Truckee Meadows Regional Storm Water Quality Management Program

SAMPLE ANALYSIS PLAN

October 1, 2010

The Truckee Meadows Regional Storm Water Quality Management Program is a comprehensive program comprised of efforts by local governments and private citizens to reduce the pollution associated with urban runoff in the Truckee Meadows. This program is required by the National Pollutant Discharge Elimination System (NPDES) permit issued jointly to the Cities of Reno and Sparks, and Washoe County, on May 26, 2010. The Truckee Meadows Interlocal Storm Water Committee (the Truckee Meadows Watershed Committee) developed the program through a series of public workshops. The program includes the following required program elements:

Intergovernmental Coordination
Public Outreach Municipal Operations
Storm water Monitoring Program
Land Use Planning
Structural Controls
Construction Site Discharge
Illicit Discharge Detection and Elimination

The **SAMPLE ANALYSIS PLAN** is part of the program element associated with the *Storm Water Monitoring Program.*

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I. Storm Water Discharge Monitoring Program

The data collected from the Truckee Meadows Storm Water Monitoring Program may be used to assess the effectiveness of nonstructural and structural BMPs. Many years of baseline data has been collected on first and second order tributaries to the Truckee River by the Nevada Division of Environmental Protection (NDEP), Desert Research Institute (DRI), Truckee Meadows Wastewater Reclamation Facility (TMWRF) and Washoe County. The data will be used for the measurable goals of the Truckee Meadows Regional Storm Water Quality Management Program.

II. Monitoring Locations

The Storm Water Monitoring Subcommittee selected 12 fixed sites on six tributaries to the Truckee River. The six tributaries are: Steamboat Creek, Whites Creek, Thomas Creek, Alum Creek, Chalk Creek, and the North Truckee Drain. Our goal for storm water monitoring has been to establishing an understanding of nonpoint source pollution entering waterways from urbanized areas, by bracketing developing areas with our samples. We ideally collect one sample upstream of urban development and one downstream or within urban development to identify impairments resulting from urbanization.

There are a couple of exceptions to the goal of bracketing urbanization. Chalk Creek is one case, as this is an ephemeral stream which has transitioned to perennial flows in its lower reaches. The area above and partially downstream through development remains ephemeral in nature and does not allow for an upstream sample during our periodic sampling intervals. There is, however, an existing fixed sampling weir downstream of development on Chalk Creek which will be utilized to characterize loading to the Truckee River. Steamboat Creek is the second exception, with three sampling points. In order to differentiate inputs to Steamboat Creek over its entire length, a third sampling location at "the narrows" has been added. Geothermal activity in the Steamboat Creek watershed has impacted water quality, and is compounded by historical mining activities. These sites were selected on the basis of existing data, the need for additional data, representativeness of the entire watershed, and proximity to existing stream flow gage equipment. Table 1 lists tributaries, sampling locations, and the method for collecting stream flow data.

Table 1. Tributary Sampling Locations and Flow Collection Method

Tributary	Sampling Location	Upstream/ Downstream	Gage?	Flow Measurement	Owner	Future
Steamboat Creek	@ Rhodes	Upstream	Yes	USGS/Real Time	TRFP	
	@ Narrows	Midstream	Yes	USGS/ Real Time	USGS	
	@ Clean Water Way	Downstream	Yes	USGS/ Read Onsite	WCDWR/ TMWA	
Whites Creek	@ Timberline	Upstream	Yes	Real Time	Washoe County	

	@ Old Virginia	Downstream	No	Manual		
Thomas Creek	@ Timberline	Upstream	No	Manual		TRFP future install: gage
Thomas Creek	@ S. Meadows	Downstream	No	Manual	Washoe County	
N. Truckee Drain	@ Orr Ditch	Upstream	Yes	USGS/ Real Time	TRFP	
	@ Kleppe	Downstream	Yes	USGS/ Read Onsite	Sparks	To abandon and move site for TRFP project - 2010/11
Chalk Creek	@ Chalk Bluff	Downstream	No	Weir	Reno	
Alum Creek	@ Steamboat Ditch	Upstream	No	Manual		
	@ Truckee River	Downstream	Yes	Weir or Manual	UNR	

III. Monitoring Frequency

The Storm Water Subcommittee will collect samples from the six tributaries on a semi-annual basis; once during the wet season near high flow (December thru May) and once during the dry season (June through November). One of the six tributaries is sampled for one full year during storm events, with a maximum of four sampling events representing two wet season storms and two dry season storms, if possible. The tributary selected for storm water sampling events is identified in the Annual Report by the Truckee Meadows Watershed Committee.

IV. Procedures and Protocols for Collecting Samples

The method of sampling is the 'grab sample method.' During each grab sample the flows must be recorded either by reading the existing staff gage, measuring with a calibrated pressure transducer on a handheld instrument, or by measuring the in stream flows with a USGS certified current meter. The stream flow information is used to calculate the mass loading of pollutants within the stream. Comparisons between mass loading and the analyzed milligrams per liter (mg/L) are used to evaluate the relationship between the stream flow and the water-quality characteristics. The grab sample method was chosen for the semi-annual sampling since these samples are taken from the stream during periods of consistent flows. The samples are taken from the main flow of the streams where the water is well mixed and homogenous. The person collecting the sample is responsible for rinsing the sample bottle and cap with stream water three times prior to collecting the sample. The person collecting the sample must be careful not to disturb the bottom sediments upstream of the sampling location. Any instream activity, such as equipment rinsing, should occur downstream of the sample collection area in order to prevent any sample contamination.

The total amount of sample needed for analysis is approximately one-half gallon. Each container is labeled with a waterproof marker identifying the location name, the date and the time of the sample. The sample is immediately put into a cooler filled with ice and must remain chilled until analysis is performed. All samples are transported to a State of Nevada Certified Laboratory ("laboratory" or "lab") for analysis.

The grab samples are used to assess the physical and chemical characteristics of the urbanized streams. All samples are analyzed for total dissolved solids (TDS), total nitrogen (TN), total phosphorous (TP), and Orthophosphorous (OP). These parameters were based on the Total Maximum Daily Loads (TMDL) defined by NDEP for the Truckee River. In addition to laboratory samples, field personnel will take note of the condition of the stream upstream and downstream of the sampling location (presence or absence of flow) and note the general characteristics of the sample water (appearance, odor, etc.). Below is a list of any additional analyses required for each location:

Alum Creek Upstream and Downstream: Total Suspended Solids (TSS).
Alum Creek Upstream and Downstream and Chalk Creek Downstream: May be sampled for sulfates, if budget allows.

All samples are to be analyzed at a State of Nevada Certified Laboratory and the Laboratory Services Manager shall be notified by the Designated Staff member of the sampling schedule two weeks in advance. Further confirmation should then be made 48 hours prior to delivery of samples to the lab. All samples should be collected during the week from Monday through Thursday as samples may not be accepted at the lab on Fridays.

Field measurements must be collected at the same time as the sample collection. The field measurements are collected with a YSI 600XLM or YSI 6920 Sonde. The Sondes are maintained by the staff, and each instrument is to be calibrated no more than one day before the scheduled day of sampling. The four field parameters that need to be calibrated for and measured at the time of sampling are:

- pH
- Specific Conductance
- Water Temperature
- Dissolved Oxygen

V. Procedures and Protocols for Storm Water Sampling during Storm Events

One stream will be sampled for storm events for one full year before moving sample locations to a different stream the following year. A maximum of four and minimum of two storm event should be sampled at the two designated locations on the selected stream within the calendar year. Up to two of the storm samples should be collected during wet season storm events (December through May) and up to two storm samples should be collected during the dry season storm events (June through November); with a minimum of one event sampled in each of the two seasons. The amount of precipitation from the storm event must generate enough runoff to raise the hydrograph of the stream. The

Designated Staff member will rely on the National Weather Service for up to date estimations of time and predictions of precipitation amounts for each storm. All precipitation data will be downloaded from the flood alert DIAD Advisor program after the actual storm event has occurred and samples have been collected. Storm water samples are to be taken to a State of Nevada Certified Laboratory for analysis.

The samples will be collected during the storm event using an ISCO model 3700 automated sampler. The automated sampler will be activated before the storm and will continue to collect samples throughout the first 24 hours of the storm event; with the option to increase sampling to 48 hours if necessary. The sampler is programmed to start sampling approximately 2-5 hours before each predicted storm event. The automated sampler is typically programmed to collect 250 milliliters every 15 minutes for a composite sample of 1000 milliliters in one hour. The sampler will continue to collect samples every 15 minutes for 24 composite samples over 24 hours. The first 24 hours of the storm will be divided into five composite samples reflecting major changes in the streams chemistry recorded by the streams hydrograph. If the option to operate the sampler for a full 48 hours is chosen, the ISCO sampler will be programmed accordingly.

The stream's hydrograph will be recorded during the storm event by the existing stream flow gage equipment if available. While deploying the ISCO sampler, a mobile transducer will be deployed to record the stream stage during the storm event. An initial stream gage height will be recorded before the storm and changes in gage heights will be measured during the entire length of the storm. The samples collected from the storm event will coincide with the changes in the gage heights related to the changes in flows. A maximum of five composite samples will be analyzed reflecting five major changes to the streams hydrograph. Based on the streams hydrograph, the hourly samples are combined together for a single composite sample. The first sample will be a composite sample representing the stream before the actual storm event. This sample represents the initial stream chemistry before the storm. The second composite sample will measure the first flush of nutrients and sediments to the streams system (rise in the hydrograph). The third composite sample will represent the maximum transport of sediments and nutrients associated with the maximum flows (peak in the hydrograph). The fourth composite sample will measure the lag travel time of nutrients from adjacent streams and drainages and their contribution to the main sample site (receding hydrograph). The final sample will be a composite sample representing the streams chemistry after the storm has passed and the stream has returned to the initial stream flow. If a "steady state" has not been achieved within the 24 hour sampling period, additional grab samples will be collected within the next 24 hours after completion of the storm.

The hourly composites are combined within a splitter that is pre-rinsed at least two times with the sample water representing the time associated with the hydrograph. Samples are then split into two 1/2 gallon plastic sample bottles that have been pre-rinsed twice with the sample. Samplers will be iced with ice cubes (water ice not blue ice) during the dry weather sampling period but not during the wet weather period. All of the samples will be directly transported to the lab and analyzed for the following constituents: All samples are analyzed for total dissolved solids (TDS), total nitrogen (TN), total phosphorus (TP),

and Orthophosphorous (OP). All sample bottles must be labeled using site names depicted in Appendix C. The labels must include the location of the sample, date and time related to hydrograph of the sample, nutrients being analyzed, and type of preservation. One 1/2 gallon bottle will be marked for TN and TP and is preserved with six drops of H_2S0_4 by the sampling staff when the samples are dropped off at the laboratory. The second 1/2 gallon bottle is left unpreserved and marked for analysis of TSS and TDS.

If upon analysis of the hydrograph during sample collection there is a question as to whether or not a storm occurred it will be requested of the Laboratory Services Manager that the samples be held for 24 hours before analysis. During this time period the Designated Staff member (of the Storm Water Monitoring Subcommittee) will contact the other Subcommittee members and come to a consensus as to whether or not enough precipitation occurred to change the hydrograph of the creek to warrant a sample. If it is decided that a storm did not create enough runoff for a representative sample, the Designated Staff member will contact the Laboratory Services Manager and request that the samples are not analyzed. If samplers are set out and there is no storm the Designated Staff member must notify the laboratory that no samples will be brought in for analysis.

After a successful sampling of a storm event, a dry period of 10 days must occur before another storm event may be sampled. The storms must generate enough precipitation to raise the hydrograph of the creek being sampled. Each year a new creek will be sampled until all six creeks have successfully been sampled for two storm events. All of the data that is collected from the sampling program must be tabulated for the annual report. The data collected from the storm events will be compared to the seasonal data for measurable goals associated with Best Management Practices (BMPs) enforced through the construction and industrial portions of the Truckee Meadows Storm Water Program.

Appendix A. Contact List of Designated Staff and Storm Water Monitoring Subcommittee Members as of October 10, 2010

Lynell Garfield	City of Reno Hydrologist, Subcommittee Coordinator
Sheldon Stone	City of Reno Environmental Control
Toby Ebens	City of Sparks Environmental Control
David Bruketta	City of Sparks - Truckee Meadows Water Reclamation Facility
Christian Kropf	Washoe County Dept of Water Resources
John Buzzone	Washoe County Dept of Water Resources

***A list of staff involved in sampling for storm water quality will be maintained and distributed to the Storm Water Committee and Monitoring Subcommittee. In case of staff changes, the Committee will be notified.**

Appendix B: Storm Water Sampling Location Map

STORMWATER MONITORING SAMPLING LOCATIONS

WATERSHED AREA (ACRES):

MOGUL CREEK – 3,446.28
WHITES CREEK – 10,266.3
THOMAS CREEK – 8,309.01
SOUTH EVANS CREEK – 6,560.65
ROBERTS CREEK, TOWER CREEK – 2,666.28
NORTH TRUCKEE DRAIN – 55,311.3
NORTH EVANS CREEK – 2,923.29
PEAVINE CREEK – 2,016.95
JONES CREEK – 2,657.74
HUNTER CREEK – 7,563.77
GALENA CREEK – 11,838.5
DRY CREEK – 11,859.4
DOG CREEK – 5,684.03
CHALK CREEK – 2,957.45
SUNRISE CREEK – 1,051.22
BROWNS CREEK – 2,721.9
ALUM CREEK – 2,425.93
STEAMBOAT CREEK – 156,052

NORTH TRUCKEE DRAIN
395
Orr
N Truckee Drain
NTD @ Orr Ditch
NORTH EVANS CREEK
PEAVINE CREEK
MOGUL CREEK
N MC CARRAN BLVD
Glendale
Oldengl
NTD @ Kleppe
CHALK CREEK
80
Chalk @ Chalk Bluff
Highland
TRUCKEE RIVER
Last Chance
Alum @ Truckee
Lake Ditch
Cochran
Pioneer
Steamboat @ Cleanwater
Alum @ Steamboat
ROBERTS CREEK/ TOWER CREEK
S MC CARRAN BLVD
ALUM CREEK
Steamboat @ Narrows
HUNTER CREEK
Thomas Cr @ South Meadows Parkway
DRY CREEK
SOUTH EVANS CREEK
Whites Cr @ Old Virginia
Steamboat
THOMAS CREEK
Thomas Cr @ Timberline
Whites Cr @ Timberline
341
431
WHITES CREEK
Steamboat Cr @ Rhodes
JONES CREEK
STEAMBOAT CREEK
GALENA CREEK
BROWNS CREEK

WCDWR TR SITES
Creeks
Ditches

0 0.5 1 2
Miles

Department of Water Resources
Engineering Division
Washoe County, Nevada
4930 Energy Way Reno, Nevada 89502 (775) 954-4600

Notes: The Scale and Configuration of all Information shown hereon are approximate only and are not intended as a guide for design or survey work. Reproduction is not permitted without prior written permission from the Washoe County Department of Water Resources.

DA_H:JHillman work/christian/watershed with DWRsites11_17.mxd

Appendix C. Sample Names Required for Labeling Bottles

Tributary	Sampling Location	Upstream/ Downstream	Sample Name
Steamboat Creek	@ Rhodes	Upstream	Steamboat @ Rhodes
	@ Narrows	Midstream	Steamboat @ Narrows
	@ Clean Water Way	Downstream	Steamboat at CWW
Whites Creek	@ Timberline	Upsteam	Whites @ Timberline
	@ Old Virginia	Downstream	Whites @ OVH
Thomas Creek	@ Timberline	Upsteam	Thomas @ Timberline
	@ S. Meadows	Downstream	Thomas @ SMP
N. Truckee Drain	@ Orr Ditch	Upstream	NTD @ Orr
	@ Kleppe	Downstream	NTD @ Kleppe
Chalk Creek	@ Chalk Bluff	Downstream	Chalk @ Chalk Bluff
Alum Creek	@ Steamboat	Upstream	Alum @ Steamboat
	@ Truckee R	Downstream	Alum @ Truckee

Appendix D: Chain of Custody for Samples Submitted to Laboratory

CHAIN OF CUSTODY

Truckee Meadows Water Reclamation Facility
8500 Cleanwater Way - Reno, NV 89502
Phone: (775) 861-4145 Fax: (775) 861-4101

TMWRF ID_____

Client Name: WCDWR

Address: 4930 ENERGY WAY City: RENO State: NV Zip: 89502

Report Attention: Christian Kropf Phone: 954-4654 email: ckropf@washoecounty.us

Sampled by: Christian Kropf Signature: [signature]

1/2

Date Sampled	Time Sampled	Sample Type [1]	Sample Identification	Preservative [2]	Number of Containers	Type of Container [3]	Turn Around Time	Analysis Requested: TN	TP	OP	TDS	Remarks
3/20/11	1000	1	STEAMBOAT @ CWW	6	1	P		X	X	X	X	
	1045		NTD @ OPR									
	1130		NTD @ KLEPPE									
	1200		THOMAS @ SMP									
	1300		WHITES @ OVH									
	1350		STEAMBOAT @ RHODES									
	1445		THOMAS @ TIMBERLINE									
	1550		WHITES @ TIMBERLINE									
	1630		CHALK @ CHALK BLUFF									

	Signature	Print Name	Company	Date	Time
Relinquished By:	[signature]	CHRISTIAN KROPF	WCDWR	3/20/11	1800
Received By:					
Relinquished By:					
Received By:					

Key: [1]Sample Type: 1=Aqueous, 2=Solid, 3=Other [2]Preservative: 1=NaOH, 2=NHO_3, 3=HCL, 4=H_2SO_4, 5=$Na_2S_2O_3$, 6=None, 7=Other [3]Type of Container: P=Plastic, G=Glass, V=VOA, O=Other

Additional Instructions / Information

11/29/2007

CHAIN OF CUSTODY

Truckee Meadows Water Reclamation Facility
8500 Cleanwater Way - Reno, NV 89502
Phone: (775) 861-4145 Fax: (775) 861-4101

TMWRF ID_____

Client Name: WCDWR

Address: 4930 ENERGY WAY | City: RENO | State: NV | Zip: 89503

Report Attention: CHRISTIAN KROPF | Phone: 954-4654 | email: ckropf@washoecounty.us

Sampled by: CHRISTIAN KROPF | Signature: [signature]

2/2

Date Sampled	Time Sampled	Sample Type [1]	Sample Identification	Preservative [2]	Number of Containers	Type of Container [3]	Turn Around Time	Analysis Requested: TN	TP	OP	TDS	TSS					Remarks
3/20/11	1700	1	ALUM @ STEAMBOAT	6	1	P		X	X	X	X	X					
↓	1730	↓	ALUM @ TRUCKEE	↓	↓	↓		X	X	X	X	X					

	Signature	Print Name	Company	Date	Time
Relinquished By:	[signature]	Christian Kropf	WCDWR	3/20/11	1800
Received By:					
Relinquished By:					
Received By:					

Key: [1]Sample Type: 1=Aqueous, 2=Solid, 3=Other [2]Preservative: 1=NaOH, 2=NHO_3, 3=HCL, 4=H_2SO_4, 5=$Na_2S_2O_3$, 6=None, 7=Other [3]Type of Container: P=Plastic, G=Glass, V=VOA, O=Other

Additional Instructions / Information

Appendix E: ISCO Autosampler Equipment Manual for Sample Collection

3700
Portable Sampler

This pocket guide is not intended to replace the instruction manual. Read the instruction manual thoroughly before operating the sampler.

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www.isco.com

Part #60-3703-149
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3700
Portable Sampler

Section 1
Setup Procedures

This section explains how to place the sampler into operation by preparing the base section, attaching the suction line, connecting a power source, installing the sampler at the site, placing the suction line inlet in the liquid source, and interfacing an external flow meter (if used).

1.1 Preparing the Base for Sequential Sampling

The sequential base section is supplied with 24 glass bottles (350-ml) or polypropylene bottles (1000-ml). Either glass or plastic bottles can be used, but glass and plastic bottles cannot be mixed in the same base section.

The stainless steel retaining ring for the glass bottles expands to hold the bottles against the inside wall of the base. Remove the retaining ring by squeezing the ring until it contracts; then lift the ring out of the base section.

The plastic retaining ring for the plastic bottles is held in place by three draw cords attached to the bottom of the base and hooked to the retaining ring. Detach the ring by disconnecting the draw cords from the hooks on the ring. Always use the ring when ice is used to cool the samples. Otherwise, the melt water will cause the plastic bottles to float and obstruct the distributor arm.

1.2 Attaching the Suction Line

The suction line is the piece of tubing extending from the pump tubing intake to the liquid source. There are three standard suction lines: vinyl tubing in $^1/_4$ inch (0.64 cm) or $^3/_8$ inch (0.94 cm) inside diameters, or FEP PTFE in $^3/_8$ inch inside diameter.

Vinyl suction line is attached to the pump tubing with the tube coupling. First, screw the threaded end into the suction line until the flat surface is flush against the suction line. Then, push the other end of the coupler into the end of the pump tube until the other flat surface is flush against the tubing.

The PTFE line is attached to the pump tubing by inserting the line into the pump tubing and securing it with a suitable clamp.

