion of the organization of the manual, an overall description of the inserts, safety precautions, and a table of technical specifications.

1.1 Manual Organization

The purpose of this manual is to provide the user with the information necessary to assemble, operate, maintain, and repair the Flow Metering Inserts. To do this, the manual is organized into three sections. The first section is a general introduction to the Flow Metering Inserts. The second section is concerned with assembly and operating procedures for field use of the inserts. The third section includes information on routine maintenance, repair procedures, and replacement parts.

1.2 Description of the Flow Metering Inserts

Teledyne Isco Flow Metering Inserts are designed to allow the recording of accurate flow rate readings from a round sewer pipe. The inserts are installed from street level, generally without having to enter the manhole. They may be used in 6", 8", 10", and 12" diameter sewers in manholes as deep as 16 feet. The inserts may be used with a Teledyne Isco Model 4230 Flow Meter, or a Model 730 Bubbler Module, and can measure flow rates ranging from one to 640 gallons per minute with 5% accuracy. See the specific product manual for more information.

1.2.1 Metering Insert

The Flow Metering Insert consists of the metal insert, inflatable rubber collar, a multi-section pole assembly, and a foot-powered air pump. The metering insert is a calibrated flow control section that generates an upstream head, or pressure, related to a particular flow rate in the pipe. Metering inserts are available for use in four different sizes of pipe: 6", 8", 10", and 12". Each metering insert has a built-in round orifice flow control section that is 60% of the diameter of the pipe. For lower flow rates, an attachable 60° V-notch weir plate flow control section is also supplied with each metering insert. The flow rate ranges for the various sizes of metering inserts with both flow control sections are listed in Table 1-1. The metering insert is sealed in place in the pipe by an inflatable rubber collar. A bubbler tube is permanently attached to the metering insert assembly, allowing the upstream pressure to be measured by the flow meter or module.

1.2.2 Multi-Section Pole Assembly

The multi-section pole assembly allows the metering insert to be installed in the sewer pipe from street level. The pole's 2½-foot sections quickly snap together, allowing the unit to be conveniently used in a range of manhole depths to 16 feet. Also sup-

plied is a right angle tube assembly used to attach the insert to the pole assembly. A foot-powered air pump is used to inflate the rubber collar, sealing the metering insert in place. A pressure gauge is attached to the pump to allow the pressure in the collar to be monitored during installation.

1.2.3 Assembly and Flow Meter Preparation

The Flow Metering Inserts and multi-section pole are designed to be easily assembled and disassembled in the field without using tools. The multi-section pole, right angle tube assembly, and metering inserts quickly snap together, which aids in installation, transportation, and storage.

The bubble line from the insert is attached to the flow meter or bubbler module. Then the bubble rate is set and the flow meter's level is set to zero. (See Section 2.2)

Refer to the manual appropriate for the flow meter you are using, i.e. Model 4230, or the Model 730 Bubbler Module, if you are using a 6700 series sampler.

1.2.4 Installation

For installation, the various pieces of the insert are snapped together with enough sections of the pole to reach the bottom of the manhole. Next, with the operator at ground level, the assembly is lowered into the manhole, and the metering insert maneuvered into the entrance pipe (upstream side) of the manhole.

The metering insert is then sealed into the sewer pipe by inflating its rubber collar using the foot-powered pump and pressure gauge. The bubble line from the insert is attached to the flow meter or module, which is suspended from a rung or other means inside the manhole. The flow meter can then begin to record flow through the insert.

The insert channels all flow in the sewer through the flow control section (either the round orifice or the V-notch weir). For removal of the Flow Metering Insert from the manhole, first release the air pressure from the inflated rubber collar. Do this by pressing the valve stem in the insert's air supply hose, and then pulling the unit out of the pipe and lifting it from the manhole. It may then be quickly disassembled for storage or transportation to the next site.

1.3 Unpacking

The Flow Metering Insert is shipped in two separate containers. The following items will be found in these containers. The flat box contains the upper riser pole, the lower riser pole, and the tubing sleeve which make up the right angle tube, the foot-powered air pump, and the six $2\frac{1}{2}$ - foot pole sections. The rectangular box contains the metering insert with the inflation/bubbler hose assembly, the instruction manual, and the accessory package. The insert is shipped with the hoses attached and coated with sealant to prevent leakage. **Do not disconnect them** unless you are replacing the hose assembly.

1.4 Safety Precautions

There are certain safety considerations that should be clearly understood before attempting to use the Teledyne Isco Flow Metering Inserts. Please read and pay special attention to the following advisory notes.

⚠ DANGER

HAZARD OF ELECTROCUTION! Contacting electric power lines with any part of the Flow Metering Insert and pole assembly will cause severe injury or death. Keep the pole away from any overhead wires.

The inserts are nearly 18 feet long with the maximum number of pole sections attached. This is enough to reach most power lines.

Before installing or removing these inserts, look overhead for interference. Make sure the pole assembly cannot possibly come close to any overhead utilities as it is lowered into or removed from a manhole.

If there are overhead utility wires anywhere near the installation, either:
1. Do not attempt to use the insert, or
2. Lower the insert, attached to the right-angle tube assembly, into the manhole. Then, attach pole sections one at a time as needed while the insert is being lowered into the manhole.

Reverse the process when removing an insert from service: disconnect each pole section one at a time as the insert is being lifted out of the manhole.

1.4.1 Entering the Manhole

In some instances, it may not be possible to install the insert from street level due to the methods of construction used in the manhole or the presence of debris. In such cases, it may become necessary to enter the manhole.

⚠ DANGER

Do not enter the manhole without observing proper safety precautions. Do not enter the manhole if you are working alone. Poisonous gases present in most sewers can KILL you quickly without warning. See Appendix A.

1.4.2 Protection Against Electric Shock

The pole sections are connected together by plastic insulating sleeves, which are intended to reduce the hazard of electric shock, should an accident occur. However, the insulating value of the plastic will be seriously reduced if the handle becomes wet or if the weather is damp or very humid. Use good judgment. **Do not depend on the plastic to protect you if you should touch a wire. Do not try to stand the pole assembly upright without first looking overhead for wires.**

In many manholes, the sewer has been opened by simply breaking off the top half of the pipe with a sledge hammer after the manhole has been built over it. In such cases the openings may be very rough, or debris may accumulate around them, preventing installation of the flow insert from street level.

