

Profilers **Samplers** Flotation



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# Remote Access Sampler User Manual



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# Chapter 1

## Introduction

### McLane RAS 3-48-500 Sampler (RAS-500)

This manual describes the operation and maintenance of the McLane Remote Access Sampler (RAS-500), a time-series sampler that autonomously collects up to 48 individual 500mL *in situ* water samples. Before first-time use of the RAS-500, complete the following:

- Become familiar with the RAS-500 by reviewing this User Manual.
- Follow procedures to connect the battery.
- Install the water flush filter.
- Install the sample bags (and optionally the filters).
- Prime to release any air trapped in the tubing or filters
- Fill the acid flush bag
- Establish communications between the RAS-500 and a PC, and see Chapter 3 in this User Manual, “User Interface” to program the deployment.
- Become familiar with the toolkit and media included with your instrument.



The media included with a new instrument includes instructional videos. See Appendix B in this User Manual for more information about this material.

## User Key

This user manual contains the following symbols that call attention to information:



**Note**

This symbol indicates information and tips that are helpful for operating the instrument.

---



**Important**

This symbol indicates information that could affect key product operations.

---



**Warning**

This symbol indicates information that must be followed to prevent instrument damage or user injury.

## RAS Overview

The RAS-500 is a time-series instrument that collects up to 48 individual 500mL water samples. The RAS-100 collects up to 48 individual 100mL water samples. Pre and post sample acid cleaning cycles (available in an acid/sample/acid pattern) remove bio-fouling and other contaminants to keep samples pure. The user can program the multi-port valve and displacement pump, acid wash, cleaning cycles fluid volume, and sampling schedule.

The RAS can be deployed for up to 18 months. Operating temperature ranges from 0° to +35°C water and maximum depth is 5,500m.

During the deployment, the system logs data such as electrical parameters, sample timing, volume, rate and flow. This data is offloaded after the RAS is recovered. All of the RAS components are mounted inside a 316 stainless steel frame (a titanium frame is also available as an option). Deployment modes include:

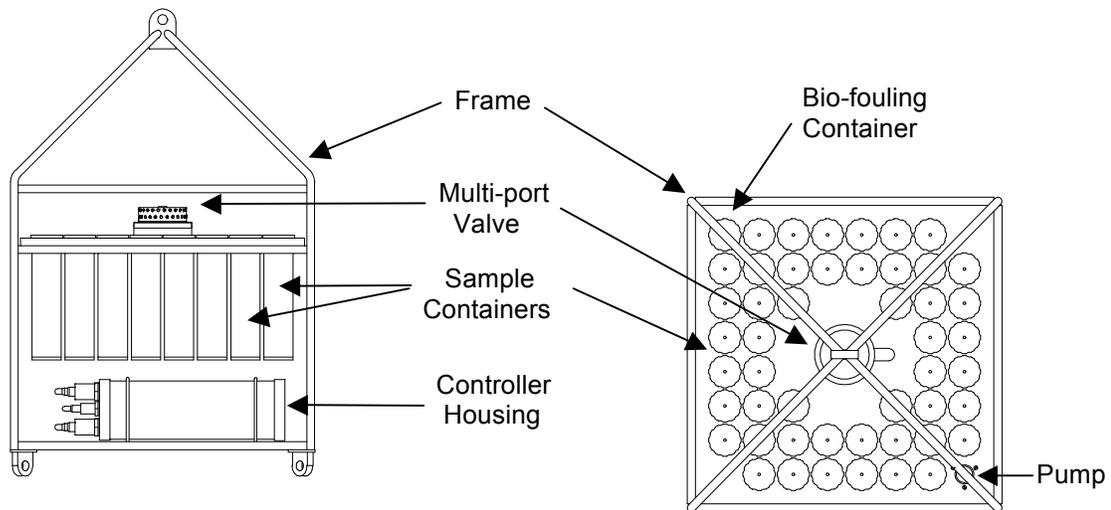
- A bottom-tethered array
- Ocean floor placement in a stand alone bottom lander
- Tethered profiling from a ship (as done with a CTD sensor and Rosette sampler)

The RAS components are:

- Controller housing
- Pump assembly
- Multi-port valve
- Sample containers

### RAS-500 Line Drawing

The RAS-500 line drawing in Figure 1-1 and the Specifications List that follows illustrate the major components and mechanical design of the RAS-500 sampler.