1.3 Placement of Suction Line and Intake

Route the line from sampler to sampling point so it is always sloped downhill. Avoid coiled

suction line which may hold residual liquid. This minimizes cross contamination. Be sure the vertical distance between the level of the liquid source and the pump is less than 26 feet. The pump will not deliver samples for heads greater than 26 feet.

The suction line tends to float in deep flow streams, dislodging the line and strainer. Table 1-1 shows the maximum depths you can submerge the lines and strainers without risks of flotation. At depths exceeding the safe depths, anchor the line and strainer securely.

The $^3/_8$ inch ID vinyl suction lines are shipped from the factory with our standard weighted polypropylene strainer installed on one end of the suction line and a tubing coupling on the other end.

Additionally, Teledyne Isco offers two low flow stainless steel strainers for $^1/_4$ inch ID and $^3/_8$ inch ID suction lines. For installation in PTFE suction line, heat the end of the suction line to make it more flexible, then carefully screw the strainer's threaded connector into the suction line.

Table 1-1 Safe Depths of Submersion for Suction Line

Strainer	Vinyl $^1/_4$" (6 mm)	Vinyl $^3/_8$" (9 mm)	PTFE $^3/_8$" (9 mm)
Standard Weighted Polypropylene	-------	22 feet (6.7 m)	15 feet (4.5 m)
Stainless Steel Low Flow	14 feet (4.3 m)	22 feet (6.7 m)	15 feet (4.5 m)
CPVC	-------	4 feet (1.2 m)	4 feet (1.2 m)

For sampling from highly acidic flow streams, a weighted plastic CPVC strainer is available.

1.4 Connecting to Power Source

The 3700 Sampler must be supplied with power from an AC Power Pack, an Isco Nickel Cadmium Battery Pack, an Isco lead-acid battery, or an external 12 VDC source such as an automotive or marine battery.

1.4.1 Mounting Isco Power Sources

Place the power source in the recess at the rear of the center section. Stretch the two black rubber draw catches up and into the "U" shaped receptacles on either side of the source. Attach the connector on the short cable of the power

source to the 12 VDC connector on the control box.

1.4.2 External 12 VDC Source

The 3700 Sampler can be powered with a 12 V automotive or marine battery. A cable terminating in battery clips connects the sampler to the battery. Plug the connector on the end of the external battery cable into the "12 VDC" connector on the control box. Connect the cable clips to the battery terminals. The positive lead of the cable is painted red and stamped with a plus sign.

1.5 Flow Meter Connection

For flow-proportional sampling, attach the flow-meter connect cable to the flow meter and to the 6-pin flow meter connector on the rear of the sampler.

If a cable is not attached to the flow-meter connector, keep the protective cap tightly screwed in place to keep the control box watertight.

1.6 Placing the Sampler into Operation

Install the sampler in a level position. It can be suspended during operation by the optional suspension harness. Start the sampling program with the Start Sampling key.

1.7 Restarting

The sampler may be started again by pressing the Start Sampling key. Reprogram the start time, if necessary.

1.8 Field Printer and Computer Connections

To collect data from the sampler, attach the field printer or interrogator cable to the sampler's 6-pin printer connector.

Both the field printer and the interrogator cable are compatible with Isco's 25-foot extension cable. If preferred, install the extension cable on the sampler's printer connector and route the cable to an alternate location.

⚠ CAUTION

If an interrogator cable is not attached to the printer connector on the sampler or the unattached end of the extension cable, keep the connector cap tightly screwed in place. This will prevent moisture damage to the connectors and to the control box.

1.9 Master/Slave Connections

If operating a pair of samplers configured for Master/slave operation, connect the samplers with the Master/Slave Interconnect Cable by attaching the cable to the flow-meter connector on both samplers. Configure both samplers for the master/slave mode in the Enable Pin configure option. Start master/slave sampling

by pressing Start Sampling on both machines. The samplers cannot reverse roles if both samplers are not in the run state. The first machine started becomes the master.

1.10 Recovering the Sampler

When recovering the sampler, keep it level to avoid spilling the collected samples. Cap the sample container(s) before transporting them. If the sampler is not to be returned to the office, install a base section with empty bottles and start the sampler again.

1.11 Conversion for Composite Sampling

To convert the 3700 Sampler for composite sampling:

1. Separate the center section from the rest of the sampler. Next, remove the pump tube. Disconnect the distributor arm.
2. Turn the center section over and install the float and float cage. Install the shaft on the "diving-bell" float in the hole in the distributor shaft. Attach the float cage to the center section with the four screws and 1-inch spacers provided with the float cage kit (Figure 1-1).

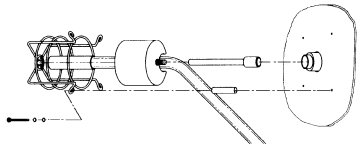


Figure 1-1 Float Cage Installation

3. Feed the 34.5-inch (88.5-cm) composite pump tube through the port in the center section, place it in the float cage tube guide, and install it in the pump.
4. Check the bottle number and size settings in the Bottles and Sizes configure option (Refer to Section 2). Set the bottle number to "1" and enter the appropriate bottle volume.

Note

Composite sampling routines can be programmed in both the basic and extended programming mode. To use nonuniform times or sampling stops and resumes in a composite sampling application, use the extended programming mode.

1.11.1 Standard base section

There are two sizes of composite containers: 2.5-gallon (9400-ml) glass or polyethylene and 4-gallon (15000-ml) polyethylene. The 2.5-gallon containers require the standard base section composite bottle locating deck. Prepare the standard base by placing the locating deck,

open side down, in the bottom of the base section. Then, place the sample container on the locating deck and re-assemble the sampler.

1.11.2 Optional Composite Base Section

The 4-gallon wide mouth composite bottle requires the composite base. No locating deck is required. Simply place the 4-gallon bottle in the composite base.

Note

When cooling composite samples with ice, melt water may cause the bottle to float when you remove the center section.

3700 Portable Sampler

Section 2 Programming

The sampler's programming process is self-prompting. Prompts displayed on the LCD step you through the program in a logical order, indicating the needed value or option. The sampler will reject any unacceptable settings. Settings can be changed at any time. If the sampler is turned off or power disconnected, settings are retained in memory by a lithium battery. Before programming the sampler, you should be familiar with the keypad and displays. These are discussed in later sections.

2.1 Operating States

The sampler has three operating states:

1. The *standby state*: the sampler is waiting for instructions from the keypad.
2. The *run state*: the sampler is running a sampling routine, displaying status messages on the LCD, and storing sampling results in memory.
3. The *interactive state*: the sampler is being programmed.

2.2 Interactive State

The interactive state allows you to program the sampler. It is divided into two branches: the configure sequence and the program sequence. The configure sequence contains the input displays that configure the sampler to your unique requirements. The program sequence has two programming modes: basic and extended. The basic mode is used for conventional sampling routines. The extended mode is for more complex routines. (Select the mode in the Programming Mode configure option.)

In both programming modes, the program sequence is divided into four sections: Sample Pacing (interval between samples), Sample Distribution (number of samples in each bottle), Sample Volume (sample size in ml), and Key Times (start times and, in the extended mode, stop and resume times).

Sampling capabilities available through the basic and extended program modes are summarized in Table 2-1. Setup options available in the configure sequence are listed in Table 2-2.

Table 2-1 Sampling Capabilities

Pacing:	Mode	Feature
Time-pacing: Uniform Time Intervals	Basic & Extended	Samples taken at regular time intervals from 1 minute to 99 hours, 59 minutes.
Time-pacing: Nonuniform Clock Time Intervals	Extended	Samples taken at irregular intervals by specifying the time and date of each sample. Dates can be entered up to 1 month in advance of current date.
Time-pacing: Nonuniform Intervals in Minutes	Extended	Samples taken at irregular time intervals by specifying the amount of time in minutes (from 1 to 999 minutes) between each sample.
Flow-pacing:	Basic & Extended	Samples taken at regular flow intervals. The sampler will totalize intervals of 1 to 9999 pulses.
Storm™ Pacing:	Extended	Combines time and flow pacing in one routine. Timed samples taken at regular time intervals from 1 minute to 999 minutes. Flow-weighted samples taken at regular flow intervals. The sampler will totalize intervals of 1 to 9999 pulses.

Table 2-1 Sampling Capabilities (Continued)

Distribution:		
Sequential	Basic & Extended	One sample volume placed in each bottle.
Samples per Bottle Multiplexing	Basic & Extended	More than one sample volume placed in each bottle.
Bottles per Sample Multiplexing	Basic & Extended	Sample volumes placed in more than one bottle at each sample event.
Multiple Bottle Compositing	Extended	More than one sample placed in a set of bottles. Bottle sets can be switched after a specified number of samples or after a period of time.
Volumes and Accuracy:		
Sample Volume	Basic & Extended	Volumes from 10 to 9990 ml can be entered.
Suction Head	Basic & Extended	Suction heads from 1 to 20 feet can be entered.
Calibration	Basic & Extended	Sample volumes can be calibrated, if desired.
Key Times:		
Start Times	Basic & Extended	Specific start times can be entered for both time- and flow-paced routines. If no start time is entered, the Start Time Delay will be used.

Table 2-1 Sampling Capabilities (Continued)

First Switch Time	Extended	Sets time of first time-base bottle switch so that switch times can be placed on schedule.
Stop/Resume Times	Extended	Intermittent sampling routines defined with sampling stop and resume times. Up to 12 stop times and 12 resume times can be entered.

Table 2-2 Configure Option Functions

Configure Option	Mode	Function
Set Clock	Basic & Extended	Sets the sampler's real time clock.
Bottles and Sizes	Basic & Extended	Sets the number and size of bottles used.
Suction Line	Basic & Extended	Sets the line type (vinyl or PTFE), line diameter ($^1/_4$ or $^3/_8$ inch), and line length (3 to 99 ft.).
Liquid Detector	Basic & Extended	Enables/disables the liquid detector, sets the number of rinses (0 to 3), enables/disables the suction head entry, and sets the number of retries (0 to 3).
Programming Mode	Basic & Extended	Sets the programming mode: basic or extended.

Table 2-2 Configure Option Functions (Continued)

Configure Option	Mode	Function
Load Stored Program	Extended	Loads one of up to three previously saved sampling programs.
Save Current Program	Extended	Saves current sampling program.
Flow Mode Sampling	Extended	Directs sampler to take a sample at the beginning of a flow-paced program and/or at time-switches.
Nonuniform Time	Extended	Directs sampler to accept nonuniform intervals as clock times or in minutes.
Calibrate Sampler	Basic & Extended	Enables/disables the calibration sequence.
Sampling Stop/Resume	Extended	Enables/disables Sampling Stops and Resumes feature.
Start Time Delay	Basic & Extended	Sets the start time delay (from 0 to 9999 minutes).
Enable Pin	Basic & Extended	Enables/disables master/slave sampling. Directs the sampler to sample when disabled and/or enabled. Allows you to restart the sampling interval upon enable.
Event Mark	Basic & Extended	Allows you to select one of four types of event marks.
Purge Counts	Basic & Extended	Adjusts the pre- and postsample purge counts.

Table 2-2 Configure Option Functions (Continued)

Configure Option	Mode	Function
Tubing Life	Basic & Extended	Displays the pump tubing life information. Resets the tubing life count.
Program Lock	Basic & Extended	Enables/disables the password protection for input displays.
Sampler ID	Basic & Extended	Allows you to enter a 10 character ID number.
Run Diagnostics	Basic & Extended	Tests the RAM, ROM, distributor & pump. Allows for re-initialization.

2.2.1 Keypad Description

Control keys manually control the sampler. Numeric keys enter program values, and programming keys direct programming activities.

Control Keys

- **On/Off** – The ON/OFF key turns the sampler on (placing the sampler in standby) or off. If you turn the sampler off during a routine, resume the routine with the RESUME SAMPLING key.
- **Pump Forward** – In standby, the PUMP FORWARD key runs the pump forward until the STOP key is pressed.

- **Pump Reverse** – In standby, the PUMP REVERSE key runs the pump in reverse until the STOP key is pressed.
- **Stop** – The STOP key stops the pump when it is running. In the run state, it halts the routine and transfers the sampler to standby. Press the STOP key at an input display to see the display's reference number.
- **Start Sampling** – In standby, the START SAMPLING key starts the sampling program. When entering a sampler ID number, the START SAMPLING KEY types a space.
- **Resume Sampling** – When "PROGRAM HALTED" is displayed, press the RESUME SAMPLING key to resume the program from the point it halted. When entering a sampler ID number, the RESUME SAMPLING key types a period.
- **Manual Sample** – The MANUAL SAMPLE key takes a manual sample. The MANUAL SAMPLE key is valid in the standby and run states, and when calibrating the sampler. When entering a sampler ID number, the MANUAL SAMPLE key types a dash (-).
- **Next Bottle** – The Next Bottle key moves the distributor to the next bottle. If the distributor is over the last bottle, the distributor will move to position one.

Program Keys

- **Display Status** – Press the DISPLAY STATUS key in standby to view the program settings or the sampling results.
- **Exit Program** – Press the EXIT PROGRAM key in the program sequence to return to standby. Press the EXIT PROGRAM key in the run state to halt the program.
- **Clear Entry** – When entering a number, press the CLEAR ENTRY key to clear the new entry. The display will return to the original entry.
- **Enter/Program** – Press the ENTER/PROGRAM key in standby to enter the interactive state. At an input display, press ENTER/PROGRAM to store a value or selection.

Numeric Keys

- **Digit Keys** – The digit keys are used to enter quantities.
- **Left Arrow** – The LEFT ARROW key selects one of two or more program options displayed in the interactive state. When more than one numeric entry is displayed, the LEFT ARROW steps back to a previously entered value. When entering a number, the LEFT ARROW will erase the most recently entered digit.

- **Right Arrow** – The RIGHT ARROW key selects a program option and steps through display status information.

2.2.2 Displays

There are two types of displays: displays which present information about the sampler's status and displays which prompt for input.

- **Informational Displays** – Informational displays communicate information about the sampler's status. For example, when a sampling program is finished, a display communicates: "DONE," the number of samples taken, and the current time and date.
- **Input Displays** – Input displays can be identified easily because they contain a blinking word or number. The blinking word or number serves as a prompt for input and is said to be "selected." Nearly all input displays have a number assigned to them. The number is used to cross-reference the input displays with a explanatory listing found in Appendix A at the back of this guide. Access a display's number by pressing the STOP key.

There are two types of input displays: displays which prompt you for a choice and displays which prompt for numeric input.

- **Displays With Choices** – In an input display prompting for a choice, the blinking word indicates the currently

selected choice. If the blinking word is acceptable, press the ENTER/PROGRAM key. If the blinking word is not acceptable, press the LEFT ARROW or RIGHT ARROW key until the preferred choice is blinking, then press the ENTER/PROGRAM key.

- **Numeric Input Displays** – A numeric input display prompts for input by blinking the currently stored number. If the blinking number is acceptable, press the ENTER/PROGRAM key. To enter a new number, press the appropriate numeric keys followed by the ENTER/PROGRAM key. The sampler will not accept a number that exceeds the range of values placed in parentheses. If an entered number exceeds the range, the sampler will beep and the original number will reappear. Enter a new number.

Editing Numbers

The LEFT ARROW and CLEAR ENTRY key edit numeric entries if used *after* you press a numeric key and *before* you press the ENTER/PROGRAM key to store the number. The CLEAR ENTRY key clears any typed number and the original number will reappear. The LEFT ARROW erases the most recently typed number.

Some numeric input displays prompt for multiple values: hours, minutes, day, month, and year. The LEFT ARROW key and RIGHT

ARROW keys move back and forth between each of the five entries. Pressing the RIGHT ARROW or ENTER/PROGRAM key on the last entry will store the values and advance to the next display. Enter times in 24-hour format; enter dates in European format: DD-MMM-YY.

2.3 Programming Procedures

The procedure for programming the sampler in extended mode is slightly different that the procedure used to program the sampler in the basic mode. Differences are noted by placing the extended mode procedure in *italics*. When programming the sampler in the extended mode, follow the basic procedure, modifying it according to the noted differences. Two programming examples are included at the end of the procedure.

Procedure

1. Identify the number and size of the bottles. Determine the inside diameter, type, and length of the suction line. Convert the sampler for composite sampling, if necessary.
2. Turn the sampler on with the ON/OFF key. The "STANDBY" message will appear. If the sampler were turned off while running a routine, the "PROGRAM HALTED" message will be displayed. Both messages indicate the sampler is in standby.
3. Check the configuration settings.

a. From standby, press the ENTER/PROGRAM key to access the interactive state.

b. Select “CONFIGURE” to access the configure sequence.

c. Press the LEFT ARROW or RIGHT ARROW key at the “SELECT OPTION” displays to scroll through the list of options without viewing each input display. To access a configure-option input display, press the ENTER/PROGRAM key at the option name.

d. Check the Bottle Size and Suction Line configure option settings. The settings must match the bottle and suction line identified in step 1.

e. Select “BASIC” or “EXTENDED” in the Programming Mode configure option.

f. Revise other configure option settings as needed.

g. Press the EXIT PROGRAM keys to return to standby.

4. From standby, press the ENTER/PROGRAM key to access the interactive state. Select “PROGRAM” to access the program sequence.

☑ Note

If you want to return to a previous display while programming, press the EXIT PROGRAM key. The sampler will return to standby. Press the

ENTER/PROGRAM key until you locate the display in question.

5. Enter the Sample Pacing settings. Select either time- or flow-pacing. Then, enter the time or flow pulse interval between samples.

IN THE EXTENDED MODE

Select time, flow, or Storm pacing. If you select time pacing, you will be prompted to select one of two types of time pacing: uniform or nonuniform. Select Uniform to pace the sampler at regular intervals; enter the time interval. Select Nonuniform to pace the sampler at irregular intervals. If you have configured the sampler for Clock Time intervals, enter specific times and dates for each sample event. If you have configured the sampler for Minutes, enter the quantity of samples at each interval. If you select flow-pacing, the next display will prompt you for the pulse interval.

If you select Storm pacing, the next display will prompt you for the delay to the first group sample. The Storm programming sequence is divided into two sections. The first section determines the settings for the first bottle group; the second section contains the settings for the second bottle group. Each section requires separate settings for the delay to the first sample of each group, the sample volume, and sample distribution. The first bottle group always receives

time-paced samples. The second group can receive either time-paced or flow-paced samples, depending on your selection in the second section of the storm programming sequence. The Storm settings for volume and distribution are identical to those used in the basic and extended mode.

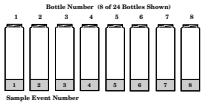
6. Enter the Sample Distribution settings. The first display of the Sample Distribution section asks if you want to multiplex samples. Select no for sequential sampling; the sampler will then prompt you for the Sample Volume settings. Select Yes for multiplexed sampling. The next display will prompt you to select either Bottles Per Sample or Samples Per Bottle. See Figure 2-1 for multiplexing types.

IN THE EXTENDED MODE

Entering the extended Sample Distribution setting requires three steps: 1) enter the number of bottles per sample event; 2) select the method used to switch bottles or sets. You can switch multiplexed bottles or bottle sets after a programmed time period (select Time) or after samples have been deposited (select Samples or Samples/bottle); 3) enter the number of samples to be deposited or the time period during which each bottle or set is to receive samples.

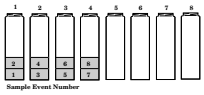
Follow the same procedure for storm-pacing. The sampler will prompt you for separate distribution settings for each section of the Storm sequence.

Sequential Sampling



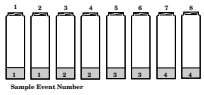
Each bottle receives one sample from one sample event.

Samples-per-bottle Multiplexing



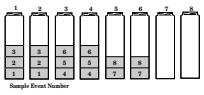
Each bottle receives a sample from multiple sample events.

Bottles-per-sample Multiplexing



Multiple bottles receive a sample from one sample event.

Multiple Bottle Compositing



Multiple bottles receive samples from multiple sample events.

Figure 2-1 Sample Distribution Diagrams

7. Enter the Sample Volume settings. Because the programmed sample volume is a "nominal" value, enter a volume somewhat less than the capacity of the bottle to minimize the effects of cumulative error.

   If bottles-per-sample multiplexing is being used to add preservatives to a bottle set, take the volume of the preservative into account.

   The sampler can be configured through the Liquid Detector configure option to add the suction head input display to the program sequence. This display follows the sample volume input display.

☑ Note

Under most conditions, you should not need to use the suction head setting. This allows the liquid detector to determine the operating suction head each time a sample is taken, allowing the sampler to deliver consistently accurate samples in varying head conditions.

When the head is unknown or variable, always omit the suction head setting. Omit the head setting with the following selections in the Liquid Detector configure option: enable the detector (Display 240) and do not enter the head manually (Display 242).

   To calibrate the sample volume, select "ENABLE" in the Calibrate Sampler configure option. The calibration displays follow the sample volume displays (and the suction head settings, if used).

8. Enter the Key Times settings. You will be asked if you want to enter a start time for the routine. If you select "YES," you will be prompted for the start time and date. If you select "NO," the sampler will use the start time delay.