⚠ CAUTION

The Flow Metering Inserts cause a restriction in the flow stream. While they may be used in some instances for an extended period of time, they should be used with caution in any flow streams that have suspended solids or high grease content. They may cause clogging and may require maintenance. Check such installations frequently. **The inserts are not recommended for permanent installation under any circumstances.** The inserts must be installed on the **upstream** (inlet side) of the sewer. They cannot be used on the **downstream** (outlet side) of the sewer pipe.

Where permanent monitoring of the pipe is required, the use of flow metering inserts will almost certainly cause clogging sooner or later, unless the flow stream contains neither solids nor grease. Instead, use a bubble line outlet attached to a Teledyne Isco mounting ring, either a Spring Ring, or for pipes larger than 15 inches in diameter, a Scissors Ring. Refer to the Model 4230 Flow Meter Instruction Manual or contact Teledyne Isco for additional information on these rings.

The inserts are made of anodized aluminum and the inflatable collar from tough butyl rubber; both are resistant to chemical attack. However, avoid flow streams that contain any chemical agents capable of attacking either the aluminum, (strong alkalies), or the inflated rubber collar, (certain organic solvents).

Whenever an insert is removed from service, check to see that it does not have any debris trapped in the orifice. If debris is found obstructing the orifice, clean the insert and re-run the test. Even partial clogging will cause the flow rate to be inaccurate.

1.5 Technical Specifications

The following table contains technical specifications for the Teledyne Isco Flow Metering Inserts.

Table 1-1 Technical Specifications for Flow Metering Inserts

Equipment Provided	Six 2 1/2-foot pole sections, 17° riser pole, 12-inch tubing sleeve, 73° riser pole, one flow metering insert with detachable weir plate, and a foot-powered air pump. Each insert is provided with a 20-foot bubble line (clear) and a 20-foot air line (black rubber) used to inflate the rubber collar. Hoses are connected lengthwise.	
Maximum Depth of Manhole	16 feet	
Typical Accuracy of the Inserts (for pipe slopes of 2 1/2% or less)	± 1 GPM up to 20 GPM ± 2 GPM for 20 to 40 GPM ± 5% of reading above 40 GPM	
Calibrated Ranges	**Gallons per Minute**	**Gallons per Day (Max.)**
6" Flow Metering Insert V-Notch Weir Round Orifice	 1 to 90 5 to 180	 129,600 259,200
8" Flow Metering Insert V-Notch Weir Round Orifice	 1 to 160 10 to 320	 230,400 460,800
10" Flow Metering Insert V-Notch Weir Round Orifice	 1 to 230 20 to 480	 331,200 691,200
12" Flow Metering Insert V-Notch Weir Round Orifice	 1 to 320 40 to 640	 460,800 921,600

Flow Metering Inserts

Section 2 Operating Procedures

The following sections contain procedures for the field use of the inserts. Included are sections covering selection of the proper insert, field assembly of the unit, lowering the unit into the manhole and pipe, measuring the flow rate, and removal and disassembly.

2.1 Selecting the Metering Insert Configuration

The first step in using the Flow Metering Insert is to decide which insert is best suited for the site. This means choosing an insert to match the diameter of the sewer pipe where the measurement will be made, and then deciding whether the round orifice or V-notch flow control section will be used.

2.1.1 Size of Metering Inserts

As discussed in Section 1, the Flow Metering Inserts are designed to be used in 6", 8", 10", and 12" inside diameter sewer pipes. The actual outside diameter of each metering insert is approximately 90% of the pipe diameter, to allow for an undersized pipe or for a pipe that is out of round. Normally, a 6" metering insert is selected to be used in a 6" ID pipe, and so on. However, in some cases, as described in Section 2.4.6, it may be necessary to use the next smaller size; for example, an 8" insert in 10" pipe.

2.1.2 Selection of Flow Control Sections

Once the size of the metering insert to be used has been selected, the round orifice or V-notch flow control sections must be selected. This decision is normally made on the basis of the amount of flow present in the pipe. As shown in the flow rate ranges for the various size metering inserts in Table 1-1, the round orifice flow control section is used with higher flow rates, while the V-notch section is used with lower flow rates. In general, if the sewer is flowing more than 1/4 to 1/3 full, flow should be measured using the round orifice flow control section. If the sewer is flowing less than this, the V-notch flow control section should be used.

2.1.3 Overlap in Ranges

As shown in Table 1-1, there is an overlap in the calibrated range of flow rates for the round orifice and V-notch weir flow control sections for a given size metering insert. For example, the round orifice of a 6" metering insert has a calibrated range of 5 to 180 GPM, while the V-notch insert has a range of 1 to 90 GPM. Thus, for a 6" insert, the two flow control sections have an overlapping range of 5 to 90 GPM. In general, when the flow rate in the sewer is likely to be in the overlapping range and accuracy is the main consideration, it is preferable to use the V-notch weir flow control section to measure the flow rate.

The V-notch flow control section is generally more accurate than the round orifice in this overlapping range, and is less affected by increased pipe slopes. However, this is simply a recommendation to maximize accuracy; the round orifice flow control section will function throughout its calibrated range to the accuracy stated in Table 1-1. If the installation will be left unattended for any period of time, the round orifice should be used to reduce the chances of clogging.

2.1.4 Construction of the Flow Metering Insert

A metering insert is shown in Figure 2-1. The metering insert is made of anodized aluminum for corrosion resistance. The insert has three integral ribs which form two circular channels. An inflatable rubber collar is installed in the front channel. The purpose of the collar is to seal the metering insert in the pipe, when inflated, and force all the pipe's flow through the flow control section of the insert. The rear channel in the metering insert is provided to aid in properly aligning the insert in the pipe by providing a longer section.

An aluminum bubbler tube is permanently attached to the inside of the metering insert. The bubbler tube, which ends at the bottom center of the upstream face of the insert, is part of the system that allows the Flow Metering Insert to measure the pressure or head upstream from the insert. The metering insert has a handle section which is used to attach it to the right angle tube and the pole assembly, and also has two tubes. One tube connects the insert's rubber collar to the foot-powered air pump, allowing the collar to be inflated. The other tube is a bubble line connected to the flow meter or module.