*Figure 1-1: RAS-500 Line Drawing – Overall View*

## RAS-500 Specifications

<b>Dimensions</b>	Height	128 cm (50 in)
	Width	73 cm (29 in)
	Length (body)	73 cm (29 in)
<b>Weight</b>	In air, sample containers empty	110 kg (240 lbs)
	In air, sample containers filled	148 kg (325 lbs)
	In water	57 kg (125 lbs)
<b>Multi-port Valve</b>	Material (50 Ports)	HYDEX valve stators
	Drive	High torque stepper motor
	Gear head	100:1 planetary
	Positioning	Optical sensor with slotted disk
<b>Sample Bags (48)</b>	Material	Clear Tedlar or or opaque laminated
<b>Pump</b>	Flow rate / Flow rate error	75 ml/min fixed / rate error $\pm 3\%$ average
	Type	Gear pump; not affected by dilute acid
	Drive	Brushless 3 phase DC motor
<b>Controller</b>	Housing Material	Aluminum, 6061-T6 hardcoat anodized
	Power Supply	31.5 VDC Alkaline battery pack
	Current consumption	3500 mAh (1 year deployment)
	Communications	Serial (RS-232)
<b>Frame</b>	Material	316 electro-polished stainless steel (titanium option available)
	Structure & bridle configuration	In-line mooring, weldment, 4 in-line
	Frame & bridle eyes	19 mm diameter, insulated
	Max. in-line tension	2,300 Kg (5,000 lbs)
<b>Operation Conditions</b>	Maximum depth	5,500 meters
	Min. / Max deployment time	10 minutes per sample / 18 months
	Operating temperature	0 to 35°C

## RAS-500 Components

The RAS-500 components are further described below.

<b>Component</b>	<b>Description</b>
Controller Housing	The controller housing is a sealed pressure housing tested to a depth of 5,500 meters. The housing contains a battery pack, a micro-controller, a 3-phase pump-motor driver, and a stepper-motor driver for the multi-port valve.
Communications	The communication link between the RAS-500 and a PC is a standard, 3-wire, full duplex, RS-232 connection.
Pump Assembly	A positive displacement gear pump draws seawater through small disc filters in the sample containers at a fixed rate of 75 ml/min. A brushless DC 3-phase servo-motor is magnetically coupled to the pump head. The motor is in a pressure compensated housing filled with Dow Corning 200 fluid (5 cSt.). Hall-effect encoders provide feedback to control shaft speed.
Multi-port Valve	A multi-port valve directs the seawater to the sample bags. The multi-port valve can be programmed to flush old water from the tubes and valve before each sample is collected to help prevent sample contamination and reduce accumulated bio-fouling. A small 25 mm disc filter with a pore size from 3 to 20 microns is placed in-line with the water port to protect the pump from potential damage by large particles.
Sample Bags	Each sample bag is connected in series between the intake head (top half of valve) and the exhaust head (lower half of valve). The pump draws water out of the sample container in which the collapsed sample bag is mounted. This pumping creates a pressure gradient that drives the flow of ambient seawater through the intake and into the sample bag. After each sample is taken, the multi-port valve returns to the Home Port (0), sealing the sample in the bag.

## RAS Toolkit

Each RAS comes with a Toolkit that contains tools, software, and spare parts including:

- Wrenches, screwdrivers, and hex drivers sized for the RAS hardware.
- Spare o-rings, nylon and stainless steel screws and bolts.
- Spare polyurethane tubing.
- Communications cable for serial port connection to a computer.
- Media with the Motocross software and firmware documentation.
- USB to RS-232 connector.



*Figure 1-2: RAS Toolkit*



The RAS toolkit in Figure 1-2 is shown only as an example. Do not use the photo to compare with your actual toolkit. Note that the backup battery hardware was removed beginning with Firmware v3.12 and toolkits for newer samplers will not contain backup batteries.

## Customer Support Resources

McLane Research Laboratories is on the Web at <http://www.mclanelabs.com> or via email at [mclane@mclanelabs.com](mailto:mclane@mclanelabs.com). The [RAS pages](#) on the McLane website contain links to documentation including Technical Bulletins, and papers that describe the development and use of the RAS.