   IN THE EXTENDED MODE
   The Stops and Resumes settings are available only when you have enabled the Sampling Stop/Resume configure option. The Stops and Resumes settings follow the start time settings. When entering Stop/Resume settings, first enter the number of stops and resumes, from 0 to 24. (Enter "0" if you want to omit the settings without disabling the Stops/Resumes option in the configure sequence.) Next, enter the stop and resume clock times. The first entry will be a stop time.

9. The sampler will automatically return to standby. Press START SAMPLING to start the routine. Press Start Sampling to start the routine. Enter the starting bottle number. If you make no response within 60 seconds, the sampler automatically begins with bottle 1. If you start the routine after the programmed start time, the sampler will allow you to enter a new start time.

10. Use the run state displays to monitor the sampler's progress. Examples 2-4 through 2-6 list the run state displays.

Example 2-1 Time Paced Programming

This example uses the Basic Programming mode to program the sampler for time paced sampling. The programming steps instruct the sampler to collect a sample four times every hour and deposit four samples in each bottle.

1. `. . . STANDBY . . .`
   `10:34:50 19-APR-`

   Press Enter/Program to enter the interactive state.

2. `[PROGRAM, CONFIGURE]`
   `SAMPLER`

   Select "Program" to access the program sequence.

3. `[TIME, FLOW]`
   `PACED SAMPLING`

   Select "Time."

4. `SAMPLE EVERY`
   `0 HOURS, 1 MINUTES`

   Enter "0" to set the hours at zero. Press Enter/Program to store "0" and move to the minutes entry.

5. `SAMPLE EVERY`
   `0 HOURS, 15 MINUTES`

   Enter "15" to set the minutes entry to 15.

Example 2-1 Time Paced Programming (Continued)

6. `MULTIPLEX SAMPLES?`
   `[YES, NO]`

   Select "Yes" for samples-per-bottle multiplexing.

7. `[BOTTLES PER SAMPLE,`
   `SAMPLES PER BOTTLE]`

   Select "Samples Per Bottle."

8. `4 SAMPLES PER`
   `BOTTLE (1 - 50)`

   Enter "4" to set the number of samples per bottle to 4.

9. `SAMPLE VOLUMES OF`
   `200 ml (10 - 990)`

   Enter the sample volume of "200" ml.

10. `ENTER START TIME?`
    `[YES, NO]`

    Select "Yes" so you can enter the specific start time.

11. `TAKE FIRST SAMPLE AT`
    `6:00 20-APR-04`

    Enter the desired start time. For this example, the start time is 6:00 on April 20.

Example 2-1 Time Paced Programming (Continued)

12.
```
PROGRAMMING SEQUENCE
  COMPLETE . . .
```
After this message is displayed briefly, the sampler will automatically return to the standby state.

13.
```
. . . STANDBY . . .
10:37:23    19-APR-04
```
To run the program, press the Start Sampling key after the sampler is installed.

14.
```
START SAMPLING
AT BOTTLE 1 (1-24)
```
To start the sampling routine with the first bottle, accept the blinking "1" by pressing the Enter/Program key. To start the routine with another bottle, enter the starting bottle number here.

Example 2-2 Calibration Procedure

This example demonstrates the method used to calibrate the sampler for a 200 ml sample volume. The Calibrate Sampler configure option must be enabled in the configure sequence before the calibration displays shown below will appear.

1.
```
. . . STANDBY . . .
9:34:50     19-APR-04
```
Press Enter/Program to access the interactive state.

2.
```
[PROGRAM, CONFIGURE]
  SAMPLER
```
Access the program sequence by selecting "PROGRAM."

3.
```
[TIME, FLOW]
PACED SAMPLING
```
Step through the program until the "CALIBRATE SAMPLER?" input display appears.

4.
```
↓
↓
```
Other program sequence displays.

5.
```
CALIBRATE SAMPLER?
[YES, NO]
```
Select "YES."

Example 2-2 Calibration Procedure (Continued)

6.
```
PRESS MANUAL SAMPLE
KEY WHEN READY . . .
```
Before pressing the Manual Sample key, make sure a collection container is underneath the pump tube.

7.
```
. . . MANUAL SAMPLE . . .
  PUMPING  200 ml
```
The sampler will deliver the programmed sample volume.

8.
```
200 ml VOLUME
  DELIVERED
```
Measure the actual volume delivered and enter that value here.

9.
```
CALIBRATE SAMPLER?
[YES, NO]
```
Repeat the procedure if desired or select "NO."

10.
```
↓
↓
```
Other program sequence displays.

11.
```
. . . STANDBY . . .
9:39:50     19-APR-04
```
The sampler will return to standby. Press the Start Sampling key to run the program.

Example 2-3 Composite Sampling

This example uses the Basic Programming mode to program the sample for composite sampling. The programming steps instruct the sampler to collect a sample four times every hour and deposit all samples in a single bottle.

1.
```
. . . STANDBY . . .
10:38:50  19-APR-04
```
Press the Enter/Program key to access the interactive state.

2.
```
[PROGRAM, CONFIGURE]
  SAMPLER
```
Select "Program" to access the program sequence.

3.
```
[TIME, FLOW]
PACED SAMPLING
```
Select "Time."

4.
```
SAMPLE EVERY
0 HOURS, 1 MINUTES
```
Enter "0" to set the hours at zero. Press Enter/Program to store the number "0" and move to the minutes entry.

5.
```
SAMPLE EVERY
0 HOURS, 15 MINUTES
```
Enter "15" to set the minutes entry to 15.

Example 2-3 Composite Sampling (Continued)

6.
```
48 COMPOSITE
SAMPLES ( 0-200)
```
Enter the number of samples to be collected: “48.”

7.
```
SAMPLE VOLUMES OF
250 ml EACH (10 - 310)
```
Enter the sample volume: “250.”

8.
```
ENTER START TIME?
[YES, NO]
```
Select “Yes” to enter the start time for the routine.

9.
```
TAKE FIRST SAMPLE AT
6:00 20-APR
```
Enter the start time and date: 6:00 on April 20.

10.
```
PROGRAMMING SEQUENCE
COMPLETE . . .
```
After this message is displayed briefly, the sampler will automatically return to the standby state.

11.
```
. . . STANDBY . . .
10:40:23 19-APR-04
```
After the sampler is properly installed, press the Start Sampling key to run the program.

2.4 Foreign Language Displays and Metric Units of Measure

The sampler presents displays in English, Spanish, French, and German. Samplers presenting Spanish, French, and German displays support metric units for suction line and suction head measurements. Samplers operating with English displays support either English or metric units for line and head measurements. (Sample volumes are always entered in milliliters).

To program the sampler for foreign language displays, place the sampler in standby. Then, press STOP five times. The standby display will be replaced by an input display with these options: [English, German, Spanish, French]. Select the preferred language from this display.

If you select Spanish, French, and German, the sampler will automatically convert English units of measure to metric units and return to standby. If you select English, a second display will appear. Select English or metric units of measure from this display. The sampler will convert the units of measure as required and return to standby.

2.5 Standby State

This section discusses the displays and messages used in the standby state.

2.5.1 Start Sampling After Program Halted

Halt a running program with the STOP or EXIT PROGRAM key. “PROGRAM HALTED” will be displayed to notify you of the halt status. Start the program again with the START SAMPLING key; the sampler will ask you to start the program from the beginning or to resume the program from the point at which it halted. Select “START” to start from the beginning. (“START” will re-initialize the display status memory.) Select “RESUME” to resume the program from the point at which it halted. If you make no selection within 60 seconds, the sampler will automatically select the currently blinking choice. The sampler can also be restarted with the RESUME key.

2.5.2 Done

The sampler will inform you it has completed a program by displaying “DONE.” If a problem were encountered during the routine, one of two displays listed below may alternate with the “DONE” display.

Problem Occurred

The “PROBLEM OCCURRED” display indicates a missed sample. The sampler logs the probable cause in memory. This information is available through the display status procedure. Causes are listed in section 2.5.5.

Float Tripped

Samplers converted for composite sampling display the Float/weight Tripped message when the overflow float terminates the routine.

2.5.3 Display Status

Access a summary of the program settings and the results of the most recent sampling routine with the DISPLAY STATUS key. Display status information remains in memory until you start another program. If a sampling routine is in progress when you press the DISPLAY STATUS key, the sampling routine will be suspended until you exit Display Status.

If the pump count reaches the Tubing Life Warning setting, the Pump Tubing Warning will be displayed as soon as you press the DISPLAY STATUS key. The next display, “REVIEW PROGRAM,” gives you three choices: “NO,” “SETTINGS,” and “RESULTS.”

Select “NO” to return to the previous operating state. If you entered display status from the run state, the sampling routine will resume.

Select “SETTINGS” to view the program settings. Use the LEFT ARROW, RIGHT ARROW, and the ENTER/PROGRAM keys to scan the settings. When the RIGHT ARROW key or the ENTER/PROGRAM key is pressed at the last setting display, the “REVIEW PROGRAM” input display will reappear.

Select “RESULTS” to view the results of the sampling routine. Use the LEFT ARROW, RIGHT ARROW, and the ENTER/PROGRAM keys to scan the results. The results include: program start time and date, sample volume, source (see section 2.5.4), cause of any missed samples (see section 2.5.5), start time, number

of pump counts to liquid detection, pumping time, and time the routine was completed.

2.5.4 Source of Sample Event

Nine sources are reported:

- **Time** – The sample event was one of the program's time-paced samples.
- **Flow** – The sample event was one of the program's flow-paced samples.
- **Start** – The sample event occurred at the program's start time.
- **Resume** – The sample event compensated for a sample missed while the sampler was halted.
- **Power** – The sample event compensated for a missed sample missed while the sampler was without power.
- **Enable** – The sample event occurred when: the sampler became enabled by a device connected to pin F of the flow meter connector, or, at a programmed resume time.
- **Manual** – The sample event was initiated with the MANUAL SAMPLE key and was counted as one of the programmed sample events.
- **Time Switch** – The sample event was initiated at the programmed switch time.
- **Disable** – The sample event was initiated when: the sampler became disabled by a device connected to pin F of

the flow meter connector, or, at a programmed stop time.

2.5.5 Cause of Missed Samples

The probable cause of a missed sample follows the sample number/source display of the display status results. Twelve causes are reported:

- **Pump 'STOP' Key Hit** – The sampler was halted with the STOP key during the sample event.
- **Pump Jammed** – The sampler was unable to take the sample because the pump jammed.
- **Started Too Late** – This message is reported for all samples skipped because of an expired start time.
- **Program Halted** – The sample event was interrupted by the STOP or EXIT PROGRAM key.
- **Power Lost** – The sampler's power source was disconnected.
- **Sampler Inhibited** – The sampler was prevented from taking the sample by an inhibit signal sent to the sampler by the flow meter or Liquid Level Actuator.
- **Distributor Jammed** – The distributor jammed.
- **Probable Overflow** – Overflow is determined by multiplying the sample volume by the number of samples

deposited in a bottle and comparing the product to the volume of the bottle entered in the Bottle and Sizes configure option. If the product exceeds the bottle volume, no sample will be taken and the sampler will record the "Probable Overflow!" message.

- **Float/Weight Tripped** – Samplers converted for composite sampling display the Float Tripped message when the overflow float terminates the routine.
- **No More Liquid** – The sampler's pump drained the flow stream before it delivered a full sample volume.
- **No Liquid Detected** – No liquid was detected.
- **Sampler Shut Off!** – The sampler was halted with the ON/OFF key during the sample event.

☑ *Note*

If the sampler misses a sample, it places an asterisk (*) in the lower right corner of the display.

2.6 Run State

A sampler in the run state is executing the sampler's program. To start a sampling program and place the sampler into the run state, press the Start Sampling key. The sampler will present a number of displays which allow you to monitor the sampler's progress. See Examples 2-4 through 2-6.

There are two instances where the sampler will enter the run state after the Start Sampling key is pressed, but will not begin the sampling program:

- If the sampler is acting as a slave in a Master/Slave pair, the slave will not begin the program until it receives an enable signal from the master. While waiting for the enable signal, the display will read "Master/Slave Mode…Waiting For Master."
- If the sampler is interfaced with a flow meter, a Liquid Level Actuator, or other equipment capable of transmitting an inhibit signal, the sampler will not begin the program until the inhibit signal is suspended. The display will read Sampler Inhibited as long as it receives the inhibit signal.

Example 2-4 Run State Displays: Time Paced Sampling

1.
```
        BOTTLE 5
AT 5:44       5:42:33
```
Indicates the bottle number of the next sequential sample. The second line reports the scheduled sample event time followed by the current time.

2.
```
     BOTTLES  1- 4
AT  6:00     5:55:33
```
Indicates the scheduled time and receiving bottle numbers for an upcoming sample event. The program requires 4 bottles/sample event.

3.
```
   1  OF  4,  BOTTLE 1
AT  6:00     5:55:33
```
Indicates the number of the upcoming sample, the total number of samples each bottle is to receive, and the current bottle number. The program requires 4 samples/bottle.

4.
```
   1 OF 4,  BTLS  1- 4
AT  6:00     5:55:33
```
Indicates the sample and bottle numbers of the next sample event. The bottle set has 4 bottles.

Example 2-4 Run State Displays: Time Paced Sampling (Continued)

5.
```
SAMPLE 3, BOTTLE 1
AT  6:00    5:42:33
```
Indicates the sample and bottle number of the next sample event The current time is shown in the lower right corner. The program requires 1 bottle/sample event. Bottles be switched on a time basis. Alternates with the display in 6.

6.
```
NEXT BOTTLE CHANGE
AT 10:00          19-APR
```
Indicates the time of the next bottle switch.

7.
```
SAMPLE 2, BTLS 1 - 4
AT  6:00    5:42:33
```
Indicates the sample and bottle numbers of the next sample event. The current time is shown in the lower right corner. The program requires 4 bottles/sample event. Sets are switched on a time basis. Alternates with the display in 8.

8.
```
NEXT SET CHANGE
AT 8:00           19-APR
```
Indicates the time of the next bottle set switch.

9.
```
BOTTLE 1
PUMPING  200 ml
```
Indicates a sample in progress.

Example 2-5 Run State Displays: Flow Paced Sampling

1.
```
START AT 6:00     19-APR
5:42:43           19-APR
```
Indicates the programmed start time of a flow-paced sampling program when no sample is to be taken at the start time. The first line reports the programmed start time, the second line reports the current time and date.

2.
```
        BOTTLE 1
AT  6:00    5:42:33
```
Indicates the programmed start time of a flow-paced sampling program when a sample is to be taken at the start time. The current time is shown in the lower right corner.

3.
```
        BOTTLE 1
AFTER      5 PULSES
```
Indicates the bottle number of the next sequential sample. The second line reports the number of flow pulses remaining until the next sample event.

4.
```
     BOTTLES 5- 7
   AFTER 25 PULSES
```
Indicates the bottles which will receive samples at the next sample event. The second line reports the pulses remaining until the next sample event.

Example 2-5 Run State Displays: Flow Paced Sampling (Continued)

5.
```
   1  OF  4,  BOTTLE 1
AFTER       10  PULSES
```
Indicates the number of the upcoming sample, the total number of samples each bottle is to receive, and the current bottle number.

6.
```
   1 OF 4,  BTLS  1- 4
AFTER       1000 PULSES
```
Indicates the sample and bottle numbers of the next sample event. The bottle set consists of 4 bottles. The program requires 4 samples be placed in each bottle of the set.

7.
```
SAMPLE 2, BOTTLE 1
 AFTER 10 PULSES
```
Indicates the sample and bottle number of the next sample event. The program requires 1 bottle/sample event. Bottles are switched on a time basis. Alternates with the display in 8.

8.
```
NEXT BOTTLE CHANGE
AT 10:00          19-APR
```
Indicates the time of the next bottle switch.

Example 2-5 Run State Displays: Flow Paced Sampling (Continued)

9.
```
SAMPLE 2, BTLS 1 - 4
AFTER 10 PULSES
```
Indicates sample and bottle numbers of the next sample. The program requires 4 bottles/sample event. Bottle sets are switched on a time basis. Alternates with the display in 10.

10.
```
NEXT SET CHANGE
AT 10:00          19-APR
```
Indicates the time of the next bottle set switch.

11.
```
BOTTLE 1
PUMPING  200 ml
```
Indicates a sample in progress.

Example 2-6 Run State Displays: Composite Sampling

1.
```
SAMPLE 1 OF 12
AT 6:00     5:43:33
```
Indicates the sample number of the next sample and the total number of samples. The current time is shown in the lower right corner.

2.
```
SAMPLE 1 OF 12
AFTER 10 PULSES
```
Indicates the sample number of the next sample and the total number of samples required. The number of pulses to the next sample appears on the bottom line.

3.
```
BOTTLE 1
PUMPING  200 ml
```
Indicates a sample in progress.

3700 Portable Sampler

Section 3 Service

3.1 Cleaning the Suction Line and Bottles

Clean the suction line and pump tubing by placing the end of the suction line in a cleaning solution and pumping this solution through the tubing using the pump forward and pump reverse keys. Follow with a clean water rinse. Wash the glass bottles with a brush and soapy water, a dishwasher, or use an autoclave. The plastic bottles and lids can be washed in a dishwasher but cannot be autoclaved.

3.2 Pump Tubing

⚠ WARNING

Disconnect power before replacing the pump tubing. The pump is extremely powerful. If the sampler activates the pump while you are manipulating the tubing, you can be seriously injured.

To remove the pump tubing:

1. Disconnect power.
2. Detach the outer case of the liquid detector by loosening the two thumbscrews. Pull the tubing away from the detector.
3. Remove the outer pump lid and pull the tubing from the pump. Rotate the pump rollers manually to help remove the tubing.

To install new pump tubing:

1. The pump tube is marked with two black bands. Facing the liquid detector, place the end band against the upper inlet of the detector and the inner band at the outlet. See Figure 3-1.

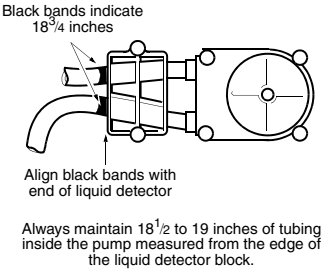


Figure 3-1 Pump Tube Installation

2. Replace the pump lid and the case of the liquid detector.

Note

For proper operation of the liquid detector, tighten the detector's thumbscrews securely.

3. Feed the tube down through the center section, turn the center section over and pull the tube through the spring. Insert the tube into the distributor arm so that the end of the tube is flush with the end of the arm.
4. Reinstall the suction line and the distributor arm. Secure the distributor arm retaining nut. The exposed tube should continuously slope downward from the center section the distributor arm.
5. Reset the pump tube count in the Tubing Life configure option to zero.

3.3 Replacement of Suction Line

The vinyl suction line is removed from the pump tubing by detaching the tube coupling. The PTFE suction line is removed by loosening the clamp securing the line to the pump tube and pulling the suction line out of the pump tube. New line is attached by reversing this procedure.

3.4 Cleaning the Sampler

Clean the top cover, center section, and base section with warm soapy water or by spraying

them with a hose. Be sure a power source is attached to the 12 VDC connector and the flow meter connector is tightly capped.

3.5 Charging the Nickel-Cadmium Battery

Charge the Nickel-Cadmium Battery Pack with the Isco AC Power Pack or Isco Battery Charger. Connect the plug on the battery cable to the mating receptacle on the AC Power Pack or the Battery Charger. Charge the battery for 15 to 18 hours. While charging, the battery will feel cool to the touch. Discontinue charging when the battery temperature rises. Because a nickel-cadmium battery produces almost constant voltage, even under load, you cannot use voltage measurements to determine the charge. Repeated overcharging reduces the life of the battery.

3.6 Charging the Lead-Acid Battery

Charge the lead-acid battery with an Isco AC Power Pack. Measure the output voltage to determine the charge level of the lead-acid battery. A chart on the battery lists the charge level and the time required to recharge.

3700 Portable Sampler

Appendix A Display Index

A.1 Display Reference Index

The following pages list each input display in numeric order. Each display is accompanied by a brief explanation.

1

```
[PROGRAM, CONFIGURE]
SAMPLER
```

This display appears after you press the ENTER/PROGRAM key while in standby. Select “PROGRAM” to access the program sequence. Select “CONFIGURE” to access the configure sequence.

3

```
----- COUNTS FORWARD
```

This display appears when you stop the pump with the STOP key after having pressed the PUMP FORWARD key. It reports the number of pump counts detected while the pump was in operation. Exit with any key except STOP and ON/OFF.

3

```
----- COUNTS REVERSE
```

This display appears when you stop the pump with the STOP key after having pressed the PUMP REVERSE key. It reports the number of pump counts detected while the pump was in operation. Exit with any key except STOP and ON/OFF.

10

```
[TIME, FLOW]
PACED SAMPLING
```

This display appears when you select “PROGRAM” in Display 1. Select “TIME” for time-paced sampling, or select “FLOW” for flow-paced sampling.

11
```
[UNIFORM, NONUNIFORM]
TIME INTERVALS
```
This display appears only in the extended programming mode and follows Display 10 when you have selected “TIME.” Select “UNIFORM” for uniform time intervals, “NONUNIFORM” for nonuniform intervals.