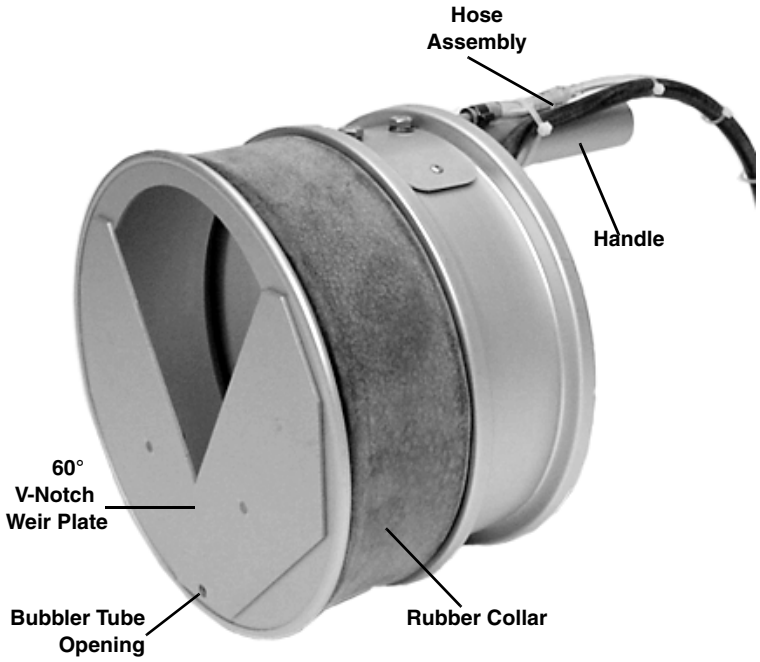


Figure 2-1 Flow Metering Insert

2.1.5 The 60° V-Notch Weir Plate

As shown in Figure 2-1, the metering insert is shipped from the factory with the removable V-notch flow control section installed. When the V-notch weir plate is removed, as shown in Figure 2-2, the round orifice flow control section that is an integral part of the metering insert may be seen. The diameter of the opening is approximately 60% of the pipe diameter. To remove the V-notch weir plate, loosen the two captive wing nuts on the back side of the weir plate (inside the metering insert). Then, pull the weir plate up and out of the metering insert. Note that the removable weir plate has a hole near the bottom that slips over the metering insert's bubbler tube, and two small studs on its rear side that hold the V-notch orifice in the insert. The hole and studs properly align the weir plate on the insert.

Figure 2-2 Metering Insert Round Orifice

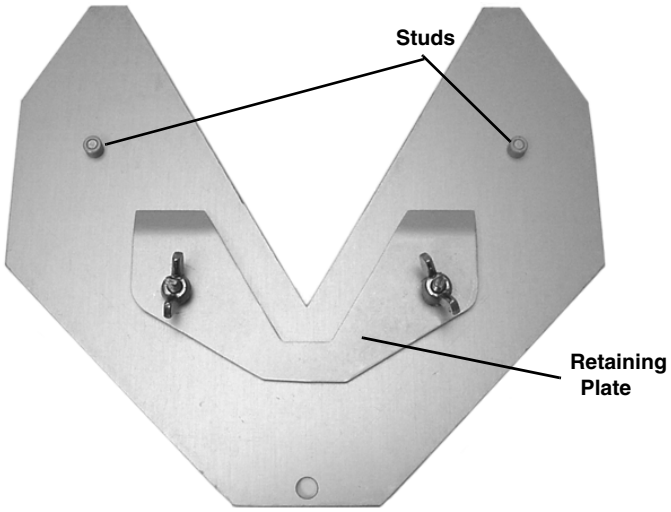


Figure 2-3 Back of 60° V-Notch Weir Plate

To attach the V-notch weir plate to the metering insert, completely loosen the two wing nuts. Then, line up the hole in the bottom of the V-notch weir plate above the bubbler tube on the front of the metering insert and below the bottom of the orifice. Reach through the insert, and grasp the retaining plate on the back of the weir plate.

At the same time, slip the retaining plate over the back of the round orifice plate in the metering insert, and slide the weir plate down along the face of the orifice towards the bubbler tube. Then, slip the hole in the weir plate over the insert's bubbler tube, being sure that the studs on the back of the weir plate fall inside the orifice opening. Finally, holding the weir plate in place, tighten the two wing nuts, locking the V-notch weir plate in place by pressing the retaining plate down on the orifice plate of the insert.

Figure 2-4 Weir Plate, Installed

2.2 Calibration of the Flow Meter

It may be necessary to calibrate the flow meter used with the insert before the insert is installed. The reason is that neither the bubble rate nor the zero level can readily be set, viewed, or adjusted accurately once the insert is installed in a sewer. The Model 730 Bubbler Module is non-adjustable, as it has a built-in fixed orifice.

2.2.1 Setting the Bubble Rate (Model 4230 only)

Refer to the appropriate flow meter manual for bubble rate adjustment information. Set the insert upright in a large pan of water deep enough to cover the bubble line outlet on the insert by a couple of inches. Adjust the bubble rate for one to two bubbles per second. As stated previously, there is no adjustment for the Model 730 Bubbler Module.

2.2.2 Setting the Zero Level Offset

Like the bubble rate, the flow meter zero level must be set before the insert is installed, because there will already be some level inside the sewer. After the bubble rate is set as described previously, remove the insert from the container of water. Using the PURGE button on the flow meter, blow out any water which might be inside the bubble line. Be sure all water is removed. This is important, as any water remaining inside the bubble line will affect the accuracy of the zero setting. If necessary, shake the flow metering insert vigorously to remove all traces of water. Do not attempt to set the zero point before setting the bubble rate; the bubble rate affects the zero level and must be set first. When the line is dry and the insert is sitting in open air, adjust the level reading on the flow meter's display to zero; this can be done by going to the ADJUST LEVEL step in the flow meter's program and using the number or the arrow keys on the flow meter's keypad. If necessary, refer to the flow meter's manual.

2.2.3 Programming the Flow Meter

Programming differs between the flow meter and the Model 730 Bubbler Module. Refer to the appropriate manual for the flow meter/module you are using for information on programming for the flow metering inserts.

2.3 Field Assembly

After the metering insert and flow control section have been selected, the next step is to assemble the various pieces, which are disassembled for convenience of storage and transportation. This consists of putting together the multi-section pole and the right-angle tube; attaching the metering insert to the right-angle tube and attaching the air pump to the multi-section pole assembly.