### McLane and Firmware Information

Option <8> from the profiler Main Menu interface also displays McLane contact information and the firmware version.

```
Selection [] ? 8

                McLane Research Laboratories, Inc.
                Falmouth Technology Park
                121 Bernard E. Saint Jean Drive
                East Falmouth, MA 02536-4444 USA

                Email: McLane@McLaneLabs.com
                Web: http://www.McLaneLabs.com
                Tel: 508-495-4000 Fax: 508-495-3333

                Configuration: RAS-125M500
                Source file: CF2-3_03.c
                Electronics S/N: ML12345-02
                Compiled: Aug 4 2014 13:07
```

*Figure 1-3: McLane Contact Information*

### Technical Support

When contacting McLane for technical support, please provide the following:

- Firmware version and instrument serial number. Serial number is printed on a silver label attached to the controller housing or on the Contact screen (Figure 1-3).
- A description of the problem.
- A text file of data created using the Motocross file capture utility.

### Instrument Training

McLane also offers a 1-2 day instrument training course at our facility free of charge with the purchase of a new instrument. Participants conduct trial deployments and work directly with members of the McLane engineering staff. Conducting trial deployments is a beneficial way to learn system operations before actual field investigations. For more [product training](#) information refer to [www.mclanelabs.com](http://www.mclanelabs.com).

## Notes

# Chapter 2

## Communicating with your McLane Instrument

The RAS toolkit includes a COM cable for connecting the sampler to a host computer. You must also install the Motocross terminal emulation program (MotoCrossML.exe) on the computer. Once the COM cable is connected to the sampler and host computer, connecting the main instrument battery powers on the firmware. The following topics are part of instrument connection:

1. Cable and COM connectors
2. Configuring MotoCrossML.exe
3. Powering on the instrument (main battery connection)

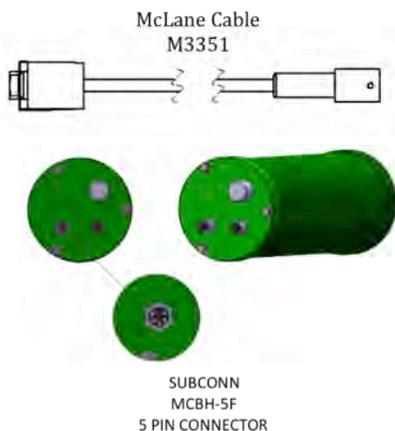
### Cable and COM Connectors

Locate the COM cable (in the instrument's toolkit) that connects the sampler and a computer. Determine whether the computer has a built-in serial port. Built-in serial ports are preferred for connection with your instrument. However, a USB to RS-232 adaptor is included in the toolkit for connection to computers without built-in serial ports. The adaptor is a DS\_US232R-10(R-100/500) adaptor cable (manufactured by FTDI Ltd).

The COM bulkhead connector is a 5-pin MCBH style. Some instruments may have a 3-pin XSG style bulkhead connector (Figure 2-1). Both style cables have a serial connector. The serial connector either plugs directly into the computer or into the USB to RS-232 adaptor and then into the computer (Figure 2-2).

#### COM Cable Setup

Cable Style 1: Subconn 5-pin connector



Cable Style 2: Impulse 3-pin connector

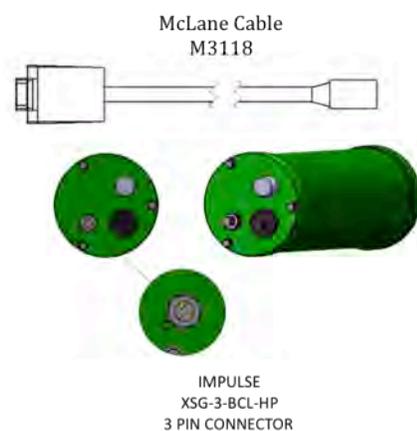


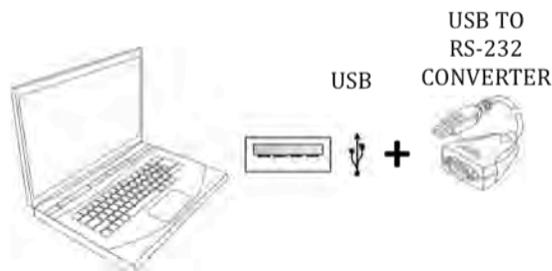
Figure 2-1: Cable Connector Styles

## Computer COM Setup

Connection Style 1: Computers with Built-in Serial Port



Connection Style 2: Computers with USB, no Serial Port



*Figure 2-2: Computer COM Setup Styles*

## Motocross Terminal Emulator

Motocross is a terminal emulator for communicating with McLane samplers and profilers. McLane created a custom version of Motocross (MotoCrossML.exe), configured with the Motocross settings required by our instruments. Other Motocross considerations:

- A built-in Motocross feature can log communications with your instrument to a capture file located on the connected host computer. McLane recommends using capture file logging when running any bench tests or setting up a deployment.



McLane instruments require Motocross [CTRL]-C keystrokes to be configured as character transmissions for canceling operations, waking from Suspend mode, and navigating menus. The other Motocross Transmission mode, Standard Windows Editing mode, uses [CTRL]-C as a text copy function and is not recognized by McLane instrument operations.

- MotoCrossML.exe is included on the media shipped with a new instrument and is available at [www.mclanelabs.com](http://www.mclanelabs.com) under Support > Software Utilities.

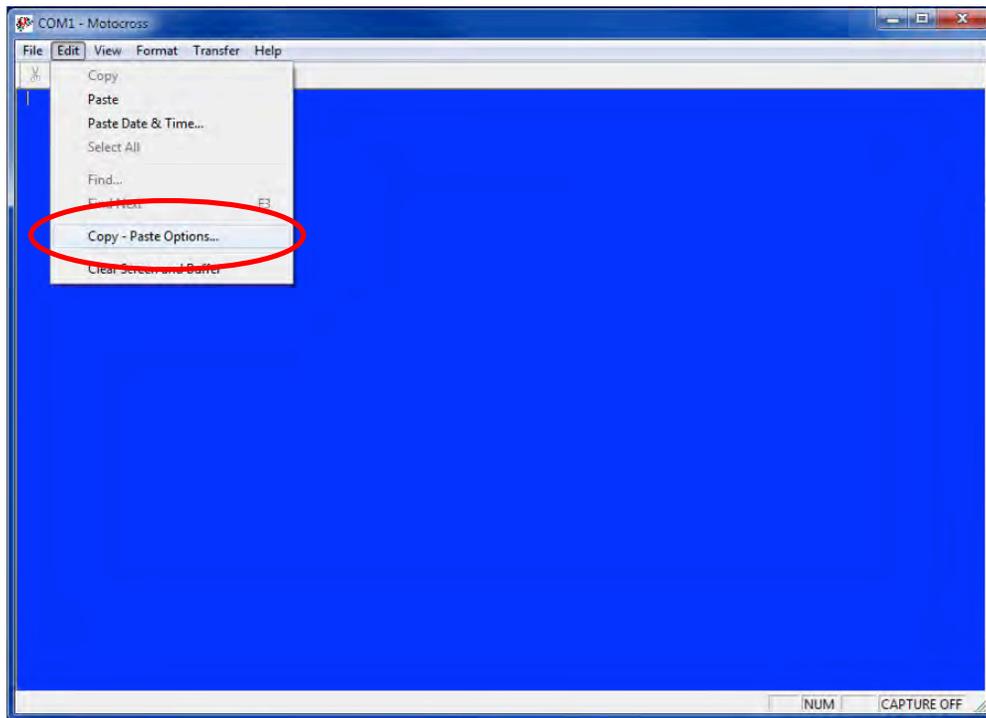
## Configuring Motocross

1. Install MotocrossML.exe. (from the media included with your instrument) on a computer.
2. Open MotocrossML.exe. MotocrossML.exe is configured with the settings required by our instruments, however some setup is still needed.



Running a Motocross executable other than the program provided by McLane (MotoCrossML.exe ) will not make the necessary configuration changes for using Motocross terminal emulation with McLane instruments.

3. Confirm that “Transmit Control Characters” (Figure 2-3) is enabled. From the top menu bar, select the Edit menu. Confirm Copy-Paste Options are set to transmit control characters (Figure 2-4), click OK.