12
```
[TIME, FLOW, STORM]
PACED SAMPLING
```
This display appears only when the sampler is configured for the extended programming mode and for 4, 12, or 24 bottles. Select Time for time-paced sampling. Select Flow for flow-paced sampling, and Storm for storm sampling.

14
```
[TIME, FLOW]
SECOND BOTTLE GROUP
```
This display appears after you select Storm in Display 12. Use it to select time pacing or flow pacing for the second bottle group of a Storm routine.

15
```
-- MINUTE DELAY TO
FIRST GROUP SAMPLE
```
This display appears after you select “Storm” in Display 12. Enter the amount of time between the time the sampler is enabled and the first sample of the first bottle group.

16
```
[DURING, AFTER]
TIME MODE
```
This display appears when you have selected “Flow” in Display 14. Select During to fill the first and second bottle groups concurrently. Select After to fill the second bottle group after the first bottle group.

17
```
-- MINUTE DELAY TO
SECOND GROUP SAMPLE
```
This display appears after you select Storm in Display 12. Enter the amount of time between the time the sampler is enabled and the first sample event for the second bottle group.

20
```
MODIFY SEQUENCE?
[YES, NO]
```
This display follows Display 11 when you have selected “NONUNIFORM.” Select “YES” to modify the existing nonuniform intervals. Select “NO” to leave the nonuniform intervals unchanged.

21
```
SAMPLE EVERY
-- HOURS  -- MINUTES
```
In the basic programming mode, this display appears after you have selected “TIME” in Display 10. In the extended mode, this display appears when you have selected “UNIFORM” in Display 11. Enter the uniform time interval.

22
```
SAMPLE EVERY
---- PULSES (1 - 9999)
```
This display follows Display 10 when you have selected “FLOW.” Enter the flow pulse interval.

23
```
TAKE -- TIMED
SAMPLE EVENTS (1 - MAX)
```
This display follows Display 15. Use this display to enter the number of sample events for the first bottle group in a Storm program.

24
```
SAMPLE INTERVALS OF
-- MINUTES (1 - 999)
```
This display follows Display 23. Enter the time interval between time paced sample events.

25
```
TAKE --- SAMPLES
(1 - MAX )
```
This display follows Display 20 when you have selected “YES” to modify the nonuniform time sequence. Enter the number of sample events. *MAX* varies with to the bottle size entered in Display 223.

26
```
TAKE SAMPLES AT
1.  HH:MM        DD-MMM
```
This display follows Display 25. Enter the nonuniform clock times and dates for each sample event.

27
```
QUANTITY AT INTERVAL
1. -- AT --- MINUTES
```
Enter the number of samples to be taken at each nonuniform minutes interval. The value entered will be one less than the total number of samples because the first sample, taken at the start time, counts as one.

30
```
-- BOTTLES PER
SAMPLE EVENT (1 - MAX )
```
This display appears for samplers configured for 24 bottles (Displays 221 or 222). Enter the number of bottles to receive a sample volume at each sample event.

31
```
-- SAMPLES PER
BOTTLE (1 - MAX )
```
In the basic mode, this display appears when you have selected Samples Per Bottle in Display 36. In the extended mode, it appears when the sampler is set up for one bottle set. Enter the number of samples to be deposited in each bottle.

35
```
MULTIPLEX SAMPLES?
[YES, NO]
```
Select Yes if you want the routine to perform bottles-per-sample or samples-per-bottle multiplexing. Select No if you want the routine to perform sequential sampling.

36 `[BOTTLES PER SAMPLE, SAMPLES PER BOTTLE]`

This display appears when you have selected Yes in Display 35. Select Bottles Per Sample for bottles-per-sample multiplexing. Select Samples Per Bottle for samples-per-bottle multiplexing.

40 `CHANGE BOTTLES BASED ON [TIME, SAMPLES]`

This display appears in the extended mode when the number of bottles per sample event is 1. Select Time to switch bottles after a period of time. Select Samples to switch bottles after a number of samples have been deposited.

41 `CHANGE SETS BASED ON [TIME, SAMPLES/BTL]`

Select Time to switch bottle sets after a specified period of time. Select Samples/Btl to switch bottle sets after a specified number of samples have been placed in a set of bottles.

42 `CHANGE BOTTLES EVERY -- HOURS -- MINUTES`

This display appears after you select Time in Display 40. Enter the amount of time each bottle is to receive samples.

43 `CHANGE SETS EVERY -- HOURS -- MINUTES`

This display appears after you select Time in Display 41. Enter the amount of time each bottle set is to receive samples.

44 `CHANGE BOTTLES EVERY -- SAMPLES`

This display appears after you select Samples in Display 40. Enter the number of samples each bottle is to receive.

45 `CHANGE SETS EVERY _SAMPLES`

This display appears after you select Samples/btl in Display 41. Enter the number of samples each bottle set is to receive.

46 `FIRST BOTTLE CHANGE AT HH:MM DD-MM`

This display appears when you have selected Yes in Display 95. Enter the time of the first bottle switch. The remaining bottle changes will occur according to settings entered in Display 42.

47 `FIRST SET CHANGE AT HH:MM DD-MM`

This display appears when you have selected Yes in Display 95. Enter the time of the first bottle set switch. The remaining bottle set changes will occur according to settings entered in Display 43.

48 `SAMPLE CONTINUOUSLY? [YES, NO]`

This display appears when the sampler is configured for 4, 12, or 24 bottles and when the sampler is programmed for time, nonuniform time, or flow pacing. Select “Yes” to sample continuously. Select “No” to stop the sampling routine after the sampler fills the last set of bottles.

50 `SAMPLE VOLUMES OF --- ml EACH (10 - MAX )`

Enter the size of the sample volume. MAX will vary with the number of samples per bottle and bottle size.

60 `--- COMPOSITE SAMPLES (0 - MAX )`

Enter the number of composite samples. Enter “0” to take samples until a float shut-off terminates the routine.

70 `SUCTION HEAD OF -- FEET (1 - MAX )`

This display appears when you have selected “YES” in Display 242 or have selected “DISABLE” in Display 240. Enter the measured suction head. MAX will be the smaller of the suction line length or “20.”

80 `CALIBRATE SAMPLE VOLUME? [YES, NO]`

This display appears in the program sequence when you have selected “ENABLE” in Display 290. Select “YES” to use the calibration sequence, “NO” to omit the calibration sequence.

81 `PRESS MANUAL SAMPLE KEY WHEN READY . . .`

This display is part of the calibration sequence. Press the MANUAL SAMPLE key when a collection bottle is underneath the distributor and the suction line is in place.

82 `--- ml VOLUME DELIVERED`

This display is part of the calibration sequence. When it first appears, the blinking number reports the programmed sample volume. If the measured volume differs from the reported volume, enter the measured volume here.

83 `---ml! ARE YOU SURE? [YES, NO]`

This display is part of the calibration sequence and appears if the measured volume and the programmed volume differ by a factor of two or more. Select “YES” to confirm the entry in Display 82. Select “NO” to return to Display 80.

90
```
ENTER START TIME?
[YES, NO]
```
Select “YES” to enter a start time. Select “NO” to begin the sampling routine according to the delay entered in Display 310.

91
```
TAKE FIRST SAMPLE AT
HH:MM DD-MMM
```
This display appears when you have selected “YES” in Display 90. Enter the start time and date for the first sample event. This display will appear if you have started the routine after a programmed start time. Reenter the new start time.

92
```
START FLOW COUNT AT
HH:MM DD-MMM
```
This display appears when you have selected “YES” in Display 90. Enter the start time and date for the flow pulse countdown. This display appears when you have started the routine after a programmed start time. Reenter the new start time.

93
```
STORM ENABLED AFTER
HH:MM DD-MM
```
This display is the last display of the storm branch. It appears when you select Yes in Display 90. Enter the start time for the storm-sampling routine. The sampler will disregard enable or disable signals from the flow meter until the start time you enter here.

95
```
ENTER FIRST SWITCH
TIME? [YES, NO]
```
This display appears when you have selected Time in either Display 40 or 41. Select Yes to specify a clock time for the first bottle or bottle-set switch. Select No to begin the switch interval at the routine's start time.

100
```
-- STOP or RESUME
TIMES  (0 - 24)
```
This display appears when you have selected “ENABLE” in Display 300. Enter the number of stop and resume times. Enter “0” to skip the stops and resumes settings without disabling the feature in the Stops/Resumes configure option.

101
```
STOP SAMPLING AT
1. HH:MM
```
This display appears when the setting in Display 100 is greater than zero. Enter the appropriate stop time.

102
```
RESUME SAMPLING AT
1. HH:MM
```
This display appears when the setting in Display 100 is greater than one. It follows Display 101. Enter the appropriate resume time.

110
```
MAX FLOW INTERVAL OF
-- HOURS, -- MINUTES
```
This display follows Display 22. Enter the maximum amount of time you want between flow-paced sample events in a storm program. If the time period is exceeded, the sampler will terminate the routine.

140
```
[START, RESUME]
SAMPLING PROGRAM
```
This display appears when a routine is halted and you press the start sampling key. Select “START” to start the sampling program at the beginning, “RESUME” to continue the sampling program from the point at which it was halted.

141
```
START SAMPLING
AT BOTTLE -- (1 - MAX )
```
This display appears after you start a routine and the sampler is configured for multiple bottles. Enter the starting bottle location for the sampling routine. Max varies according to number of bottles and the number of bottles per sample event.

142
```
CHANGE START TIME?
[YES, NO]
```
This display appears when you have started a routine after the programmed start time. Select Yes to enter a new start time. Select No to start the routine immediately.

143
```
CHANGE START TIME?
[YES, NO]
```
This display appears when you have started a routine after the programmed start time. Select “YES” to enter a new start time. Select “NO” to start the routine immediately; some sample events may be missed or late.

148
```
[REVIEW, PRINT]
PROGRAM INFORMATION
```
Select “REVIEW” for the summary of the current program settings and for sampling results. Select “PRINT” to send the current status, program settings, and sampling results to an Isco Field Printer.

149
```
PRINT PROGRAM [NO,
SETTINGS, RESULTS]
```
This display appear after you select “Print” in Display 148. Select “NO” to return to standby. Select “Settings” to print the settings report. Select “RESULTS” to print the results report.

150
```
REVIEW PROGRAM [NO,
SETTINGS, RESULTS]
```
This display appears after you press DISPLAY STATUS. Select “NO” to return to the previous operating state. Select “SETTINGS” to view program settings. Select “RESULTS” to view the results completed when you pressed DISPLAY STATUS.

151
```
SETTINGS DISPLAYS
```
Display 151 is used to identify the displays used to summarize the current program settings which appear when you select “SETTINGS” in Display 150.

152
```
RESULTS DISPLAYS
```
Display 152 is used to identify sampling results displays which appear when you select “RESULTS” in Display 150.

200
```
SELECT OPTION (← →)
name of configure option
```
Display 200 is used to identify the displays which identify each configure option. Press ENTER/PROGRAM to access the input displays for each option. Use the LEFT ARROW and the RIGHT ARROW keys to move through the options.

210
```
HH:MM  MM/DD/YY
HH:MM  MM/DD/YY
```
Set Clock configure option. Enter the time and date to set the controller’s clock. Use military time. Note that the configure options does not use the European date format.

220
```
[PORTABLE, REFRIG.]
SAMPLER
```
Bottle Size configure option. Select “PORTABLE” when you are using a 3710 Portable Sampler. Select “REFRIG.” when you are using a 3710 refrigerated sampler.

221
```
[1, 2, 4, 8, 12, 24]
BOTTLES
```
Bottles and Sizes configure option. This display appears when you have selected Refrig. in Display 220. Select the number of bottles in the bottle base. Note that 12 bottle configuration is only available for the 3700FR.

222
```
[1, 4, 12, 24] BOTTLES
```
Bottles and Sizes configure option. This display appears when you have selected Portable in Display 220. Select the number of bottles in the base.

223
```
BOTTLE VOLUME IS
----- ml
```
Bottle Size configure option. Enter the bottle volume in milliliters.

224
```
---- ml  . . . ARE YOU
SURE?  [YES, NO]
```
Bottle Size configure option. This display appears when you have entered a bottle volume, in Display 223, that exceeds a standard Isco bottle size.

230
```
SUCTION LINE ID IS
[1/4, 3/8] INCH
```
Suction Line configure option. Select “1/4” if you are using 1/4 inch suction line, “3/8” if you are using 3/8 inch suction line.

231
```
SUCTION LINE IS
[VINYL, PTFE]
```
Suction Line configure option. This display appears when you have selected “3/8” in Display 230. Select “VINYL” if you are using vinyl suction line, “PTFE” if you are using PTFE suction line.

232
```
SUCTION LINE LENGTH
IS -- FEET (3 - 99)
```
Suction Line configure option. Enter the length of the suction line. The length should not include the tube coupling or the strainer.

240
```
[ENABLE, DISABLE]
LIQUID DETECTOR
```
Liquid Detector configure option. Select “ENABLE” to turn the detector on, “DISABLE” to turn the detector off. If you turn the detector off, you will be required to enter the suction head measurement (Display 70) in the program sequence.

241
```
- RINSE CYCLES (0 - 3)
```
Liquid Detector configure option. This display appears when you have selected “ENABLE” in Display 240. Enter the number of rinse cycles. Rinse cycles condition the suction line to reduce cross contamination.

242
```
ENTER HEAD MANUALLY?
[YES, NO]
```
Liquid Detector configure option. This display appears when you have selected “ENABLE” in Display 240. Select “YES” to add the suction head setting (Display 70) to the program sequence. Select “NO” to omit the setting.

243
```
RETRY UP TO - TIMES
WHEN SAMPLING (0 - 3)
```
Liquid Detector configure option. This display appears when you have selected “ENABLE” in Display 240. Enter the number of retries: the number of times the sampler will try to detect the presence of liquid for each sample event.

250
```
[BASIC, EXTENDED]
PROGRAMMING MODE
```
Programming Mode configure option. Select “BASIC” if you want to use the basic programming mode. Select “EXTENDED” if you want to use the extended programming mode.

255 | LOAD PROGRAM [#1, #2, #3, NONE]

Load Stored Program configure option. Select the number of the sampling program you want to use. Select “NONE” to exit the display without loading a program.

260 | SAVE PROGRAM AS [#1, #2, #3, NONE]

Save Current Program configure option. Select the number you want to use to identify the current program with when saved. Select “NONE” to exit the display without saving a program.

270 | TAKE SAMPLE AT START TIME? [YES, NO]

Flow Mode Sampling configure option. This setting affects flow-paced sampling routines. Select “YES” to take the first sample at the start time, “NO” to take the first sample at the end of the first flow interval.

271 | TAKE SAMPLE AT TIME SWITCH? [YES, NO]

Flow Mode Sampling configure option. This setting affects flow-paced, time-switched sampling routines only. Select Yes to take a sample at switch times. Select No if no sample event is desired at the switch times.

280 | ENTER INTERVALS IN [CLOCK TIME, MINUTES]

Nonuniform Time configure option. Select “CLOCK TIME” to enter the nonuniform time intervals as clock times (Display 26). Select “MINUTES” to set the nonuniform intervals in minutes (Display 27).

290 | [ENABLE, DISABLE] CALIBRATE SAMPLER

Calibrate Sampler configure option. Select “ENABLE” to add the calibration sequence to the program sequence. Select “DISABLE” to omit the calibration sequence.

300 | [ENABLE, DISABLE] SAMPLING STOP/RESUME

Sampling Stop/Resume configure option. Select “ENABLE” to add the Sampling Stop and Resume settings to the program sequence. Select “DISABLE” to omit the settings.

301 | SAMPLE AT STOP? [YES, NO]

Sampling Stop/Resume configure option. This display appears when you have selected “ENABLE” in Display 300. Select “YES” to take a sample at stop times. Select “NO” if no sample event is desired at the stop times.

302 | SAMPLE AT RESUME? [YES, NO]

Sampling Stop/Resume configure option. This display appears when you have selected “ENABLE” in Display 300. Select “YES” to take a sample at the resume times. Select “NO” if no sample event is desired at the resume times.

310 | ---- MINUTES DELAY TO START (0 - 9999)

Start Time Delay configure option. Enter the amount of time, in minutes, you want to delay the start time. This setting affects programs that do not have a programmed start time.

320 | MASTER/SLAVE MODE? [YES, NO]

Enable Pin configure option. Select “YES” to turn the Master/Slave mode on. Select “NO” to turn the Master/Slave mode off.

321 | SAMPLE UPON DISABLE? [YES, NO]

Enable Pin configure option. Select “YES” to take a sample at the time the sampler becomes inhibited. Select “NO” if no sample event is desired when the sampler becomes inhibited.

322 | SAMPLE UPON ENABLE? [YES, NO]

Enable Pin configure option. Select “YES” to take a sample when the sampler becomes enabled. No sample will be taken if the signal initiates the start time delay countdown. Select “NO” to take no sample upon enable.

323 | RESET SAMPLE INTERVAL? [YES, NO]

Enable Pin configure option. Select “YES” to restart the sample interval countdown at the time the sampler becomes enabled. If “NO” is selected, the interval countdown is determined by the setting in Display 324.

324 | INHIBIT COUNTDOWN? [YES, NO]

Enable Pin configure option. This display appears when “NO” was selected in Display 323. Select “YES” to halt the pacing interval when the sampler is disabled. Select “NO” to continue the countdown.

330 | [CONTINUOUS SIGNAL, PULSE]

Event Mark configure option. Select “CONTINUOUS SIGNAL” to send a variable duration event mark signal out pin E of the flow meter connector. Select “PULSE” to send a 3 second event mark signal.

331
```
DURING [PUMP CYCLE,
FWD PUMPING ONLY]
```
Event Mark configure option. Select “PUMP CYCLE” to send the signal continuously during the entire pump cycle. Select “FWD PUMPING ONLY” to send the signal while the pump is delivering a volume.

332
```
AT THE BEGINNING OF
[PURGE, FWD PUMPING]
```
Event Mark configure option. Select “PURGE” to transmit an event mark pulse signal to a flow meter at the beginning of the pre-sample purge. Select “FWD PUMPING” to transmit a pulse when the pump switches forward.

340
```
--- PRE-SAMPLE
COUNTS (0 - 9999)
```
Purge Counts configure option. Enter the number of pre-sample pump counts needed to purge the suction line. This value is set to 150 when the controller is re-initialized.

341
```
--- POST-SAMPLE
COUNTS (0 - 9999)
```
Purge Counts configure option. Enter the number of post-sample pump counts needed to purge the suction line. The number that initially appears is derived from the suction line ID and length entered in Displays 230 and 232.

350
```
------ PUMP COUNTS,
WARNING AT ------
```
Tubing Life configure option. This informational display reports the number of pump counts elapsed since the last reset and the number of counts required to trigger the Pump Tubing Warning. Exit this display by pressing any key.

351
```
RESET PUMP COUNTER?
[YES, NO]
```
Tubing Life configure option. After changing the pump tube, select “YES” to reset the pump counter to zero. Select “NO” to leave the counter unchanged.

352
```
------ PUMP COUNTS
TO WARNING
```
Tubing Life configure option. Enter the number of pump counts required to trigger the pump count warning. This value is reset to 500,000 when the controller is re-initialized.

360
```
[ENABLE, DISABLE]
PROGRAM LOCK
```
Program Lock configure option. Select “ENABLE” to turn the program lock on: input displays will be protected by a pass-number: 3710. Select “DISABLE” to turn the program lock off.

365
```
SAMPLER ID NUMBER IS
----------
```
Sampler ID configure option. Enter the ID for the sampler. Use any of the numeric keys. Press START SAMPLING for a space. Press RESUME SAMPLER for a period. Press MANUAL SAMPLE to enter a dash (-).

370
```
TEST DISTRIBUTOR?
[YES, NO]
```
Run Diagnostics configure option. Select Yes to run the distributor test. Select No to skip the test. The distributor is tested by moving it to position 24 then back to position 1.

371
```
RE-INITIALIZE?
[YES, NO]
```
Run Diagnostics configure option. Select “YES” to re-initialize the sampler. Select “NO” to the leave the controller unchanged.

Appendix F: Flow Device Manual for Monitoring

MODEL 3000

OPERATING INSTRUCTIONS

Software Version
3.3f
17 May 2002

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MODEL 3000

CURRENT VELOCITY AND STREAM DISCHARGE INDICATOR
The *Model 3000* is used with rotating sensor current meters for calculating, storing, and processing stream velocity and discharge data to enable on-site evaluation. The *Model 3000* can operate in units of either feet or meters. There are four basic modes of operation:

CALIBRATE MODE

This mode is used to input directly or to field calculate the pitch of a "prop". Field calibration is accomplished by towing the prop through a water course of known length while the *Model 3000* counts the number of pulses produced. The prop pitch is then automatically calculated;

(1) pitch = number of pulses / course length (10 feet & 10 meters)

dimensions are pulses per foot OR pulses per meter

COUNT (COUNT REVOLUTIONS) MODE

This mode counts prop (meter) revolutions for a user definable time period. The number of pulses per revolution of a prop will vary for different props and rotor assemblies. After the timing period and pulses per revolution are set the number of revolutions during the time period can be calculated; This mode is primarily used with the USGS Price Type AA and Pygmy meters using the original "catwhisker contactor" sensors, magnetic head (preferred) or the Swoffer optic-head retrofit (Model 2200) sensors.