2.3.1 Multi-Section Pole Assembly

The main structure of the Flow Metering Insert for reaching down into the manhole is the multi-section pole assembly. The pole assembly consists of six 2½-foot regular pole sections. One or more of the regular pole sections may be connected together to form a pole assembly ranging in length from 2½ feet (one regular section) to 15 feet (six regular sections). The regular sections consist of a 1⅛" diameter anodized aluminum pole, with a black plastic union permanently attached to the top end and a stainless steel snap button near the bottom end. The regular sections have an actual overall length of 32¼" and an effective length of 29½". The pole assembly is multi-sectioned to allow it to be broken down into small sections for storage and transport and to allow its length to be easily adjusted to match the manhole depth.

2.3.2 Assembling the Pole

The first step in putting together the Flow Metering Inserts is to assemble the multi-section pole to the correct length for the depth of the manhole. The pole should be assembled with a total length somewhat greater than the distance from the top of the manhole to the bottom of the invert.

The sections of the pole assembly are attached to each other by stainless steel snaps that pop into mating holes in the matching section, similar to some vacuum cleaner attachments. To join two

sections, press in on the snap, slide the smaller diameter section into the larger section such that the snap is aligned with the mating hole, and push the smaller section in until the snap pops into the hole, securing it in place. The sections are disassembled by pressing in on the snap and pulling the sections apart. Add pole sections this way until the necessary overall pole length is reached.

2.3.3 Assembling the Right-Angle Tube

The right-angle tube (Figure 2-5) is made up of three separate pieces which must be put together. One piece (the lower riser pole) contains a sharp bend of 73°; this is the bottom section of the right-angle tube. The end closest to the bend will be snapped to the flow insert. The short, straight sleeve connects the 73° section to the other section with a bend. Push the two angled pieces into the sleeve until they lock. The other angled section (17°, the upper riser pole) should be inserted so that the end closest to the angle is farthest from the sleeve.

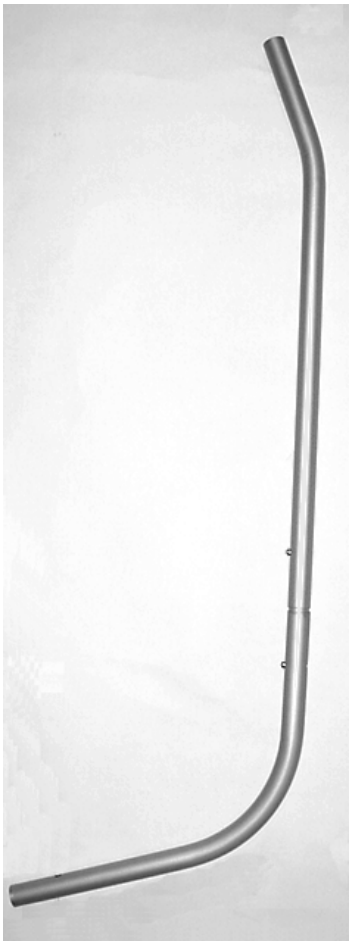


Figure 2-5 Right-Angle Tube, Assembled

2.3.4 Attaching the Flow Metering Insert

After the pole has been assembled, the next step is to attach the metering insert to the pole assembly using the right angle tube. Normally, the right angle tube is then attached to the bottom of the pole assembly in the position shown in Figure 2-5. To achieve the placement shown in the illustration, the 17° angle end of the tube should be attached to the pole assembly.

This places the front face of the metering insert approximately 2½ feet from the center line of the pole; this has been found to be the preferred alignment for many manhole situations. However, the tube is designed so that it is reversible, and may be turned in the opposite direction. This alignment may be helpful in certain unusual or difficult manhole configurations. When the tube is reversed, the distance from the front face of the insert to the center line of the pole is approximately 4⅓ feet.

2.3.5 Attaching the Insert to the Tube

After the right angle tube has been attached to the pole assembly, the metering insert should be attached to the end of the right angle tube, with the body of the insert hanging down, as shown in Figure 2-6.

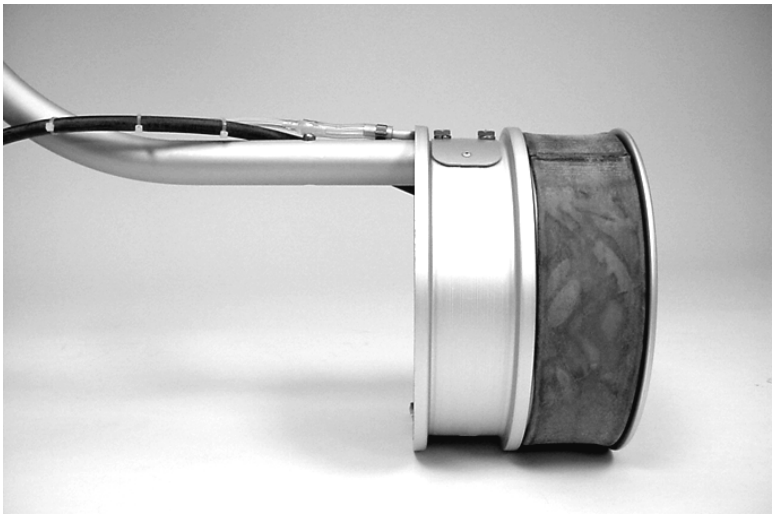


Figure 2-6 Insert Attached to Right-Angle Tube

2.3.6 Attaching the Hose Assembly

The inflation/bubbler hose assembly is already attached to the metering insert. The 7/16" OD black butyl rubber inflation hose connects to the foot-powered air pump and the ¼" OD clear plastic bubbler hose connects to the bubble line fitting on the flow meter. This hose assembly is 20 feet long. Secure the hose assembly to the foot-powered air pump by attaching the valve stem on the inflation hose to the chuck on the air pump. In shallow manholes, there will be extra footage of hose. Any excess hose may be coiled near the top of the pole. It should not be allowed to dangle loosely in the flow stream or hang lower than the top of the insert.

2.4 Insertion Into the Manhole and Pipe

After the various pieces of the Flow Metering Insert have been assembled in the field, the next step is to lower it into the manhole and secure it in the upstream sewer pipe. As a general rule, the Flow Metering Inserts may be used in manholes up to 16 feet deep. At this depth, with all six regular pole sections being used, the sixth section will be slightly above ground level. The Flow Metering Inserts may also be used in shallow manholes.