(2) revolutions = pulses during period / pulses per revolution

VELOCITY MODE

This mode calculates the velocity of water flowing past the sensor using the formula;

(3) velocity = (n/p) / t
t = measurement period in seconds
p = prop pitch in pulses per 10 feet OR pulses per 10 meters
n = number of pulses counted during period t

dimensions are feet per second OR meters per second.

DISCHARGE MODE

This mode calculates total stream discharge using individual partial area and velocity measurements taken across the stream bed.

(4) $Q = \eth\, av$

Q is total discharge in ft^3 per second OR m^3 per second
a is an individual partial cross section area
v is the corresponding mean velocity of the flow normal to the partial area

The cross section is defined by depths at locations 1, 2, 3, . . . n. At each location the velocities are measured to obtain the mean of the vertical distribution of velocity. The partial discharge is now computed for any partial section at location x as:

(5) $$q_x = v_x \left[(b_x - b_{(x-1)}) /2 + (b_{(x+1)} - b_x) /2 \right] d_x$$

$$= v_x \left[b_{(x+1)} - b_{(x-1)}/2 \right] d_x$$

$x = 1, 2, 3, \ldots n$, observation points

q_x = discharge through partial section x

v_x = mean velocity at location x

b_x = distance from initial point to location x.

$b_{(x-1)}$ = distance from initial point to preceding location

$b_{(x+1)}$ = distance from initial point to next location

d_x = depth of water at location x

The v_x's in the above formula are usually measured using one of two methods:

1. Velocity measurement taken at depth $(0.6)d_x$.

2. The average of two velocity measurements taken at depths of $(0.2)d_x$ and $(0.8)\ d_x$.

NOTE: Other methods are also valid and in fact are called for in special types of measurement situations. The ones stated here are merely shown as guides to help use the *Model 3000* in natural streams.

This procedure for discharge measurement is used by the US Geological Survey and is described in detail in Chapter A8, *Discharge Measurements at Gaging Stations*, a publication of the US Geological Survey. The procedure is also covered in *Hydrology and Hydraulics Systems*, Ram S. Gupta, Prentice Hall, and *Hydraulic Engineering,* Roberson/Cassidy/Chaudhry, Houghton Mifflin. *Open-Channel Flow,* M. Hanif Chaudhry, Prentice Hall, ISBN 0-13-637141-8 is also an excellent reference work for applications in many different types of channels.

KEYPAD OPERATION

The operator controls the *Model 3000* through a 20 button keypad. The keypad is configured as 4 rows by 5 columns:



THE PRIMARY FUNCTIONS AND THE SHIFT FUNCTIONS

The primary functions are printed in the lower half of the key, and the shift functions are printed in the upper half.

Select a primary function by pressing only that key.

Select a shift function by first momentarily pressing the SHIFT key, then the desired key. *Do not hold the SHIFT key down while pressing a shifted function key*.

POWER ON AND OFF

The PWR key turns the *Model 3000* on and off. ON is instant after pressing the PWR key. OFF requires that the key be held depressed for four seconds. The *Model 3000* display counts down from three seconds to OFF while the key is depressed.
The *Model 3000* also has an "auto off" feature. After no keypad activity for 20 minutes, the instrument shuts down. To restart press the PWR key. No saved data is lost at auto shutdown.

The ENTER key

The ENTER key is used to tell the *Model 3000* that a number has been entered and generally to progress to the next display screen.

The ESC (Escape) key.

One of the most important keys on the pad since it allows you to "back out" of almost anywhere and any function. Generally, to enter into a new Function you must begin from the initial screen. Press the ESC key the number of times necessary to reach the initial screen, which is:

M3000 (feet) Command

For the display to show meters press the "0" (numeral zero key) at the initial screen (see UNITS OF MEASURE):

M3000 (meters) Command

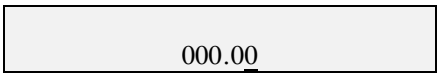
DISPLAY OPERATION

The *Model 3000* communicates to the user by the Liquid Crystal Display (LCD). The display is arranged as 2 rows by 16 characters per row:

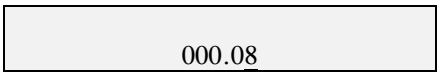
Model 3000 LCD 2 rows X 16 char

ENTERING NUMBERS

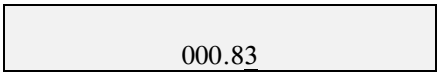
When the *Model 3000* requires numerical input the display will show the number field to be entered with a cursor under the rightmost digit position:



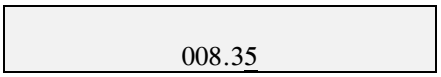
As the number keys are pressed the last number pressed will appear in the rightmost position and the other digits will be shifted (scrolled) left. For example, if the digit "8" were pressed the display would look like this:



and after following with the digit "3":



then after pressing the digit "5":



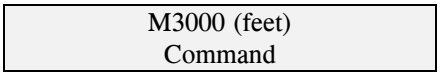
Pressing any of the number keys will cause the digits to appear on the LCD entering at the rightmost position while shifting the other digits to the left. The left most digit is "thrown away" each time a number key is pressed. This means that if a mistake is made just enter the number you want until it appears correctly in the LCD.

Press the ENTER key after you are satisfied with the number you see displayed.

IMPORTANT NOTE: *Changing numbers or values is not possible without a visible cursor. Be careful however, when you do see the cursor that you do not accidentally change figures you may only wish to view, not modify. If the cursor is visible, you can edit the data…whether you want to or not. Pressing the ESC key when the cursor is visible will make it disappear and prevent editing. This is most important in the DISCHARGE MODE.*

POWER ON MESSAGE

When the *Model 3000* is first powered on it will display:



UNITS OF MEASURE

The Model 3000 works in both feet and meters units of measure. The *Model 3000* does not show the units on the LCD except at the initial screen. Units may be toggled from feet to meters by simply using the 0 key (zero) while the Indicator is in the initial screen. Each press of the 0 key will change units from feet to meters to feet, etc. No data will be lost in the stored registers and all data in the Model 3000 will be recalculated instantly based on the new units selected. Units may be changed any time by returning to the initial screen and toggling the 0 key.

MEMORY CAPACITY

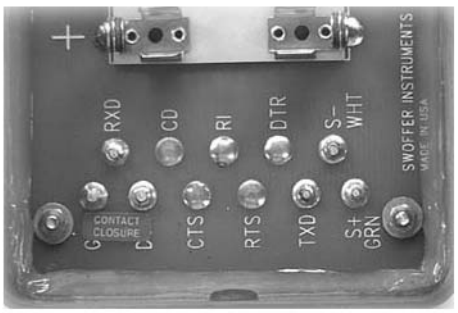
The *Model 3000* is capable of holding one hundred stream cross-sections (referred to as **Transects** or **Sections**) with a total of 1000 Stations. Any combination of station numbers can be used in the Sections as long as the total number does not exceed 1000 Stations. (Example: two Sections of 500 Stations, five Sections of 200 Stations or one Section of 1000 Stations, etc.) Each **Station** stored in memory consists of, **the Station Number** (width from initial point 0), **Depth**, **Velocity**, **Angle** and **Time & Date**.
Any of the Sections may be erased completely and separately at any time without affecting the other Sections *and* any Station in any Section may be erased or modified at any time.
When memory has reached the 1000 Station capacity, the Model 3000 will display "MEMORY FULL". No further storage is possible until a Section or Sections are deliberately erased using the procedure described in the Data Erase portion of the instructions. (p. 16,17)

SELECTING A SENSOR (PROP key)

Before any measurements can be made a "prop" must be selected. The default is Prop no. 1, the 2 inch propeller which has been standard with all previous Model 2100 instruments and is now standard with the *Model 3000*.

The *Model 3000* Indicator uses *calibration numbers* or the "pitch" of the prop (or other type sensor) connected to it to determine velocities. The *Model 3000* indicator stores the pitches for five different props plus the USGS AA meter, Pygmy meter and a spare location for any other "contact-closure" type sensor. The props are identified as 1, 2, 3, 4, and 5, AA 1/1, Pygmy and "Contact closure". There are two additional positions for input of the equation supplied with AA and Pygmy Price Type vertical axis meters with their rating charts. These two positions follow the contact closure position and are called "Equation/Contact" and "Equation/Optic". Scrolling through the PROP menu is accomplished by pressing the PROP key repeatedly. When the last Prop position is reached the menu returns to the first one again. ("Scrolling" of Prop selections goes only in one direction). Selecting a Prop is done by pressing ENTER when the desired Prop is displayed. When a selection has been made, press the ESC key to return to the initial screen. The Model 3000 will always power up with this prop selection until changed again.

The *Model 3000* comes with default calibrations for the three standard propeller - sensor combinations normally used with the instrument. 1, 2 and 3 are the 2", 3" and $1^{3}/_{8}$" propellers. 4, 5, and "Equation/Optic" are pre-calibrated for AA and Pygmy meters using the Swoffer Model 2200 optical retrofit sensor. Positions **AA 1/1**, **Pygmy, Contact closure** and **Equation/Contact** automatically convert the *Model 3000* from optical input to contact closure input (non optical sensors) and require connecting the sensor wires to different positions in the battery compartment. (Several options for alternate cabling hookups are available with the *Model 3000* . Please see any supplemental sheets for the most recent variations. *Your version may differ in some ways*.)



To select a prop press the PROP key, the display will look like this (with units=Feet selected): [1]

```
Prop 1
Pitch :  186.00
```

If prop number 1 is not the desired prop press PROP again, the display will look like this:

```
Prop.  2
Pitch :   130.00
```

Repeated pressing of the PROP key will cause the *Model 3000* to display the pitches for prop numbers 3, 4, and 5. Pressing PROP again will scroll the display to show the pitch for a USGS AA meter using the original catwhisker contactor (one pulse per revolution) on the 1/1 connection. Pressing PROP again will display the calibration number for a USGS Pygmy meter using the cat whisker contactor and pressing once again will display "Contact closure", "Equation/Contact", and "Equation/Optic". The Props scroll around to No. 1 again with the next press of the PROP key. When the desired prop number is displayed you may press the ENTER key to select it. (See page 25 for a list of the default calibration numbers). The display will read:

```
Prop p
        SELECTED
```

The *Model 3000* will always use this Prop selection even after shut down and re-start until changed again**.** *Remember that the **AA 1/1**, **Pygmy**, **Contact Closure** and **Equation /contact** positions also change the Model 3000 from an optical input (electronic signal processing) to a contact closure type of system **only**.* Different electrical connections in the battery compartment are required for operation in these three positions.

NOTE: Calibration numbers (Pitch) displayed for the different props represent the number of sensor pulses produced when a sensor/propeller combination (AA and Pygmy meter included) is dragged though a distance of ten units (feet or meters) of quiet water. The *Model 3000* uses these figures along with an internal timer to compute velocity. Default calibration numbers have been derived by Swoffer (and others) to be the *norm* for each sensor/propeller combination represented, however, these can be changed to match any new or newly derived calibrations determined by the user's field trials.

IMPORTANT !: *If very accurate and consistent velocity data is to be derived from the Model 3000 then the following calibration procedures must be put to use regularly .*

CALIBRATE MODE

a: Automatic Entry of Prop Pitch by *Model 3000* Calculation:

< < < WARNING> > > Make sure that the Model 3000 Indicator is in the correct units mode (feet or meters) when calibrating a sensor. I.e. do not input "metric" data while the instrument is in the "feet" mode. Your velocity measurements as well as the discharge measurements (as calculated by the Model 3000) will be in error. Back out using the ESC key to the initial screen and toggle the "0" key for desired units selection.

To determine the pitch of a propeller by actual field calibration trials use the Calibrate mode. Calibration is then accomplished by towing the propeller through a course of known length of quiet water while the Model 3000 counts the number of sensor pulses produced. The prop pitch is then calculated:

$$\text{Pitch} = \frac{\text{number of pulses}}{\text{course length}} \quad \text{pulses in 10 feet (or meters)}$$

To calibrate a propeller, first select the propeller number to be used (press PROP until the desired Prop No. is displayed then press ENTER to select it. Press ESC twice to return to the main screen. Next enter the Calibrate mode by pressing *shift* then CALIBRATE. Display will read:

0 = Calculate 1 = Manual Entry

To do an actual field calibration, press 0.
To determine a reliable calibration number for your *Model 3000* [something you must do if you are working with slow flows (below about 1.5 FPS) and for measurements taken in very shallow streams] perform the following:

SUGGESTED METHOD OF COURSE LAYOUT AND PROCEDURE FOR FIELD CALIBRATIONS

Mark a straight course of 10 to 20 feet in length in a body of calm, current-free water along which the sensor can be towed by walking the course. A swimming pool or dock into a quiet lake serves well.

Place the sensor in the water a few feet before the beginning of the course, 6 to 12 inches below the surface. Begin walking the sensor through the course at a rate close to that which you will be measuring. Using the *wand* or wading rod rather than the sensor as a guide, press and release **COUNT** at the instant the wand enters the course. The *Model 3000* indicator will count the number of sensor pulses generated as you walk through the length of the course. At the instant the wand leaves the course press and release **COUNT** again. The displayed number is the number of sensor pulses counted in the course length. Several passes through the course in *both directions* will develop a reliable average calibration figure for the rotor-propeller assembly being tested.

IN PRACTICE

Following the in-water placement of the sensor and the walking procedure just described:

Pressing the 0 key will prompt the *Model 3000* display to ask you for the course length. Enter the length of course to be used by pressing digits followed by ENTER. Any course length will do since the Model 3000 adjusts the number to equal counts in 10 feet/10 meters, but the longer the distance the better.
NOTE: Be very sure which units mode the Model 3000 is in before entering figures. (Don't enter feet as the course distance while the Model 3000 is in the METERS mode for instance!).
Display will read:

Course length? 0.00

Press ENTER again and the display will read:

Count = Pass number = 1

Begin walking the sensor several feet before course start mark and at the instant the sensor wand enters the actual course press the COUNT button. Display will begin counting up sensor pulses generated through the length of the course. At the instant the wand reaches the course end, press COUNT again. Counting will stop and the *Model 3000* will automatically calculate a pitch, converting the pulses into a figure in 10 feet (or 10 meters).
Display will read:

Pitch = ppp.pp ENTER or REJECT

This pitch is entered in the memory if accepted and it is expressed as the number of sensor output pulses generated in ten feet or meters. It is strongly advised to take four to six passes through the course in both directions to determine a reliable average count for the pitch. The model 3000 keeps track of the number of "passes" back and forth and you may accept or reject any pass as necessary by aborting mid-way (press ESC anytime during the pass) or *shift* REJECT at the end of a pass. Press ENTER after a successful pass to save the count. Press COUNT again to begin another pass and COUNT to stop counting at the end of the next pass. ENTER to accept.

IMPORTANT NOTE: Pressing ENTER a second time after accepting any count will total and average the counts up to that point and will assign the average as the calibration number for that prop pitch. Once done, you have three choices: accept the figure, enter a different figure manually, or start the passes over again for a new set of data.

b: Manual entry of Prop Pitch:

If the pitch of a propeller is known and it is desired to enter it, the manual Calibration mode is used:

< < < WARNING > > > Make sure that the Model 3000 Indicator is in the correct units mode (feet or meters) when manually inputting calibration numbers for a sensor. I.e. do not input "metric" data while the instrument is in the "feet" mode. Your velocity measurements as well as the discharge measurements (as calculated by the model 3000) will be in error. Back out using the ESC key to the initial screen and toggle the "0" key for units selection.

First, select the sensor (Prop No.) to be used by scrolling through the menu then pressing ENTER. ESC to the main screen and enter the calibrate mode by pressing *shift* CALIB. Display will read:

0 = Calculate 1 = Manual Entry

Press 1. Display will read:

Prop # N
Pitch = PPP.PP

Enter the digits necessary to display the known pitch (pulses per unit of measure). Then press ENTER to put this pitch in the memory.
Manual Calibration mode may be used when changing optic rotor assemblies. New designs may have more (or fewer) pulses per revolution, for instance the AA meter can have an upgraded optics rotor which has four pulses instead of the original 2 pulses per revolution, effectively doubling the calibration number.

It is important to note that errors in measurements due to Calibration Number variation will be in direct percentage proportion to the difference *between the ideal (correct) Calibration Number for a Prop or rotor and the number that the indicator displays for the rotor.*
Example: If the ideal number is 186 and the displayed number is 184 then the velocity error due to calibration error will be about 1%.

EQUATION / CONTACT and EQUATION / OPTIC ... CALIBRATION INPUT

In the Equation mode, the *Model 3000* uses the slope - equation normally provided with some propeller and all vertical axis meters ($y = mx + b$). In the Equation / Contact mode the *Model 3000* converts from optic

(electronic) to contact closure input signal only (catwhisker, reed switch, etc.). In the Equation / Optic mode the *Model 3000* converts back to optical (electronic signal) input only. In both cases the operator must first tell the *Model 3000* what the variables in the equation are. *< < < WARNING > > > Make sure that the Model 3000 Indicator is in the correct mode (feet or meters) when inputting the equation. I.e. do not input a "metric" equation while the instrument is in the "feet" mode. Your velocity measurements as well as the discharge measurements (as calculated by the Model 3000) will be in error. Back out using the ESC key to the initial screen and toggle the "0" key for units selection.*

1. Select by using the PROP key the Equation version desired. We will use the standard magnetic head input for these instructions. Press PROP until "Equation / Contact" is displayed then press ENTER.
2. Press ESC until the initial screen is reached.
3. Press (shift) Calibrate.
4. The display will show:

m part of equation 02.180

5. Enter the first number on the Rating Chart (for an AA meter it will probably be about 2.180, Pygmy Meter =0.977).
6. Press ENTER again and the display will show:

b part of equation 00.020

7. Enter the b part of the equation, usually about 0.020 for a standard AA meter (Pygmy = 0.028).
8. Press ENTER again and the screen will read;

pulses per rev 01

9. This will be the number of sensor pulses generated in one meter revolution. With an AA or Pygmy meter, cat whisker contactor (or magnetic head), the figure should be 1. (AA meters also have a position for one pulse in five revolutions but it is not necessary to use this position. Optical sensors by Swoffer (2200-3000) provide at least two and some are available with four or six pulses per revolution. *Gurley Precision* makes an optical sensor that produces one pulse per revolution.
   It is very important that this information be entered correctly. Count and verify the number of pulses in a meter revolution before proceeding. If you are using fiber-optic sensors count the number of “eyes” you see in the fiber-optics rotor. There will always be an even number ; two, four, six, eight, etc.
10. When all three data are entered press ESC three times (or until the initial screen appears). You are now ready to take velocity measurements in the normal manner using either the menu selected by the Velocity key or the Discharge key.

COUNT REVOLUTIONS MODE

This mode is used with the US Geological Survey's Price Type AA and Pygmy current meters. The manufacturers of these meters provide rating tables that are a listing of rotor revolutions and time periods to turn those revolutions. Opposite these parameters are tabulated the corresponding velocities.

Before initiating this mode select the "PROP" (sensor) you will be using. The *Model 3000* default for this setting is an AA or Pygmy meter using the Swoffer optical retrofit sensor producing 2-pulses per revolution. (PROP positions 4, AA optic or 5, Pygmy optic). If you are using that combination no further selections are necessary. In this mode the *Model 3000* computes revolutions based on 2 pulses per rev with an opto-electronic input signal. You may also scroll forward to “Equation/Optic” if you wish to enter the calibration equations supplied with your AA and Pygmy meters. All these choices leave the Model 3000 Indicator in the Optic input mode.
If you will be using an AA or Pygmy meter with the original catwhisker contactor or a Magnetic Head (preferred) you must first do three things:

1. Scroll the PROPs key until one of the contact closure inputs is selected ("AA 1/1", "Pygmy", "Contact Closure" or “Equation/Contact”). Without this selection no signal will be processed by the *Model 3000* .

2. Change the pulses per rev from 2 to 1 at the first COUNT screen. (If using the COUNT mode) Otherwise revolutions shown will be ½ (or fewer) than actually turned.

3. Connect your meter to the “contact closure” posts (marked GND" and DSR) in the battery compartment. (Note: some Model 3000 indicators have been modified with alternate connection methods.)

To determine the number of rotor revolutions for a selected time period the *Model 3000* must receive two user inputs: (1) Length of timing period in seconds; (2) Number of pulses per revolution of the rotor.

Press the COUNT key to enter count revolutions mode and the LCD will look like this:

Pulses / Rev. ?
00

Using the number keys enter the number of pulses produced for each prop (meter) revolution then press the ENTER key. The LCD will then look like this:

Time period ?
00 seconds

Using the number keys enter the time period for counting revolutions, then press the ENTER key. The LCD will then look like this:

Pulses =
ENTER to start

When the meter is correctly positioned and you are ready to start counting revolutions press the ENTER key and the LCD will look like this:

Pulses = rr
Time = tt

As pulses of the rotor are counted they will be displayed on the top line. The bottom line will display seconds remaining in the timing period.

If you wish to stop the counting, press ESC any time during the count. You may then start over.

When tt = 00 the total accumulated pulses will be divided by the pulses per revolution and the display will look like this; showing the number of revolutions counted and the elapsed time in seconds:

rr.rr revs.
tt.tt seconds

Note: The timing period displayed will always be slightly longer than that selected because timing is stopped only after the next input pulse occurring after the timing period has counted to zero. Numbers of revs may also be greater (by decimal fractions) than a whole revolution if using an optical sensor (or any sensor with greater than one pulse per revolution). i.e., a rotor with two pulses could produce 10.5 revs, one with 4 pulses per rev. could produce 10.25, 10.5 or 10.75 revs., etc.

COUNT MODE TO DETERMINE OPTICAL ROTOR CONDITION (rotor maintenance)

You may also use the COUNT MODE of the *Model 3000* to determine the condition of the bearings of a propeller rotor assembly. The standard rotor assembly "off the shelf", equipped with the 2" propeller, should be able to "spin up" counts from a zero reset to about 350 to 400 pulses.
Enter the Count Mode by pressing the COUNT key. Enter the number of sensor pulses per revolution. With propeller sensors it will be four (the default in this mode is 2 so be sure to change it). Set the Time Period to a high figure (about 100 seconds. If you do not then the meter converts the numbers to revs at the end of the countdown and your "counts" will be ¼ that of actual pulses generated). Alternatively you may enter "1" as the number of pulses per rev, then after final countdown the "Revs" will equal the "pulses".
Place the sensor in a position so that the propeller is pointing straight up in the air. Blow down as hard as you can on the propeller and at the instant you stop blowing press and release the ENTER key. Let the rotor coast to a stop. The final count should be about 350 or more to equal a rotor assembly that will perform to the limits of its design. This method requires some practice to perfect but the results are a good indicator of the response characteristics of a particular rotor assembly. (More detailed rotor testing and care instructions are included with the sensor wand portion of the instructions.)
If you are not consistently getting the counts suggested then check the method again and if valid, disassemble the rotor assembly and clean it thoroughly. You may need to replace worn parts then give the spin test another try.

SELECT AN AVERAGING TIME

For the *Model 3000* to calculate velocity, the desired measurement period in seconds must be entered. This is done by pressing the SHIFT key followed by the AVG. TIME key, this will cause the LCD to look like this:

Avg. period?
020 seconds

20 seconds is the default timing period. If this number does not need to be changed press ESC.
If you wish to change the timing period use the number keys to enter a new figure, then press ENTER. The *Model 3000* retains whatever value is entered. The LCD will then look like this:

Averaging period
sss seconds

Where sss can be either the original number displayed or the new value. Any number from 1 to 999 seconds is valid and will remain as the default until changed again. Press ESC to return to the previous screen.

Note: because the *Model 3000* starts and stops timing from the first input pulse (after a timing period has started) through to the first input pulse after the timing period has stopped, the actual time in measurement will always be slightly longer than the time selected for your averaging period.

VELOCITY MODE

Used for determining point velocities in open channels. Values cannot be stored in this mode. If storage of data for later upload is required, use the DISCH mode.

Before using the velocity mode select a prop using the PROP key and enter a new averaging period if desired. Default Prop is #1, 2" dia. propeller and averaging period is 20 seconds but whatever you select will become the default.

Pressing the VELOCITY key will put the *Model 3000* in velocity mode, and the LCD will look like this:

Avg. time:	xx_
Avg. vel:	0.00

When the prop is in position in the stream press the ENTER key. The *Model 3000* will display:

Press Enter to start

Press Enter again and the display will instantly turn to:

Time = (your averaging time) Pulses =

with the pulses counting up as the sensor rotates. The *Model 3000* counts up sensor pulses as it counts down the seconds remaining for the measurement. If the ESC key is pressed before tt = 0 then the measurement will be aborted and the LCD will go back to the last measured velocity:

Avg. time:	tt_
Avg. vel:	0.00

If allowed to proceed to the end of the timing period the display goes to:

Velocity: vv.vv Enter or Reject

If ENTER is pressed now the velocity will be averaged with the previous one and the LCD will return to:

Avg. time tt_ sec Enter to start

and a new measurement can be started by pressing ENTER again. If you want to average this velocity measurement with other measurements pressing ENTER will command the *Model 3000* to average a velocity with subsequent velocity measurements.

When the measurement completes and tt = 0 then the LCD will look like this:

velocity = vv.vv ENTER or REJECT

If you do NOT want to average this measurement, press the *shift* REJECT key. The LCD will then look like this:

Avg. time: tt Avg. vel: vv.vv

Where vv.vv is the accumulated average velocity. The *Model 3000* is then ready to make another velocity measurement.
There is no limit to the number of measurements that can be taken and averaged, with the options of aborting, rejecting, or using each measurement.
To exit the velocity mode press ESC. You may then start another series of averaged velocities by pressing VELOCITY and beginning the process again.

NOTE: Any time you exit the velocity mode any accumulated average velocity is lost and will be reset to zero. You may only record and store velocities in the Discharge Mode.

DISCHARGE MODE

Discharge mode allows the operator to make velocity and depth measurements at Stations and record this information in the *Model 3000's* memory. The *Model 3000* can then calculate total stream discharge using formulas (4) - (5), (page 3) . The data stored in memory can also be transferred to a computer (page 18) for more detailed analysis.

DEFINITIONS

SECTION — A stream cross-section (Transect) made up of a series of at least two Stations.

STATION - The distance from an initial point at the edge of a stream to positions (Stations) on a "tag line" stretched across the stream. Decimal units are in feet or meters between 000.000 and 999.999. This number is input by the operator, and is used by the *Model 3000* to calculate total discharge.

STATION DEPTH - The measured water depth at a STATION, a decimal number between 000.000 and 999.999. This number is input by the keypad, and is used by the *Model 3000* to calculate total discharge.

STATION VELOCITY - This quantity is measured by the *Model 3000* at each station. Since multiple velocity measurements can be averaged to arrive at this number the 6/10 depth or the 2/10 - 8/10 depth method can be used. Additionally, if the flow at a station is not at 90° to the cross-section the actual angle can be entered and the *Model 3000* will apply a cosine correction to the velocity. Used by the *Model 3000* to calculate total discharge. Note: Only one velocity value is stored for any station.

SPECIAL KEYS USED IN THE DISCHARGE MODE

There are five keys which are used **only** in the discharge calculation mode, they are:

DISCH MODE - Commands the *Model 3000* to operate in the discharge mode. Can be addressed only from the initial screen.

STATION - Tells the *Model 3000* to ask the operator for a station number (a measured width from an initial point at the stream edge). Indicated by a flashing cursor under least significant digit. Possible Section numbers are 1 to 100.

DEPTH - Used to make a depth entry. Indicated by a flashing cursor under least significant digit.

ANGLE (A shifted key) Used to modify a velocity which is not at 90° to the stream cross section. Applies a cosine function to the velocity at the measurement point. Normally necessary only for vertical axis meters (AA & Pygmy).

CALC - A shifted function. Tells the *Model 3000* to calculate and display the total stream discharge for a section using all station data in the memory. Select a Section (1-100), ENTER then press *shift* CALC. *You must have at least two stations entered before the Model 3000 will compute a discharge.*

When in the Discharge mode the VELOCITY key is used to tell the *Model 3000* to enter the velocity calculation mode and to save the measurement for the station.

When in the Discharge mode the *shift* UP arrow and *shift* DOWN arrow are used to scroll through the stored Station data. (When not in the Disch mode the arrow keys are only used to adjust the display contrast).

Scrolling through the stations returns to the first station after the last one is reached. To rapidly scroll Stations press and release the *shift* key then hold down a direction arrow. If you release pressure on the arrow key you may then press *shift* **up** or **down** for each consecutive Station. Do not hold down the shift key while pressing other keys...

ENTERING THE DISCHARGE MODE

To enter the Discharge mode, press the DISCH key. LCD will display:

Section Number: 1 1 .. 100

The *Model 3000* shows the last Section number used and allows you to pick 1 through 100 for the next Section. Enter the Section number desired. LCD will read:

Section : S Stations : 0-1000

NOTE: If the section contains any stored data (Stations greater than 0) the Stations can be displayed using the *shift* UP (arrow) and *shift* DOWN (arrow) keys.
If all new data are to be obtained for this section, all previously stored station data should first be erased.

INDIVIDUAL SECTION ERASE PROCEDURE

Input the section number you wish to erase

Press *shift* REJECT.

Display will read:

ERASE SECTION ? REJECT = YES

Press *shift* REJECT again to accomplish erasure. LCD will now read:

Section : S Stations : 0

ALL SECTIONS ERASE PROCEDURE

Erases all Sections entirely but does not erase or reset any calibration data or other modified "defaults".

1. From the main screen press the DISCH MODE key.
2. Select section 101 and press ENTER.

Erase ALL sectns REJECT = yes

3. Press (shift) REJECT will erase all sections, ESC will cancel the erase procedure.

DISCHARGE MODE DATA ENTRY

To proceed with measurements in the Discharge mode press ENTER. The LCD will read:

Sta : 000.000	VEL:
D : 000.000	000.000

Press the STATION key and a cursor will appear under the least significant digit. Enter the station number (the measured width from a zero point) and press ENTER. Cursor will disappear and LCD will read: (Where sss = your entered number for width)

STN : SSS.SSS VEL:
D : 000.000 000.000

When station depth is determined press DEPTH key and the cursor appears under the least significant digit. Key in the depth and press ENTER. The display will read the station number and the depth: (where ddd.ddd = your entered value for stream depth).

STN : SSS VEL:
D : ddd.ddd 000.000

Notes: 1. Either depth or station may be entered first but Velocity mode cannot be entered ***until*** *a Station number is entered. Depth may be zero, but a Station* ***must*** *have a value.*
2. The Model 3000 will not allow two Station numbers of the same value. If you try to enter the same number as a Station which already exists, the Model 3000 will simply return a value of zero.

Press VELOCITY. LCD will read:

Avg. time : 20
Avg. Vel: 0.00

(where Avg. time is the *Model 3000* default averaging period.)

Press ENTER and display will read:

Press ENTER
to start

When propeller is in position in the stream press ENTER to start velocity measurement. Time will begin counting down and sensor pulses will begin counting up. (If it is desired to stop any measurement *before* countdown is complete, press ESC and start over again by pressing ENTER). LCD will be reading:

Time = tt.t
Pulses = ppp.pp

The ending screen shows the average velocity over the timing period:

Velocity: vv.vv
Enter or Reject

Entering saves the velocity, then the display shows:

Avg. time: 20
Avg. vel: vv.vv

Pressing ENTER again allows you to take another velocity reading, averaging it with the last one(s). You may repeat the procedure as many times as you wish to develop a multiple sample average, pressing ENTER after each timing period ends.
Pressing *shift* REJECT *after* any timing period ends will void that period and the *Model 3000* will not use it in the average.

Pressing ESC anytime *during* the averaging period will stop the counts and you may start that velocity over again from the last display screen:

```
Avg. time: 20
Avg. vel:      vv.vv
```

IMPORTANT NOTE: Pressing ESC *after* a velocity has been completed will terminate velocity averaging for that Station. The *Model 3000* then displays all station values as have been input (depth & width) and as calculated (velocity):

```
STN:   www.ww      VEL:
D:   ddd.ddd        vvv.vvv
```

Pressing ENTER will save the station with the message:

```
Station saved
```

The next screen will be the SECTION number along with its number of STATIONS.

```
Section:  1 (2,3,4,5)
Stations:  ss
```

To start another Station press ENTER and a new blank Station will appear for you to repeat the above procedures:

```
STN:   000.000      VEL:
D:  000.000         000.000
```

Be sure to enter an "ending station" with a width (Station Number) but with a velocity and/or a depth of zero. See Discharge Calculation in the next section.

FLOW DIRECTION CORRECTION

In some discharge measurements parts of a Station's flow direction will be at an angle other than 90° to the stream cross-section. When this is encountered, the angle can be entered (0-90°) *before* the velocity measurement is taken and the ***Model 3000*** will then compute and display the velocity component normal to the Transect.

NOTE: A*ngle measurement is only available when the Model 3000 is in the velocity reading portion of the DISCHARGE Mode. Angle cannot be used when in the VELOCITY only mode.*

If no angle is entered the *Model 3000* always assumes the angle is 0°.

To enter a velocity angle press VELOCITY, then press *shift* ANGLE. The cursor appears under the least significant digit. Display will read:

```
Cosine angle =
      00
```

Press keys to enter the angle in degrees, then press ENTER. The cursor will disappear and the angle will have been logged as part of that Station.
Press ESC and the display will change to Velocity Mode and will read:

Avg. time: tt Avg. vel: 00.00

The *Model 3000* will now compute the velocity in the normal manner except that the displayed velocity will be the measured value multiplied by the cosine of the entered angle. As many measurements as desired (at the same angle) can be averaged using the same procedures listed above.

When finished averaging press ESC to display Station data.

STN: sss.sss VEL: D: ddd.ddd vvv.vvv

Pressing ENTER ends the averaging and stores the station data with the message "Station saved".

Repeat the process for each of the desired stations across the stream.
You must re-enter any angle at each new Station.

DISCHARGE CALCULATION

At any time during a Transect the accumulated discharge can be displayed by pressing *shift* CALC keys. (You must have at least two Stations in a Section for calculation of discharge). Display will read:

Section #N
DISCHARGE = QQQQ

Additional stations can be added to a Transect at any time. See following note.

Important Note: For proper discharge calculations to be made there must be a beginning and an ending Station for any cross section. As you stretch your tag line across the stream you will almost never have the "zero point" at the stream edge. For this reason the discharge calculations in the *Model 3000* need a beginning and an ending point (the stream edges). At the edge of the stream from where you wish measurement to be calculated, input the distance (Station Number) but apply no velocity. Do the same for the other stream-edge Station. Now the *Model 3000* can accurately calculate the discharge using the data taken between those two points.

STATION ERASURE

*Individual stations can be erased by scrolling to the Station to be erased then pressing **shift REJECT**. The Model 3000 asks:*

" Erase station ?" REJECT = yes

Pressing shift REJECT a second time will erase all data for that station and it will be removed from the SECTION permanently.
Pressing ESC before the second shift REJECT will save (not erase) the Station.

STATION EDITING

You may edit data at any Station by scrolling to the Station, pressing the key for the item to be modified (Station, Depth, Velocity, (shift) Angle, etc.). The cursor appears underneath the least significant digit and allows you to input new numbers. Pressing ENTER saves the new figure, pressing ESC backs out and produces no change. Note that velocity cannot be keyed in directly but must be calculated again by using the Model 3000 with the sensor in the stream.

Note:
Whenever velocity is displayed on the LCD it is the component normal to the cross-section, i.e., the measured velocity x cosine of any angle entered. If no angle has been entered the *Model 3000* assumes the angle to be 0.0°. The actual measured velocities and any entered angles are retained in the memory and uploaded as such to the PC.

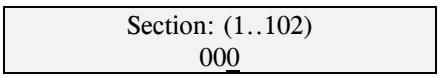
TRANSFER DATA TO COMPUTER (WINDOWS OPERATING SYSTEM)

Copy the Windows executable file (swof104.exe) to a directory on your computer and run the file. It is a self extracting and self installing program that also installs an uninstall icon on the Desktop for your convenience. Using the special adapter cable connect one end to the *Model 3000* and the other end to the DB9 serial interface connector of the computer. You will also need to determine which PC COM port the connector is attached to: The program supports COM 1 through COM 16. Use the mouse buttons with the cirsor in the selection window to advance or retreat the Com port selections.
Instructions for file transfers are available at the program interface.
Follow steps 4 through 6 below to start the file transfer from the Model 3000.

TRANSFER DATA TO COMPUTER (DOS OPERATING SYSTEM)

The station data in memory can be transferred to an IBM Compatible personal computer by connecting the *Model 3000* to the RS232C serial communication port of the computer. Swoffer supplies a serial connection cable and a simple DOS executable file for this purpose.

1. Copy the two files from the floppy disk (the data transfer utility program M3K.EXE and the ASCII file, TRANSFER.TXT) to a new directory on your hard drive or another floppy disk.
2. Using the special adapter cable connect one end to the *Model 3000* and the other end to the DB9 serial interface connector of the computer. You will also need to determine which PC COM port the connector is attached to: COM 1 or COM 2. (Only COM 1 or COM 2 will work with this transfer utility program software)**see below under NOTES and Windows program above.
3. Open a DOS window on your PC with the DOS prompt showing the directory in which the M3K.EXE program resides. On your PC keyboard type the command M3K followed by a space (spacebar) and a DOS-compatible file name (xxxxxxxx.xxx) for the file you wish to create, followed by a space (spacebar) and the number 1 or 2 (whichever COM port you are using). Example: M3K stream1.csv 1 (1 for COM 1). The computer screen will blank except for the statement
   Start transfer at the M3000
   when the sending message goes away, press any key
   [Note: The upload program will not allow you to overwrite a file with the same name. You must either choose a different filename or change the destination directory of the file. If you try the computer screen will respond with: "File: stream1.txt already exists, use a different file name"]
4. Prepare the *Model 3000* Indicator for file transfer by pressing *shift* Transfer from the initial screen. The display responds with



5. Key in the number of the section to transfer (1,2,3,4,5, etc.) and then press ENTER. The *Model 3000* responds with

Sending……

6. The next screen on the LCD will be the software version being used (3.3f).

VERSION 3.3f

7. You can now press any key on your PC. The screen message will be
   received x stations
   If any number other than zero appears it indicates that you have successfully transferred data to the new file. You may check your uploaded datafile using any text-compatible viewing or spreadsheet software. The file created is "comma delimited" or "comma separated values" type.
   If zero appears in the message it means that an error was encountered and no data was transferred nor file created. The error could be a wrong COM port (1 or 2), no data in the cross section, mistyping the commands, or a bad cable connection. Check all of these possibilities.
8. To upload another Section you must press ESC on the *Model 3000* (back out to the initial screen) then *shift* TRANSFER again. On the PC repeat the DOS command "M3K" along with a new file name and COM port and press Enter. Then on the *Model 3000* key in the number of the transect to be uploaded and press the ENTER key on the *Model 3000*. Repeat this procedure for all sections you wish to upload. (see next step for transferring multiple transects at one time.)

   Station data and the order transferred are: **station number, time and date, depth, measured velocity, (**not velocity x cosine of angle**) and angle**. If no angle was entered 0.0° will be transferred.
9. To upload the entire *Model 3000* (all cross sections) you can do it in two stages and into two files. For the first fifty Sections select station **101** (step 5 above). For the second fifty Sections select Station **102**. In both cases the data in the 50 Sections will be uploaded into a single file, designated by the Section numbers. You must then Copy and/or Cut and paste them as needed into your spreadsheet. Only Sections containing data will be uploaded. IMPORTANT NOTE ! If there are more than 600 stations in the first fifty transects, then the data transferred will be truncated at the 600th station. Example: if you have 550 stations in transects 1 through 35 and put fifty stations in sections 38 & 39, then any data in transects above 39 will not be transferred in the 101 command. You must download each transect above the 600th station by using individual transect transfers as in steps 3 through 6 above.

NOTES:
You may transfer the data in the *Model 3000* as many times and to as many file names as you desire, the data will not be changed or deleted until you deliberately erase it using one of the erase procedures. The DOS software will not allow you to over-write a PC file with the same name. If you make a mistake and assign the wrong file name to a Section transferred to your computer, you must first use a Windows or DOS file utility to erase or change the file name *or* you can transfer the data under another name or to another directory. This is designed to prevent accidentally over-writing previously transferred and saved data.
**Other devices (mouse, digitizing tablets, data-logging input boards, etc.) you may have operating on or assigned to com ports may be effected by the M3K.exe transfer program. These effects range from no effect at all to completely removing the devices from your system. It is best to check the effect with a few trial runs first.

INDIVIDUAL SECTION ERASE PROCEDURE IS:

Press DISCH to enter discharge mode.

Choose a Section to be erased by pressing its number then ENTER.

Press (*shift*) REJECT Display will read:

Erase section ? REJECT = YES

Press (*shift*) **REJECT** to accomplish erasure or **ESC** to cancel. The LCD screen will read (if REJECT was pressed):

Section : S Stations: 0

Showing that Section now has 0 Stations.

"ALL SECTIONS" ERASE PROCEDURE

Erases all Stations in all Sections but does not erase or reset any calibration data or other "defaults".
Caution: All collected data will be erased permanently and completely with this procedure. Be sure you want to do this before proceeding.

1. From the main screen press the DISCH MODE key.
2. Select section 101 and press ENTER. Display reads;

Erase ALL sectns REJECT = yes

3. Press (shift) REJECT will erase all sections. Pressing ESC instead will cancel the erase procedure. The *Model 3000* can now be loaded with another 1000 stations worth of data.