⚠ DANGER

HAZARD of ELECTROCUTION! Contacting overhead electric power lines will cause severe injury or death. Keep the pole away from any overhead lines.
You can be killed instantly if this product comes in contact with overhead power lines. Look up and check overhead for the presence of any utility wires before raising the pole assembly upright. If there is any chance of touching a wire, stop!

Take the pole assembly apart. Snap on one section and lower the insert into the manhole. Then add extra pole sections, one at a time, until the bottom of the manhole is reached. When removing the insert, lift the pole just enough to snap off the top pole section; then remove the other sections one at a time until the insert can be lifted from the manhole.

2.4.1 Checking the Length

Before putting the insert into the manhole, the overall length of the unit should be checked to be sure that it is about right for the depth of the manhole. In general, it is recommended that the top of the pole assembly be about waist- to chest-high, when the metering insert is installed in the sewer. If the length is not correct, add or remove pole sections as necessary.

2.4.2 Installation in the Manhole

After the length of the pole assembly has been checked, the flow insert should be lowered into the manhole, as shown in Figure 2-7, with the user at street level. Note that it may be necessary to tilt the unit to get the metering insert and right angle tube through the manhole opening, as shown.

Figure 2-7 Lowering the Insert Into the Manhole

Figure 2-8 Insert Lowered to Bottom of Manhole

2.4.3 Installation in the Pipe

Lower the unit down toward the invert of the pipe in the bottom of the manhole until the metering insert is resting in the pipe. If the length of the multi-section pole assembly is not correct, the unit should be pulled out of the manhole at this time, and the length adjusted as necessary. The metering insert should be facing **into the flow** coming out of the entrance (upstream) pipe of the manhole, as shown. Then, slide the metering insert into the entrance pipe, as shown in Figure 2-9.

The metering insert should be completely slid into the pipe so that the back end of the insert is totally surrounded by a full section of the pipe; this is to provide maximum natural centering of the insert in the pipe. Depending on conditions in the manhole and pipe (for example, a high flow, an oval or undersized pipe, etc.), sliding the metering insert into the pipe may be difficult. In such cases, rock the insert from side-to-side or top-to-bottom, while also pushing the insert into the pipe.

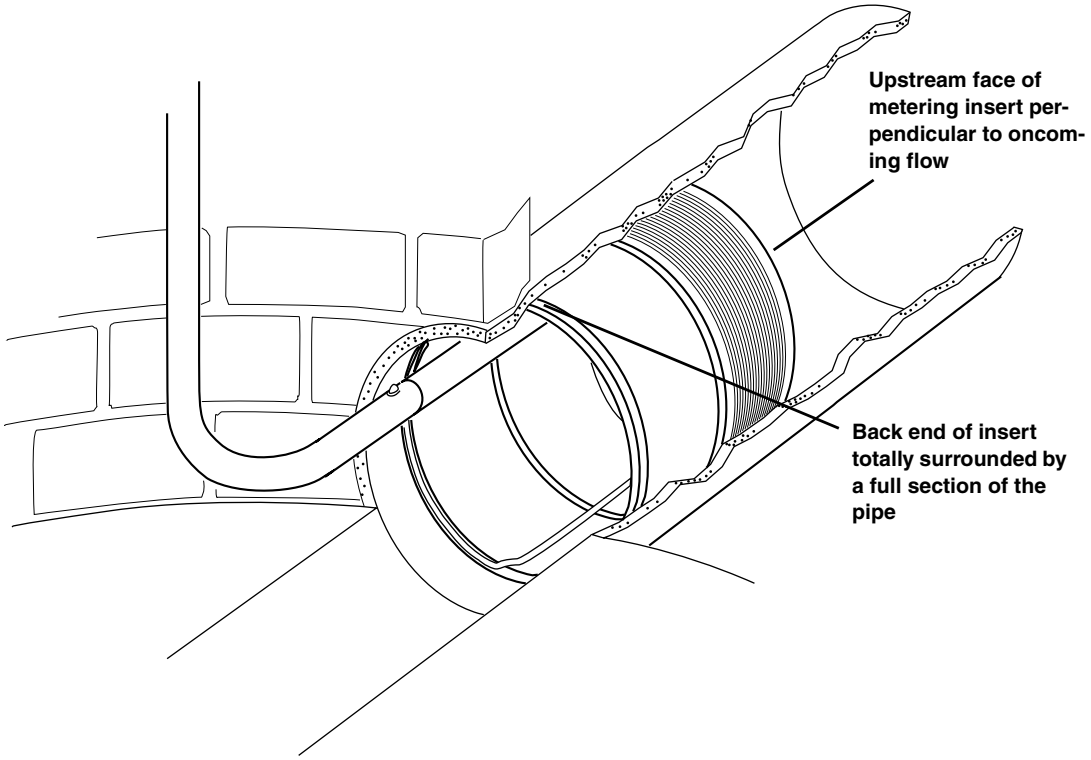


Figure 2-9 Insert Installed in Sewer Pipe

2.4.4 Inflating the Rubber Collar

Secure the metering insert in place by inflating its rubber collar. The foot-powered air pump is used to inflate the insert's rubber collar.

Figure 2-10 Metering Insert With Collar Inflated

The pressure in the collar can be monitored on the pressure gauge attached to the pump. The smaller inserts (6" and 8") should be inflated to a pressure of 15 to 20 psi while the larger inserts (10" and 12") should be inflated to a pressure of 10 to 15 psi. This should secure the metering insert in place in the pipe and seal it, channeling all the flow through the flow control section. If the flow inserts are to be installed for an extended period of time, the collars should be inflated to pressures approaching the higher end of the ranges given (15 and 20 psi.)

☑ Note

When inflating the rubber collar, make sure the pole is centered over the pipe or invert at the bottom of the manhole as close to straight up-and-down as possible. This will help the flow metering insert line up correctly inside the pipe, which is necessary for the readings to be accurate and to ensure a good seal.

Install the insert as carefully as possible because you cannot readily check or view the vertical alignment after installation. The center line of the V-notch weir or round opening should be straight up-and-down and the upstream face of the metering insert should be perpendicular to the oncoming flow.