GLOSSARY

AA & PYGMY METERS	US Geological Survey's Price Type AA and Pygmy meters. Vertical axis, rotating cup type current meters commonly used with earphones, a stopwatch and "standard rating tables". Rating tables provided with each meter convert the earphone clicks counted during specific time periods into velocity. The *Model 3000* can sense the contact closure signals produced by the original "catwhisker" or the "magnetic head" used to make the earphones sound and can give direct velocity readings. The meters may also be updated with optics as with Swoffer Model 2200 sensor, available since 1980.
AUTO SHUTOFF	After twenty continuous minutes of no keypad activity the *Model 3000* automatically shuts itself down. To restart press the PWR key. Data not saved by hitting the enter key will be lost. In no case will data loss be greater than the last station (if it was not saved) or the last velocity measurement taken.
AVERAGE VELOCITY	The velocity determined by the *Model 3000* by sampling input pulses from a rotating sensor against the internal timer. The *Model 3000* can be set to sample from 1 to 999 seconds. Each averaging period can also be averaged with as many successive sampling periods as desired to produce a moving average.
CALIBRATION NO.	Calibration numbers are also referred to as "Pitch". The *Model 3000* uses calibrations based on the number of sensor output pulses produced if the sensor is moved through still water a distance of ten feet (or ten meters). Using the propeller-optic sensors the curve is very straight through the entire range of normal operation. That is, the 2 inch propeller has a calibration number of about 186 (pulses in 10 feet) meaning that within the range of speed capability of that propeller rotor assembly

(0.1 to 20 feet per second), the sensor will produce the same number of output pulses in ten feet of travel at all speeds.

CONTACT CLOSURE

A method of making and breaking an electric circuit producing signals at an interval commensurate with rotation of a sensor. These signals are traditionally difficult to measure with electronic instruments because they are "dirty" (lots of electronic spikes which can be misread as sensor output pulses). The *Model 3000* while in the **AA 1/1, PYGMY, Contact closure** or **Equation / Contact** modes changes its input capabilities and senses these contacts making and breaking, generally without reading the "noise". Great care must be taken when adjusting AA and Pygmy meter "catwhiskers" to be sure that the contacts are not multiple-counting. To accurately determine velocities great care must be taken and periodic testing in the COUNT mode is highly recommended. The preferred sensor in this mode is a "reed switch" (magnetic sensor) which eliminates much of this problem.

DEFAULT VALUES

The *Model 3000* is shipped with calibration numbers for the standard sensor assemblies supplied with and sold as accessories to the instrument. Other default values are also installed in the Model 3000 Indicator including a sample Transect in Section 100 of the Discharge Mode. All default values may be modified by the user at any time.

DELIMITED FILE

Text files created by the Model 3000 when uploaded to a PC have commas separating each value (section number, time, date, depth, width, velocity and angle). The files are thus called "comma separated values" and each data record has been "delimited" (separated) by a comma. This allows most spreadsheet software programs to separate discreet values, placing them into individual "cells" of the spreadsheet.

MEMORY RESET

Resets to zero all values which have been entered while in the Discharge mode including Section numbers, dates, velocities, angles and depths. Does not reset clock, or other defaults like calibration numbers and averaging times. (see System Reset below). Invoke the Memory Reset feature at the initial screen by entering the DISCH mode then keying in the number 101. Pressing (shift) REJECT + ENTER will erase all 1000 stations.

"PROP" KEY

A "PROP" is any sensor that can be used with the Model 3000. Commonly it is a propeller driven opto-electronic sensor, but any sensing device can be called a PROP and therefore have a "calibration number". The calibration numbers displayed with each press of the PROP key are the values for standard sensors and propellers used with the Model 3000. All calibration numbers shown can be changed at any time - manually or by field calibration.

PULSES PER REV

Swoffer optical sensors produce pulses per revolution of a rotor based on the number of optical "eyes" seen on the fiber-optic rotor. The propeller sensors *usually* have four optic positions and the early AA and Pygmy sensors (Model 2200) optics have two optics. (Four and two pluses per revolution). Catwhisker contacts (AA and Pygmy meters) are one pulse per meter revolution. Always be sure of these figures before relying on velocity readings produced by the Model 3000 .

SHIFT KEY

Allows selection of the secondary function represented by the dual function on some keys. The upper portion of a dual-function key is the "shifted" function. Press then release the SHIFT key to access the shifted function. DO NOT HOLD DOWN THE SHIFT WHILE ACCESSING THE SHIFTED FUNCTION OF A KEY.

STATION

An individual point on a Tag Line (stream cross section) where the width from the shore, the depth, the velocity and an angle are stored for inclusion in the discharge equation.

SYSTEM RESET

Different from Memory Reset. The Model 3000 may be reset to the default configuration (all original calibration numbers, Section 100 has 10 pre-loaded stations, averaging time is 20 seconds, etc.) by completing the following:
Turn meter off by pressing & holding PWR key for four seconds. Turn meter back on by pressing PWR key. Key in the value for "PI" (31415) and then press ENTER. The Model 3000 will briefly display the message "Reset memory 1, Reset memory 2" and then all default values will have been restored. **WARNING:** *All stored data including custom calibrations along with Section and Station data will be erased and overwritten too!* Make sure you have downloaded your data to a pc if you want to save it.

SOFTWARE VERSION	You may view the Model 3000's operating software version by pressing the *shift* **Transfer** keys then the **ESC** key. The display will show the Model 3000 program software version (which should be 3.3f or greater).
TRANSECT	A stream cross section or SECTION. Consists of two or more Stations (Station = width, depth, velocity and angle) all used to measure the total discharge of the channel. A minimum of two Stations are required for the Model 3000 to determine the Discharge across a Transect.

MODEL 3000 CURRENT METER SPECIFICATIONS *

VELOCITY RANGE	*0.1 to 25 Feet Per Second* *0.03 to 7.5 Meters Per Second (Using the Swoffer Model 2100 2" diameter propeller. Velocity limits are slightly different with other props and sensors.*	
DISPLAY	*Two line by 16 characters Liquid Crystal Digital.*	
RESOLUTION	*To thousands, both feet and meters*	
ACCURACY	*Can be held to within 1% with regular user-required calibration tests and adjustments*	
DISPLAY AVERAGING	*Completely user adjustable. Remains the same as user set until adjusted again.*	
OPERATING TEMPERATURE	*LCD*	*Min.-14° F (-25.56°C)* *Max. 180°F (82°C) @ 15% relative humidity* *Max. 120°F (49°C) @ 95% humidity*
	Sensor	*Min. 0° F (-17.8°C)* *Max. 300° F (148.9°C)*
POWER REQUIRED	*Four AA batteries. Alkaline or rechargeable ni-cads. Can also be operated with three AA's with a shorting bar installed in any single battery clip.*	
INDICATOR SIZE	*4 by 6 by 2 inches (10.2 by 15.2 by 5.1 cm)*	
INDICATOR WEIGHT	*25 oz (including 4 batteries) (0.8 KG).*	
INDICATOR MATERIAL	*Vacuum-formed ABS with a clear acrylic viewing lens over the LCD.*	
INDICATOR KEYPAD	*Back-printed polycarbonate or poluester in four colors plus black.*	
FASTENERS	*Stainless Steel & Brass.*	
SENSOR WAND MATERIALS	*Aluminum = 6061-T6, Stainless Steel = #303*	
SENSOR BODY AND ROTOR	*Acetal-resin, carbon reinforced and machined from solid stock.*	
SENSOR PROPELLER	*Glass-filled nylon. 2" diameter is supplied. Other sizes are available for special applications.*	
ELECTRICAL CONNECTION	*Hyper-flexible PVC jacketed cable. Two-conductor sensor signal system. Circular plastic connector with twist-lock operation. Water resistant with gold plated contacts. Other cable available upon request.*	
SENSOR CABLE LENGTH	*Equal to any wand at full extension plus five feet. Special lengths to 1000'are also available.*	
SENSOR TYPE	*PHOTO-FIBEROPTIC with all electronics permanently encapsulated in epoxy resin*	
CONTACT CLOSURE	*Model 3000 can read contact closure signal inputs in any one of four modes; AA 1/1, Pygmy, Contact Closure and Equation / Contact, accessed by pressing the PROP key. Extreme care must be used in the adjustment of a "catwhisker" type signal input to prevent multiple counts and errors in measurement due to contact bounce. Magnetic head sensors (reed switch type) are highly recommended for optimum accuracy in contact closure mode.*	

** SWOFFER INSTRUMENTS, INC. reserves the right to change design and operating specifications to further improve the instruments at any time and without notice.*

DEFAULT PROP PITCHES

These are the figures originally shipped with the Model 3000 and are also the ones which will be re-installed if the system is "reset" using the start up key sequence described under “System Reset” in the Glossary.

PROP	**feet**	**meters**
1 (2" propeller-optic)	186	610.27
2 (3" propeller-optic)	130	426.53
3 (1 3/8" propeller-optic)	217	711.98
4 (AA meter, optic)	9.20	30.19
5 (Pygmy Meter, optic)	20.36	66.80
AA 1/1 (contact closure)	4.60	15.09
Pygmy (contact closure)	10.18	33.40
Contact Closure (generic)	0.00	0.00
Equation/Contact	0.00	0.00
Equation/Optic	0.00	0.00

NOTE: *All pitches above can be changed any time either by direct calibration or by manually entering a pitch. If you only use one type of meter or propeller you may wish to adjust the first 5 PROP positions to all be the same pitch. i.e. positions 1,2,3,4,5 could all be around "186" matching the 2" size propeller rotor (in feet), which is normally shipped as standard with the Model 3000.*

OTHER DEFAULT VALUES

1. Averaging time 20 seconds
2. PROP No. 1, (2" size with a calibration of 186 in 10 ft)
3. UNITS feet
4. COUNT MODE 2 Pulses / Rev Time period ? = the last saved value
5. Section 100 will have 10 Stations pre-loaded for evaluation. You may delete these any time if desired.
6. Time/Date will be adjusted to Seattle, WA USA (Pacific Time) at time of shipment.

DISPLAY CONTRAST ADJUST

1. Press *Shift* key then the CONTRAST key. Display will read ADJUST CONTRAST.
2. Press and release *shift* key then the **up** or the **down** arrow key to increase or decrease intensity of LCD display. Hold down either key until desired contrast is reached then release. *Shift* key must be hit each time before changing from up to down arrow key.
3. Press ENTER when an acceptable contrast is achieved.

CLOCK

To view the time and date press *shift* CLOCK. Pressing ESC takes you back to the initial screen.
To adjust the clock press *shift* CLOCK then press ENTER. (Do not hold down *shift* key)

1. Each subsequent press of ENTER will advance to the next screen from Year, to Month, to Date, to Hour, to Minute. Format is 24 hours / day.
2. At each stop you may enter the correct digits and advance or retreat using ENTER or ESC at each step.
3. When all inputs are acceptable, ESC step by step back to the main screen. The time and dates will then have been set.

CARE AND MAINTENANCE OF THE MODEL 3000 INDICATOR

Battery compartment cover is held in place by four "captive" thumb screws. These should never be more than finger tight but they should be made snug to the standoff tops. For best fit place the back onto the indicator housing, making sure the screws are located inside the standoff recesses then press each corner into the compartment while turning that corner's thumb screw. Do not force the threads of a thumbscrew into the standoff. If it doesn't seem to fit at first, unscrew the knob slightly then try again carefully, all while pressing in that corner of the back with the other hand. All four corners may need to be gently pressed into the housing in an even sequence, a bit at a time for each corner. Once installed correctly the back becomes a substantial component of the Indicator housing providing strength anp protection. The safety neck strap also attaches to the “d” ring on the battery back so it is essential that the connections between the captive screws and the indicator housing be secure.

The batter compartment is **not water proof** and if the indicator falls into the stream, remove the battery compartment cover as soon as possible and dry the battery terminals and the cable connections. Allow the compartment to air dry or use a hair dryer if available before replacing cover. Battery terminals can easily corrode so keeping them dry is essential. This is especially important if using the instrument around salt water. Remove batteries if storing the unit for periods longer than a few weeks.

WATER INCURSION: If water is visible through the window inside the housing, get the *Model 3000* to a warm, dry location as soon as possible. REMOVE THE BATTRIES. It will be necessary to breach the silicone seal with a sharp knife along the periphery inside the battery compartment to allow water to escape while heating the meter to about 150° F. Contact Swoffer for further care instructions. DO NOT ALLOW THE INSTRUMENT TO SIT FOR ANY LENGTH OF TIME WITH WATER INSIDE.

Clean the outside surfaces of the indicator only with a solution designed for plastics. The indicator lens is made of acrylic and can be easily scratched if an abrasive cloth is used. The indicator case is made of ABS and there are many chemicals that act as solvents for ABS and acrylic, severely effecting its appearance if they make contact.

Periodically check the condition of the pins and sockets in the connectors. Keep the contacting surfaces clean and bright and make sure the pins are not bent and that the sockets still fit the pins snugly. Although the connection cable is rugged, avoid sharp bending and re-bending and **DO NOT SUSPEND THE SENSOR WAND BY THE CABLE**. Breaking strength of the standard cable sensor (Belden 9397) is 10 lbs.

Extreme temperatures will effect the *Model 3000* Instrument. At below-freezing temperatures the liquid crystal display becomes sluggish, making response time slow. Some "ghosting" of unused digit segments may also be noticed. This condition is only temporary and the instrument should operate correctly after temperatures rise to normal operating levels (see specs. elsewhere).

The batteries are also affected by very low temperatures. For best results keep the indicator close to the body inside your coat during operation in the cold. Keep extra batteries in your coat close to your body and exchange them often.

High temperatures and direct sunlight will also effect the operation of the *Model 3000*. DO NOT LEAVE THE INDICATOR IN A CLOSED VEHICLE IN THE SUN. Cover the indicator and avoid prolonged exposure of the liquid crystal display to ultra-violet light. Ultra-violet will eventually degrade the display requiring its replacement.

In short, keep the Model 3000 Indicator within the recommended operating temperatures for optimum results.

NORMAL OPERATING TEMPERATURE	*77°F (25°C)*	
MIN. TEMP (FOR RELIABLE OPERATION)	*-14°F (-25.56°C)*	
MAX. TEMP.	*180°F (82°C) @ LESS THAN 15%*	*RELATIVE HUMIDITY*
	120°F (49°C) @ LESS THAN 95%	*RELATIVE HUMIDITY*

---

1 ***The default Pitch for each Prop (or more correctly; Rotor Assembly) represents sensor pulses produced in 10 feet / 10 meters for each rotor propeller combination. Prop No. 1 has a Pitch of about 186 (ft) or 610.22 (m), Prop No. 2 has a Pitch of about 130 (ft) or 426.5 (m), etc. For accurate readings with any of the Props (or other types of sensors*** **represented** ***by a Prop number) you should first calibrate the sensor rotor assemblies, developing your own calibration number for each Prop used. You may use either the calibration method as described in the instructions or direct entry via the keypad.***
NOTE: It is important to remember that the calibration number shown or derived is good only for the rotor with which it was derived. Others, even identical rotors, may have other calibration numbers. This is based on differences in wear, manufacturing tolerances, etc. The only practical way to ensure precise accuracy is to test and calibrate all sensor-rotor combinations.
Calibrations for Swoffer propeller sensors are essentially "straight line" curves. That is, the sensors (ideally) produce the same number of pulses in ten feet / meters at all velocities within their designed range of operation. You must test rotors & sensors thoroughly for optimum accuracy and repeatability.

WAND OPERATION INSTRUCTIONS

Model 3000-12, -13, -14, -C80 & -C140

STREAM VELOCITY MEASUREMENTS

1. Extend the Guide Rod slightly and swivel the Sensor to the 90° reading position.

2. Remove the Sensor Optics Protection Cap and install the Rotor Assembly (2100-A21) on the Sensor (2100-A22). *Make sure that the Set Screw is snug against the rotor shaft (2100-A26) but do not tighten it too much to avoid stripping the threads or cracking the sensor.* Check that the Rotor Assembly spins very freely.

3. Connect the sensor to the indicator via the twist-lock connector. The connector is "keyed" and only mates one way.

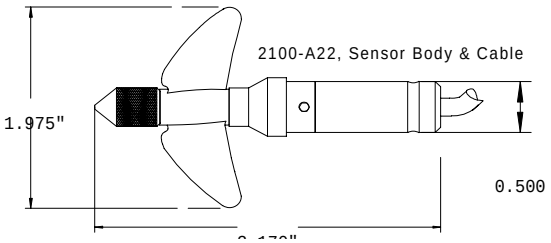
4. Place the Sensor Wand vertically in the stream and point the propeller rotor into the stream flow.

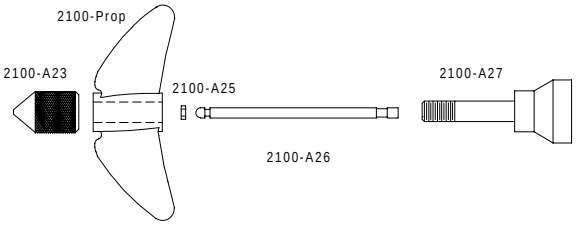
5. With the Foot of the Guide Rod at the stream bed, adjust the Depth Rod up or down until the tip of the propeller is intersected by the stream surface

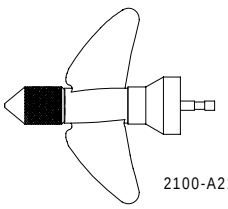
6. Read the stream depth on the Depth Rod Scale. Depth is measured at the top of the Slide Index fitting (see diagram back page).

7. Next lower the sensor until the top of the Slide Index fitting is opposite the corresponding numerical depth reading on the 6/10 Depth Scale. The sensor propeller is now at 6/10 of the stream depth from the surface of the stream.

8. Select one of the velocity measurement methods available with the Model 3000 meter and take your readings (see the Model 3000 Indicator Operation Instructions). The Model 3000 should now be reading the stream velocity directly in feet or meters per second.







SENSOR WAND-CARE AND MAINTENANCE

1. Treat the Propeller Assembly very gently. The calibration could be changed by propeller or sensor damage. *Never put the wand assembly back into the carrying case with the Rotor Assembly still attached.* Replace the Rotor with the Protection Cap (1/2" Cap Plug) and store the Rotor Assembly elsewhere, preferably with the Model 3000 Indicator.

2. When swiveling the sensor from the "stowed" position to the "read" position grip the Sensor Boom, not the Rotor or the Sensor Body. The Rotor Shaft could be damaged and the Sensor Body harmed if the swivel joint is too tight.

3. The connector is weatherproof only when mated. Keep both ends of the connector dry when not coupled

4. Dry the Sensor Wand completely before returning it to storage to reduce the possibility of corrosion. Although the wand is made of aluminum alloy, some amount of corrosion will occur making sliding of the Guide Rod difficult. A light film of oil or grease will help maintain proper sliding characteristics.

5. The sliding resistance of the Scale Rod on the Guide Rod can be adjusted by loosening the plastic set screw protruding from the Slide Index Fitting. Tightening of this screw will increase friction between the Guide Rod and the Depth Rod.

6. Keep the Sensor/Propeller above the stream bed when taking readings to prevent sand and silt from entering the bearing surfaces of the Rotor. The Photo-Fiber-Optic sensor should be frequently checked for freedom of rotation especially if the water has suspended particulates. *In some cases it may be necessary to clean the sensor after each immersion.*

CARE OF THE 2100 SENSOR

The Sensor of the *Model 3000* Current Meter is the single most important part of the instrument and great care must be observed for its continued accurate output.

Keep the Sensor/Propeller assembly above the stream bed when taking readings and avoid rocks and other hazards when moving from one measuring site to another. This will prevent damage to the Rotor, Rotor Shaft, Propeller and the Sensor Body.

Never transport or store the sensor wand with the propeller rotor installed*. Use the 1/16" hex screwdriver to loosen the setscrew and remove the entire rotor assembly when not using the Model 3000.*

Always replace the batteries in the Model 3000 Indicator with fresh ones.

1. During rough use check the propeller frequently for frayed leading edges and for cracks. Chipped or cracked props should be replaced. Frayed leading edges can be brought back to acceptable levels of operation by reshaping them with 150 grit (or finer) sandpaper. Propellers which show signs of being bent or misshapen should be discarded.

2. Rotational friction is by far the biggest cause of erroneous data especially at velocities below 2 feet per second. Check the freedom of rotation frequently especially in turbid water or after rough handling. In some measuring situations it may be necessary to completely disassemble the rotor and

clean the parts with clear water after each immersion. Use spare rotor assemblies and interchange them often. ***Never leave the rotor assembly attached to the sensor after taking readings.***

3. Water is the lubricant for the *2100* rotor. "Canned air" and spray type degreasers should be used to regularly clean the "bore" of the Rotor (**2100-A27**) and the polished surface of the Rotor Shaft (**2100-A26**). Avoid oil & grease if possible.

4. The Rotor Assembly (**2100-A21**) should spin very freely when held in the vertical position (propeller pointing up) and simply blow lightly on the propeller. If it does not, clean the bore of the Rotor and the surface of the Rotor Shaft thoroughly.
One method to determine an acceptable level of low-velocity performance by a particular Rotor Assembly is to perform a "Spin Test" :
Install the Rotor on the sensor, connect the sensor to the Indicator, and place the Indicator in the **COUNT** mode. With the propeller pointing up blow very hard straight down on the propeller. *At the instant you stop blowing* hit the **ENTER** key on the indicator and allow the rotor to coast to a stop. A rotor which will perform to the low velocity limits of its design produces counts on the indicator of at least 300.