2.4.5 Monitor the Pressure

If the flow insert will be left in the sewer for an extended period of time, the pressure in the collar should be checked periodically to make sure it is not leaking. Deflation will cause the insert to leak and become dislodged in the flow stream. If the pressure falls slowly, the connectors or the valve stem may be leaking. If this is not the case, check the tubes and the connections between the tubes and flow insert. If the insert has been used before and the pressure drop is fairly rapid, remove the insert and inspect the collar for punctures. It is a good idea to check the pressure in the collar again later in the same day or the next day. Thereafter, it is usually sufficient to check the pressure only when the battery on the flow meter is changed.

If the air pump has been disconnected from the hoses, there will be a slight loss of pressure each time the pump is re-connected to the air hose; this is normal as long as it does not exceed a pound or so. Eventually, the collar may have to be reinflated.

2.4.6 Problems

Although the outside diameters of the metering inserts are approximately 90% of the pipe inside diameters, there may be cases where the insert may not be successfully lowered into the pipe invert or slid into the entrance pipe. Typically, these problems are encountered with inverts where the top half of the pipe was not completely removed or the entrance is partially blocked by solid debris. There may be extra concrete left from construction extending out over the entrance pipe. If these conditions are found, the best solution is to enter the manhole (following proper safety procedures) and take necessary measures to open up the pipe invert or remove the entrance pipe blockage.

⚠ DANGER

Do not enter the manhole without observing proper safety precautions. Do not enter the manhole if you are working alone. Toxic fumes present in the sewer may *kill* you. Read Appendix A Safety Considerations. Also, you should be familiar with and observe OSHA regulations governing work in confined spaces.

Another possible solution, recommended **only** for spot-check flows, is to use the next size smaller metering insert. Sometimes the insert may be inflated enough to seal under these conditions. However, this will reduce the maximum flow which may be measured and may weaken or damage the insert's collar. If the next smaller size insert is used, inflate the collar with the lowest pressure necessary to seal the metering insert in place. Pressures less than 10 psi would be recommended to avoid possibly bursting the collar. Extra care should be given to the proper positioning of the metering insert to minimize loss of accuracy in the flow readings.

2.5 Measuring the Flow Rate

After the metering insert has been installed in the entrance pipe of the manhole, the next step is to actually measure the flow rate in the pipe.

2.5.1 Accuracy

The accuracy of the flow rate measurement for the Flow Metering Inserts is as specified in Table 1-1. Note that these specifications apply *only to the inserts* and characterize pipes with slopes of $2\frac{1}{2}$ % and less. If the pipe in which the flow is being measured has a slope greater than this, a correction to the reading obtained should be applied to get the most accurate flow rate measurement. The accuracy specification for the Model 4230 Flow Meter will be found in the flow meter's manual.

2.6 Removal and Disassembly

After the desired flow rate readings in the pipe have been obtained, the Flow Metering Insert may be removed from the pipe and manhole, and disassembled for transportation. The first step in this process is to disconnect the bubble line from the flow meter.

2.6.1 Deflating the Rubber Collar

Depress the valve stem inside the threaded metal fitting on the end of the inflation hose. This will release the pressure from the inflatable rubber collar around the metering insert, freeing the insert from the pipe. The metering insert may then be pulled out of the pipe into the invert in the manhole and the entire unit pulled up and out of the manhole.

⚠ DANGER

HAZARD of ELECTROCUTION! Contacting electric power lines will cause severe injury or death. Keep the pole away from power lines.

Release the insert from the sewer and lift the pole **slowly** from the manhole. Disconnect the pole sections one at a time as the pole is drawn out of the manhole. This will reduce the possibility of touching any overhead utility wires.

2.6.2 Inspection of Metering Insert

As the unit is being removed from the manhole, it is good practice to inspect the metering insert for the presence of any significant obstructions or debris which may have caught and stuck on it. If there are any, the accuracy of the flow readings would be doubtful and should be rechecked.

2.6.3 Disassembly

After the insert has been removed from the manhole, it may be disassembled for transportation and storage. Typically, this involves removing the metering insert and the right-angle tube, then disassembling the pole assembly and right-angle tube.

2.6.4 Field Cleaning

It may be desirable to wash the metering insert and right angle tube immediately after use. A container of water may be used to accomplish this by simply pouring a quantity of water over the metering insert and right angle tube. Some users have found that metering inserts may be conveniently transported from site to site enclosed in a large plastic bag.

⚠ CAUTION

Before any equipment is installed, the proper safety precautions must be taken. The discussions of safety procedures in Appendix A are only general guidelines. Each situation in which you install a flow metering insert varies. You must take into account the individual characteristics of your installation. Additional safety considerations, other than those discussed in this manual, may be required.

Flow Metering Inserts

Section 3 Maintenance and Repairs

The following section describes basic care of the Flow Metering Inserts. Included are cleaning and routine maintenance procedures to keep the unit in top operating condition, and some general repair procedures. Also included is a table of replacement parts.

3.1 Cleaning and Routine Maintenance

The metering insert and right angle tube (the parts of the Flow Metering Insert actually in the flow stream) should probably be washed after each use. At a minimum, the entire lower section of the Flow Metering Insert should be thoroughly cleaned at the end of each use. This may be done best by using a hose and brush. The V-notch weir plates should be removed from any of the metering inserts that were used, the inserts and weir plates washed and dried, and then reassembled.

3.1.1 Inspecting and Cleaning the Hose Assembly

Periodically, the inflation/bubbler hose assembly should be inspected for cuts or the presence of contamination or moisture. The bubble line may be cleaned by forcing water through it, followed by pressurized air to dry it. **Be sure to dry it completely after such a procedure.** Water left in the bubble line will cause the flow meter readings to be inaccurate. A replacement hose assembly is available; see Appendix B Replacement Parts List for the Isco part number.

3.2 Repair Procedures

The only normal repair procedure for the Flow Metering Inserts (besides replacing damaged metal components, hoses, and connectors) concerns the replacement of the insert's inflatable rubber collar. The collar is made of heavy gauge, tough butyl rubber, and is generally designed to withstand the rough environment of a sewer. However, over-inflation or sharp edges inside the manhole or around the outfall may puncture the collar.

3.2.1 Replacing the Rubber Collar

Replacement inflatable collars and clamps are available from Teledyne Isco. Refer to Appendix B Replacement Parts List for the appropriate part numbers. The collars are listed as Flow Meter Seals in the Replacement Parts List.

The collar may be replaced as follows: First, remove the weir plate from the front of the metering insert to provide freer access to the inside of the insert. Then, loosen the swivel-nut from the metal stem (a pair of pliers may be necessary).

Next, peel the collar off the insert, starting opposite the stem. To install the new collar, first feed the stem through the hole in the insert, with the stem facing the end with the handle. Then, roll the collar onto the metering insert. Next, secure the swivel-nut to

the stem. Apply a coating of pipe sealant to the second and third threads on the stem and hand-tighten. Finally, test for air leakage between the stem and the inflation hose by filling the collar with several pounds of air pressure. This may be done either by holding the inflated collar under water and looking for bubbles around the stem joint, or brushing a soapy water solution on the joint and looking for bubbles.

Figure 3-1 Removing the Metering Insert's Rubber Collar

Flow Metering Inserts

Appendix A General Safety Considerations

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

A.1 Hazards

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

1. Adverse Atmosphere
   The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. Forced ventilation may be necessary.
2. 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.
3. Traffic
   Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.
4. Falling Object
   Items placed near the manhole opening may fall and injure a worker in the manhole.
5. Sharp Edges
   Sharp edges of items in or near a manhole may cause cuts and bruises.
6. Lifting Injuries
   Unless proper tools are used to remove manhole covers, back injuries or injuries to hands and feet may result.

A.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.

A.3 Adverse Atmospheres

Refer to Table A-1. Before entering a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Since combustible or toxic vapors may be heavier than air, the tests on the atmosphere must be run at least 3/4of 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.

A.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 are 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 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 second 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.

A.5 Traffic Protection

In addition to traffic cones, markers, warning signs, and barricades, a vehicle or heavy piece of equipment should be place 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.

A.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.

A.7 Removing the Covers

Manhole covers should be removed with a properly designed hook. Use of a pick axe, 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 two inch projection should be inserted into one of the holes of the cover, the handle grasped with both hands, and the cover lifted by straightening the legs, which have been slightly bent at the knees.

A.8 Other Precautions

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

- Wear a hard hat.
- Wear coveralls or removable outer garment which can readily be removed when the work is completed.
- Wear boots or non-sparking 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.

A.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.

A.10 Field Equipment

The following equipment must be available for use:

- Blowers
- Breathing Apparatus
- Coveralls
- First Aid Kits
- Emergency Flashers
- Flashlights
- Mirrors
- Gas Detectors
- Gas Masks
- Gloves
- Hard Hats
- Harnesses
- Manhole Irons
- Pick Axes
- Rain Slickers
- Ropes
- Safety Vests
- Traffic Cones
- Waders

A.11 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. 2100 m), where the partial pressure of oxygen is equal to 16.2 percent (a normal atmosphere is about 21 percent) 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 percent of a normal atmosphere. At the top of Mt. Whitney, oxygen is equal to 12.2 percent. 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 percent.

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, 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. Wastewater containing 2 mg/l 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 the 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."

Table A-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
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

Table A-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 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
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.

Table A-1 Hazardous Gases (Continued)

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.
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.

Flow Metering Inserts

Appendix B Replacement Parts List

B.1 Replacement Parts List

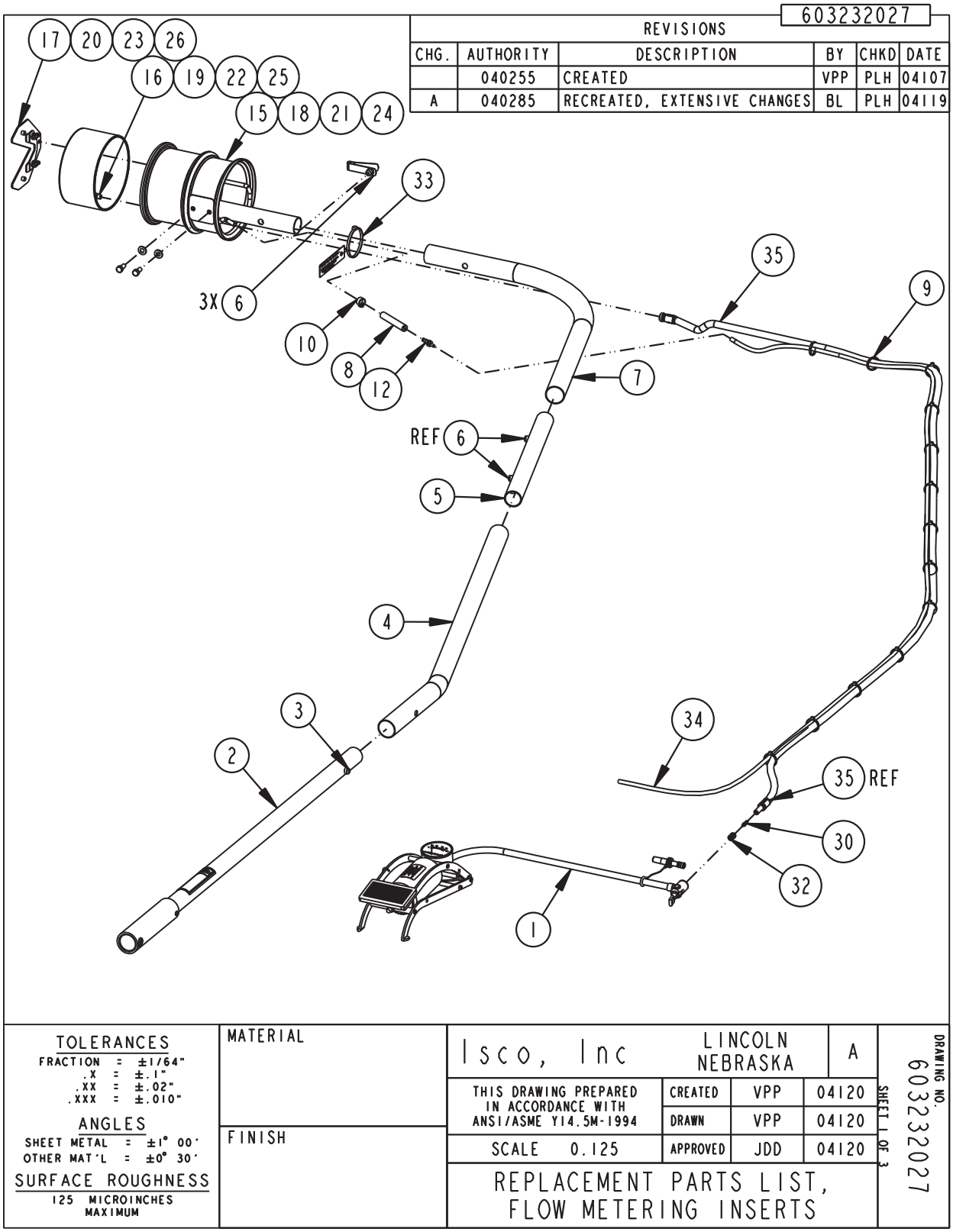
A list of common replacement parts for the Flow Metering Inserts can be found on the following pages. When ordering a replacement part, be sure to include the Isco assembly or part number and a complete description of the Flow Metering Insert on which the part is to be used.