5. If the Rotor begins to "buzz" when spun by hand it means that the bore diameter of the Rotor (**2100-A27**) and the outside diameter of the Shaft (**2100-A26**) are too far apart. In this case it is advised to replace the Rotor with a new one. If the shaft shows visible signs of wear replace it also. Severe buzzing indicates that the rotor is bouncing off the shaft as it rotates around it. This slows the rotor significantly especially at velocities above 3 FPS and will cause readings to be slower than actual. **Note:** Some slight buzzing may be heard in the later versions of the rotor when it is spun "dry". This buzzing should cause no significant loss of efficiency.

6. Periodically examine the Thrust-Bearing Nut (**2100-A23**) and check inside on the bottom (the bearing surface). If a pronounced "cup" begins to form (wear from the ball-shaped end of the Rotor Shaft) the **2100-A23** should be replaced. This is especially necessary when using the *Model 3000* in low-flow situations, 2 FPS or lower.

7. The Photo-Optics in the sensor body must be kept clean. Use soap and water and a soft tooth brush to keep the "eyes" clean if necessary. *Be careful and do not scratch the Photo-optics as this could cause unwanted light scattering and therefore erroneous readings.* Likewise the Fiber optics "eyes" in the base of the Rotor (**2100-A27**) should also be kept clean.

Treat the *Model 2100* Rotor Assembly and Sensor with care and it will continue to produce accurate data with minimum maintenance.

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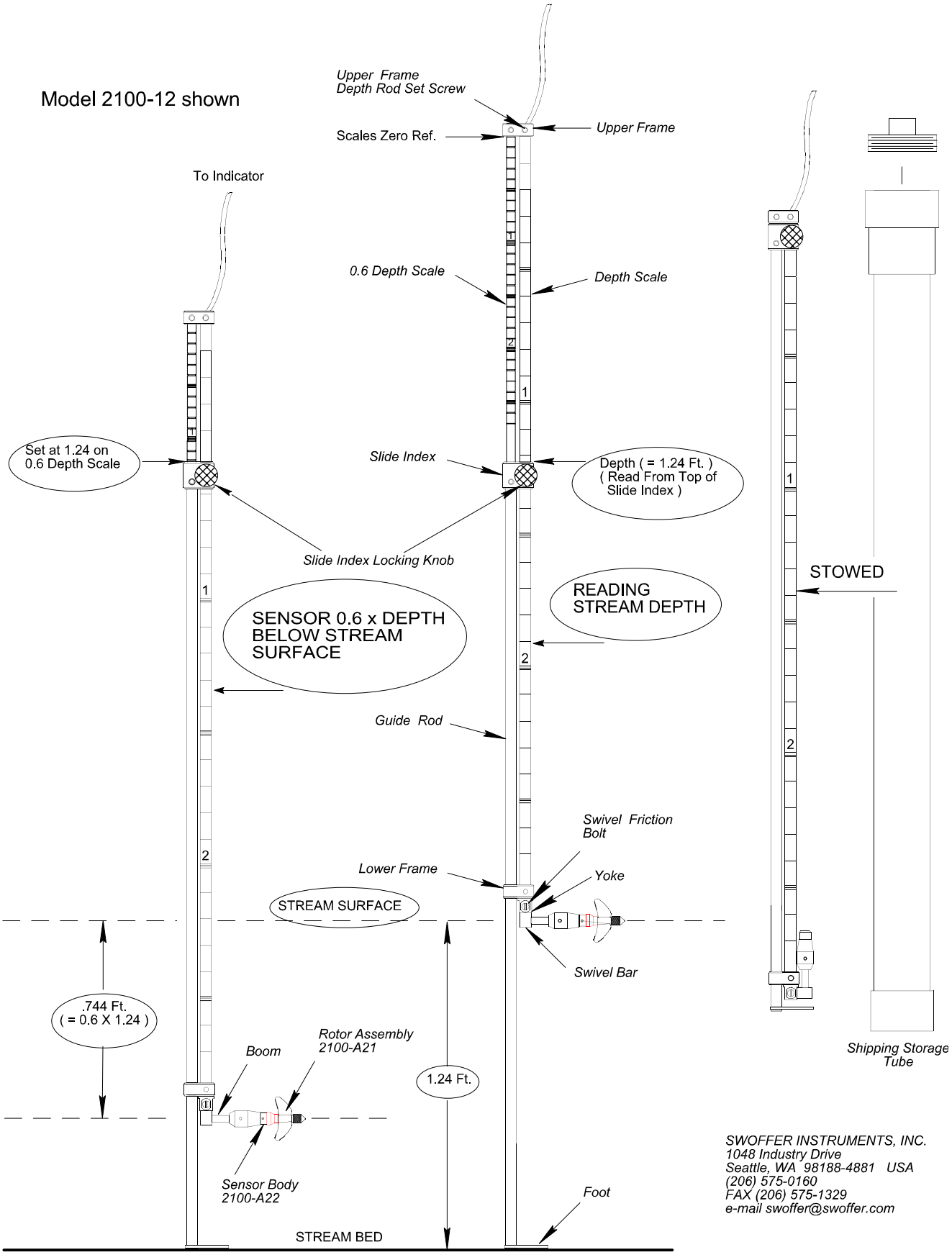
Model 2100-12 shown



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CARE OF THE 2100 SENSOR
with the Model 3000 Indicator

The 2100 Sensor and propeller rotor assembly used with the *Model 3000* Current Meter is the single most important part of the instrument and great care must be observed for its continued accurate output.

Keep the Sensor/Propeller assembly above the streambed when taking readings and avoid rocks and other hazards when moving from one measuring site to another. This prevents damage to the Rotor, Rotor Shaft, Propeller and the Sensor Body.

Never transport or store the sensor wand with the propeller and rotor and shaft installed. *Use the 1/16" hex screwdriver to loosen the setscrew and remove the entire rotor assembly when not using the Model 3000.*

1. During rough use check the propeller frequently for frayed leading edges and for cracks. Chipped or cracked props should be replaced. Frayed leading edges can be brought back to acceptable levels of operation by reshaping them with 220-150 grit sandpaper. Propellers that show signs of being bent or misshapen should be discarded.

2. Rotational friction is by far the biggest cause of erroneous data especially at velocities below 2 feet per second. Check the freedom of rotation frequently especially in turbid water or after rough handling. In some measuring situations it may be necessary to completely disassemble the rotor and clean the parts with clear water after each immersion. Use spare rotor assemblies and interchange them often. ***Never leave the rotor assembly attached to the sensor after taking readings. Even a small amount of damage to a propeller rotor can seriously effect its calibration, making your readings inaccurate.***

3. Water is the lubricant for the *2100-A21* rotor. "Canned air" and spray type degreasers may be used to regularly clean the "bore" of the Rotor (**2100-A27**) and the polished surfaces of the Rotor Shaft (**2100-A26**). Avoid oil & grease. Cleaning the rotor and its parts may be accomplished by using soap and water , alcohol, distilled water, or just about any chemical you have on hand. But remember whatever you use also needs to be cleaned off enough to satisfy any environmental requirements.

4. The Rotor Assembly (**2100-A21**) should spin very freely when held in the vertical position (propeller pointing up) and simply blow lightly on the propeller. If it does not, clean the bore of the Rotor and the surface of the Rotor Shaft thoroughly.
One method to determine an acceptable level of low-velocity performance by a particular Rotor Assembly is to perform a "Spin Test":
Install the Rotor on the sensor, connect the sensor to the Indicator, and place the Indicator in the **COUNT** mode. With the propeller pointing up blow very hard straight down on the propeller. *At the instant you stop blowing* hit the **COUNT** key on the indicator and allow the rotor to coast to a stop. A rotor, that will perform to the low velocity limits of its design, produces counts on the indicator of at least 350.

5. If the Rotor begins to "buzz" when spun by hand it means that the bore diameter of the Rotor (**2100-A27**) and the outside diameter of the Shaft (**2100-A26**) are too far apart. In this case it is strongly advised to replace the Rotor with a new one. If the shaft shows visible signs of wear replace it also. Severe buzzing indicates that the rotor is bouncing off the shaft as it rotates around it. This slows the rotor significantly especially at velocities above 3 FPS and will cause readings to be slower than actual. **Note:** Some slight buzzing may be heard in the later versions of the rotor when it is spun "dry". This buzzing should cause no significant loss of efficiency.

6. Periodically examine the Thrust-Bearing Nut (**2100-A23**) and check inside on the bottom (the bearing surface). If a pronounced "cup" begins to form (wear from the ball-shaped end of the Rotor Shaft) the **2100-A23** should be replaced. This is especially necessary when using the *Model 3000* in low-flow situations, 2 FPS or lower.

7. The Photo-Optics in the sensor body must be kept clean. Use soap and water and a soft toothbrush to keep the "eyes" clean if necessary. *Be careful and do not scratch the Photo-optics as this could cause unwanted light scattering and therefore erroneous readings.* Likewise the Fiber optics "eyes" in the base of the Rotor (**2100-A27**) should also be kept clean.

Treat the *2100-A21* Rotor Assembly and Sensor with care and it will continue to produce accurate data with minimum maintenance.

CALIBRATION OF THE MODEL 3000 CURRENT METER

The *Model 3000* Current Meter is designed to be easily calibrated by the user. This calibration must be done with each Rotor you use. *The calibration numbers recommended by SWOFFER INSTRUMENTS, INC. are not necessarily correct for all measuring situations, therefore for optimum accuracy you should calibrate the rotors before use and at or near to the velocities expected to be encountered.*

If very accurate velocity measurements are required then you must calibrate your *Model 3000* system and check the calibrations often. The instructions below should be followed very carefully for reliable measurements using the *Model 3000*.

IMPORTANT NOTE: "Calibrating a sensor" is actually calibrating a particular propeller rotor assembly for use with the *Model 3000* Indicator. If you use more than one rotor assembly you must check the calibration for *each* assembly and change the Indicator Calibration Numbers accordingly as you switch from one propeller assembly to another. Use the PROP key to change calibration numbers.

Low Velocities. Calibration numbers correctly matching a rotor assembly to a 3000 indicator are especially important at the lower velocities (1.5 FPS and lower) and can vary greatly depending on many factors; bearing surface condition in the rotor, make-up of the water being measured (amount of suspended particulates), any damage to the propeller, rotor, shaft, thrust-bearing nut, etc.

What a calibration number is:
The 2100-A21 rotors produce four pulses per revolution. Each of the four fiberoptic "eyes" in the rotor triggers an electrical pulse from the sensor. These pulses are called "Counts" and are read by the Model 3000 Indicator. The Indicator uses these counts, measuring the number of them against an internal timer to determine velocity. The calibration numbers in the Model 3000 therefore represent the number of counts a specific rotor produces as it travels through 10 feet and 10 meters of still water. When the sensor is *stationary* and water is moving past the propeller, a specific number of counts produced in a specific amount of time determines velocity when you know how many counts are produced per foot or meter (pitch). The calibration numbers then can also be referred to as Pitch.

Although rotor/propeller combinations are "similar" they are not necessarily "identical" and therefore each may have a slightly different Calibration Number. Always remember that a Calibration Number shown on the Indicator's display represents the Calibration Number for a single rotor assembly only. Double check all rotor assemblies used for any measuring job and make sure that each is within your accepted tolerance for calibration variation. Each rotor assembly may have a different calibration number. Only go out into the field with specific knowledge of each rotor assembly's calibration number. Make sure that the calibration number in the 3000 Indicator matches the rotor that is attached to the sensor before relying on readings.

CHECKING AND CHANGING CALIBRATION OF THE MODEL 3000

MODEL 3000 CALIBRATE MODE

a: Automatic Entry of Prop Pitch by *Model 3000* calculation:

<<< WARNING>>> Make sure that the Model 3000 Indicator is in the correct units mode (feet or meters) when calibrating a sensor. I.e. do not input "metric" data while the instrument is in the "feet" mode. Your velocity measurements as well as the discharge measurements (as calculated by the Model 3000) will be in error. Back out using the ESC key to the initial display screen and toggle the "0" key for desired units selection.

To determine the pitch of a propeller by actual field calibration trials use the Calibrate mode. Calibration is then accomplished by towing the propeller through a course of known length of quiet water while the Model 3000 counts the number of sensor pulses produced. The prop pitch is then calculated:

$$\text{Pitch} = \text{pulses in 10 feet (or meters)} = \frac{\text{number of pulses}}{\text{course length}}$$

To calibrate a propeller, first select the propeller number to be used (press PROP until the desired prop no. is displayed then press ENTER to select it. Press ESC twice to return to the main screen. Next enter the Calibrate mode by pressing *shift* then CALIBRATE. Display will read:

0 = Calculate
1 = Manual Entry

To do an actual field calibration, you will press 0. (see IN PRACTICE below)

To determine a reliable calibration number for your *Model 3000* (something you must do if you are working with slow flows [below about 1.5 FPS] and for measurements taken in very shallow streams) perform the following:

SUGGESTED METHOD OF COURSE LAYOUT AND PROCEDURE FOR FIELD CALIBRATIONS

Accurately mark a straight course of 10 to 20 feet in length in a body of calm, current-free water along which the sensor can be towed while walking the course. A swimming pool or dock into a quiet lake serves well.

Place the sensor in the water a few feet before the beginning of the course, 6 to 12 inches below the surface. The propeller must face into the direction of travel. Walk the sensor through the course at a rate close to that which you will be measuring. Use the *wand* or wading rod rather than the sensor as a guide, press and release **COUNT** at the instant the wand enters the course. The *Model 3000* indicator counts the number of sensor pulses generated as you walk through the length of the course. At the instant the wand leaves the course press and release **COUNT** again. The displayed figure is the number of sensor pulses counted in the course length. Several passes through the course in *both directions* will develop a reliable average calibration figure for the rotor-propeller assembly being calibrated.

IN PRACTICE

Following the in-water placement of the sensor and the walking procedure just described:
Pressing the 0 (0=calculate) key will prompt the *Model 3000* display to ask you for the course length.
Enter the length of the course to be used by pressing digits followed by ENTER. Any accurately measured course length will do since the Model 3000 adjusts the number to equal counts in 10 feet/10 meters, but the longer the distance and the quieter the water the better.
NOTE: Be very sure which units mode the Model 3000 is in before entering figures. (Don't enter feet as the course distance while the Model 3000 is in the METERS mode for instance!).
Display will read:

Course length? 00.000_

Press ENTER again and the display will read:

Count = _ Pass number = 1

Begin walking the sensor several feet before course start mark and at the instant the sensor wand enters the actual course press the COUNT button. Display will begin counting up sensor pulses generated through the length of the course. At the instant the wand reaches the course end, press COUNT again. Counting will stop and the *Model 3000* will automatically calculate a pitch, converting the pulses into a figure in 10 feet (or 10 meters). Display will read:

Pitch = ppp.pp ENTER or REJECT

This pitch is entered in the memory if accepted and it is expressed as the number of sensor output pulses generated in ten feet or meters. It is strongly advised to take four to six passes through the course in both directions to determine a reliable average count for the pitch. The model 3000 keeps track of the number of "passes" back and forth and you may accept or reject any pass as necessary by aborting mid-way (press ESC anytime during the pass) or *shift* REJECT at the end of a pass. Press ENTER after a successful pass to save the count. Press COUNT again to begin another pass and COUNT to stop counting at the end of the next pass. ENTER to accept.

IMPORTANT NOTE: Pressing ENTER a second time after accepting any count will total and average the counts up to that point and will assign the average as the calibration number for that prop pitch. Once done, you have three choices: accept the figure, enter a different figure manually, or start the passes sequence over again for a new set of data.

b: Manual entry of Prop Pitch:

If the pitch of a propeller is known and it is desired to enter it, the manual Calibration mode is used:

<<< WARNING>>> Make sure that the Model 3000 Indicator is in the correct units mode (feet or meters) when manually inputting calibration numbers for a sensor. I.e. do not input "metric" data while the instrument is in the "feet" mode. Your velocity measurements as well as the discharge measurements (as calculated by the model 3000) will be in error. Back out using the ESC key to the initial display screen and toggle the "0" key for units selection.

First, select the sensor (Prop No.) to be used by scrolling through the menu then pressing ENTER. ESC to the main screen and enter the calibrate mode by pressing *shift* CALIB. Display will read:

0 = Calculate 1 = Manual Entry

Press 1. Display will read:

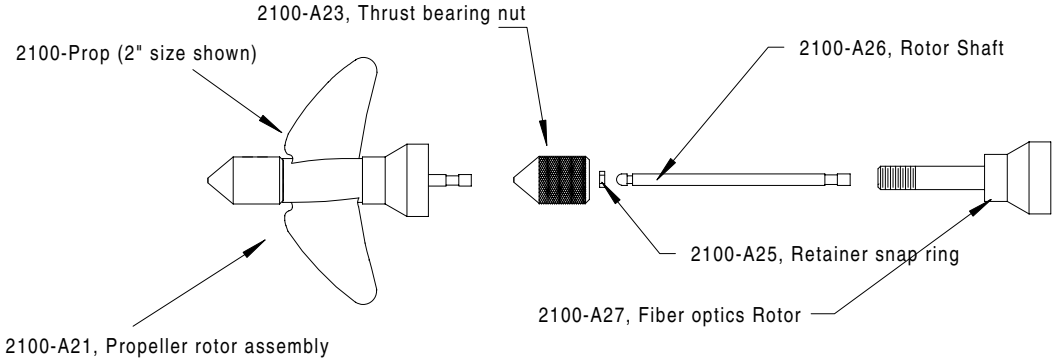
Prop # N
Pitch = PPP.PP

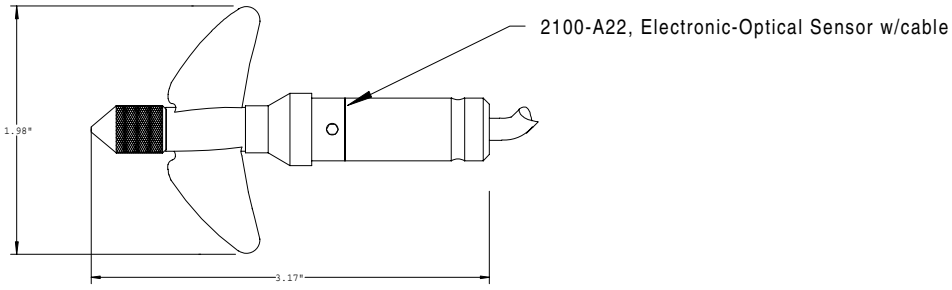
Enter the digits necessary to display the known calibration number (pulses per 10 units of measure). Then press ENTER to put this calibration in the memory.
Manual Calibration mode may be used when changing optic rotor assemblies. New designs may have more (or fewer) pulses per revolution, for instance the AA meter can have an upgraded optics rotor that has four pulses instead of the original 2 pulses per revolution, effectively doubling the calibration number.
This method may also be used if you have calibrated propeller rotor assemblies using a different meter (Model 3000 or 2100) and you know what the calibration numbers for the propeller rotors are. A calibration number therefore is good for a particular propeller rotor assembly regardless of what sensor and Indicator it is installed on.

It is important to note that errors in measurements due to Calibration Number variation will be in direct percentage proportion to the difference *between the ideal (correct) Calibration Number for a Prop or rotor and the number that the indicator displays for the rotor.*
Example: If the ideal number is 186 and the displayed number is 184 then the velocity error due to calibration error will be about 1%.

Approximate Calibration Nos. for propellers

PROP	***feet***	***meters***
2" (50 mm) prop	186	610.27
3" (70 mm) prop	130	426.53
1 $^{3}/_{8}$" (35 mm) prop	217	711.98





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Appendix G: 2006 TMDL & 303(d) listings for the Lower Truckee River watershed

TMDL Water Body	Constituents		
Truckee River	Total Nitrogen	Total Phosphorous	TDS

303(d) Water Body	Reach	Constituents				
Truckee River	Stateline to Idlewild	**Temp**				
Truckee River	Idlewild to E. McCarran	Temp	**TSS**			
Steamboat Cr.	Station 10-349300 in S. ½ of Sect. 33 to Truckee River	Zinc	Arsenic	Boron	Iron	
Galena Cr.	Origin to E. line of Sect. 18	**Zinc**				
Galena Cr.	E. line of Sect. 18 to station 10348900 in SW SW Sect 2	**Zinc**				
Galena Cr.	Station 10348900 in SW SW Sect 2 to Steamboat	Zinc				
Thomas Cr.	Origin to NF Boundary	Zinc				
Thomas Cr.	NF Boundary to Steamboat	Zinc				
Thomas Cr.	Below Steamboat	Zinc	**Arsenic**	**Boron**		
White's Cr.	Origin to E. line of Sect. 33 to Steamboat	Zinc	Arsenic	Boron		
White's Cr.	Below E. line of Sect. 33 to Steamboat	Zinc	Arsenic	Boron	TDS	Total P
White's Cr.	Below Steamboat	Zinc	Arsenic	Boron	**Fecal Coliform**	
Chalk Cr.	Origin to Truckee River	**TDS**	**Sulfates**	**Ortho P**	**Selenium**	
Alum Cr.	Origin to Truckee River	**TDS**	**Sulfates**	**Ortho P**	**Escherichia coli**	**Turbidity**
		TSS	**Temp**	**Total P**	**Iron**	

Bold indicates new listing on 2006 303(d) list.

The analysis of all constituents must be performed using the methods outlined in 40CFR, Part 136.3 – Identification of Test Procedures.