Replacement parts can be ordered 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:IscoInfo@teledyne.com


603232027
REVISIONS
CHG. | AUTHORITY | DESCRIPTION | BY | CHKD | DATE
040255 | CREATED | VPP | PLH | 04107
A | 040285 | RECREATED, EXTENSIVE CHANGES | BL | PLH | 04119
17 20 23 26
16 19 22 25
15 18 21 24
33
3X 6
10
8
12
35
9
7
REF 6
5
4
3
2
1
34
35 REF
30
32
TOLERANCES
FRACTION = ±1/64"
.X = ±.1"
.XX = ±.02"
.XXX = ±.010"
ANGLES
SHEET METAL = ±1° 00'
OTHER MAT'L = ±0° 30'
SURFACE ROUGHNESS
125 MICROINCHES MAXIMUM
MATERIAL
FINISH
Isco, Inc
LINCOLN NEBRASKA
A
THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1994
CREATED VPP 04120
DRAWN VPP 04120
APPROVED JDD 04120
SCALE 0.125
REPLACEMENT PARTS LIST, FLOW METERING INSERTS
DRAWING NO. 603232027
SHEET 1 OF 3

603232027

REPLACEMENT PARTS LIST

SHEET: 2 OF 3

Isco, Inc.

REV: A | DATE: 04119

ITEM NO.	PART NUMBER	DESCRIPTION
1	602814058	AIR PUMP ASSEMBLY
2	602814046	POLE SECTION ASSEMBLY
3	603004114	SNAP SECTION ASSEMBLY
4	612823099	UPPER RISER POLE, CLEAR ANODIZED
5	602814011	TUBING SLEEVE ASSEMBLY
6	239100001	SNAP BUTTON FASTENER, SINGLE BUTTON
7	612813101	LOWER RISER POLE, CLEAR ANODIZED
8	602813083	BUBBLER TUBE EXTENSION
9	489010100	CABLE TIE, 0.87 MAX BUNDLE
10	489001500	HOSE CLAMP, 7/16 DIAMETER, STEEL
11		
12	209016677	REDUCER, 3/16 TO 1/8
13		
14		
15	612814018	HOUSING SUB-ASSEMBLY, 6"
16	602813051	SEAL,4.6" ID FOR 6" INSERT
17	602814017	V-NOTCH WEIR ASSEMBLY, 6"
18	612814022	HOUSING SUB-ASSEMBLY, 8"
19	602813052	SEAL, 6.3" ID FOR 8" INSERT
20	602814021	V-NOTCH WEIR ASSEMBLY, 8"
21	612814026	HOUSING SUB-ASSEMBLY, 10"
22	602813053	SEAL, 7.8" ID FOR 10" INSERT
23	602814025	V-NOTCH WEIR ASSEMBLY, 10"
24	612814030	HOUSING SUB-ASSEMBLY, 12"
25	602813054	SEAL, 9.5" ID FOR 12" INSERT
26	602814029	V-NOTCH WEIR ASSEMBLY, 12"

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

603232027

REPLACEMENT PARTS LIST

SHEET: 3 OF 3

Isco, Inc.

REV: A | DATE: 04119

ITEM NO.	PART NUMBER	DESCRIPTION
27		
28		
29		
30	209009607	VALVE CORE
31		
32	209009608	VALVE CAP
33	489010500	CABLE TIE, 2.0 MAX BUNDLE
34	6032330 61	BUBBLE TUBE, VINYL, 1/8" ID X 20'
35	603234030	HOSE INSERT ASSEMBLY, 20'

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.

Teledyne Isco One Year Limited Warranty*

Factory Service for Teledyne Isco Flow Meters, Waste Water Samplers, and Syringe Pumps

This warranty exclusively covers Teledyne Isco instruments, providing a one-year limited warranty covering parts and labor.

Any instrument that fails during the warranty period due to faulty parts or workmanship will be repaired at the factory at no charge to the customer. Teledyne Isco's exclusive liability is limited to repair or replacement of defective instruments. Teledyne Isco is not liable for consequential damages.

Teledyne Isco will pay surface transportation charges both ways within the 48 contiguous United States if the instrument proves to be defective within 30 days of shipment. Throughout the remainder of the warranty period, the customer will pay to return the instrument to Teledyne Isco, and Teledyne isco will pay surface transportation to return the repaired instrument to the customer. Teledyne Isco will not pay air freight or customer's packing and crating charges. This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

The warranty for any instrument is the one in effect on date of shipment. The warranty period begins on the shipping date, unless Teledyne Isco agrees in writing to a different date.

Excluded from this warranty are normal wear; expendable items such as charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts of valves; and damage due to corrosion, misuse, accident, or lack of proper maintenance. This warranty does not cover products not sold under the Teledyne Isco trademark or for which any other warranty is specifically stated.

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

This warranty is expressly in lieu of all other warranties and obligations and Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

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. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

Before returning any instrument for repair, please call, fax, or e-mail the Teledyne Isco Service Department for instructions. Many problems can often be diagnosed and corrected over the phone, or by e-mail, without returning the instrument to the factory.

Instruments needing factory repair should be packed carefully, and shipped to the attention of the service department. Small, non-fragile items can be sent by insured parcel post. **PLEASE BE SURE TO ENCLOSE A NOTE EXPLAINING THE PROBLEM.**

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:	Repair service: (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

March 8, 2011 P/N 60-1002-040 Rev E

TELEDYNE ISCO
A Teledyne Technologies Company