*Figure 2-3: Change Default Settings for Sending Control Characters*

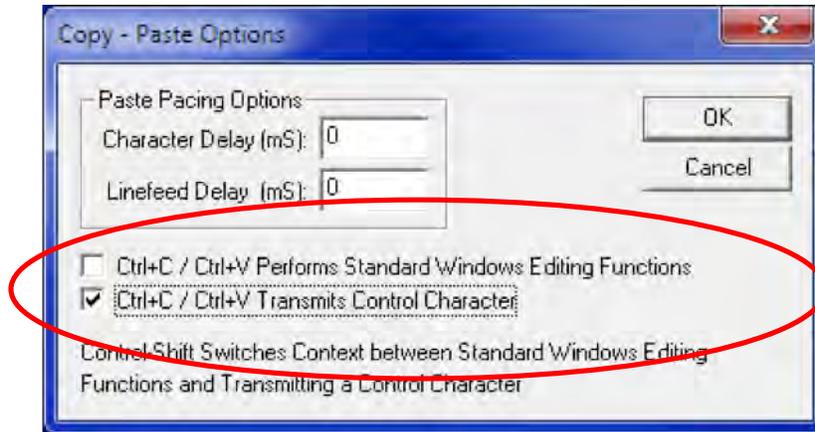


Figure 2-4: Ctrl+C/Ctrl+V Transmits Control Characters

4. From the File menu, select “Communication Settings” (Figure 2-5). Set parameters as follows and click OK:

- Port #: (the connected port).
- Baud Rate: 9600 baud
- Parity: None
- Data Bits: 8
- Flow Control: None

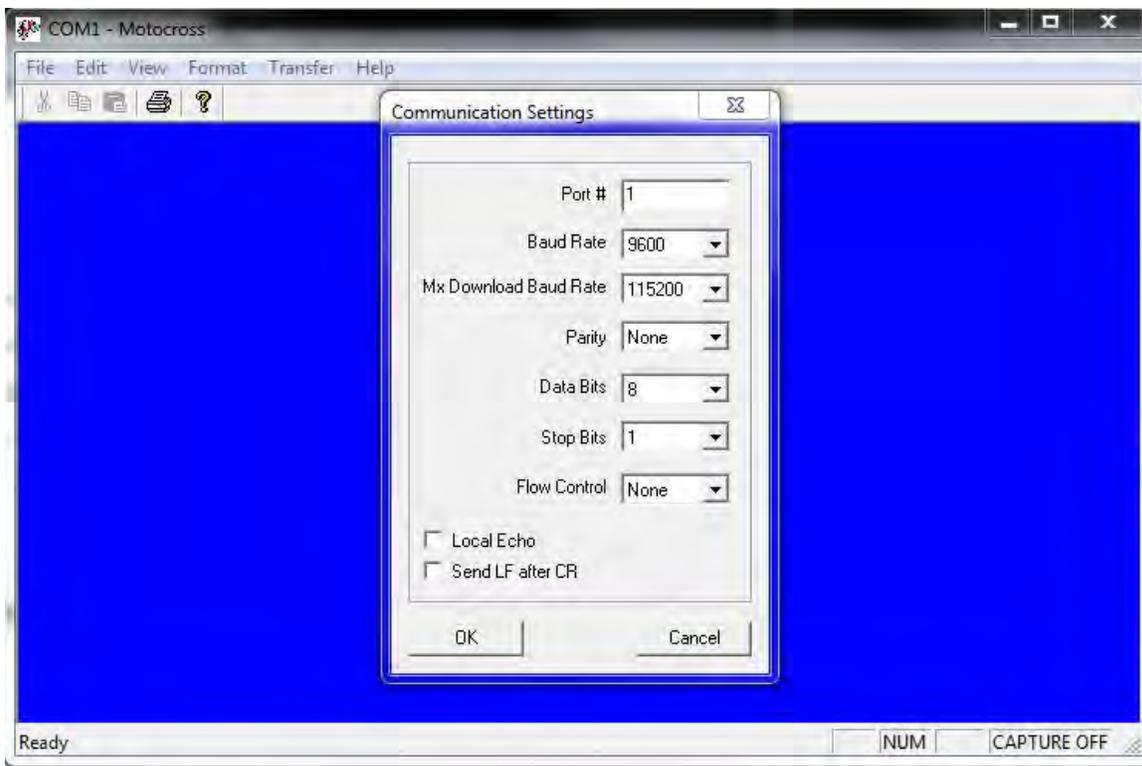
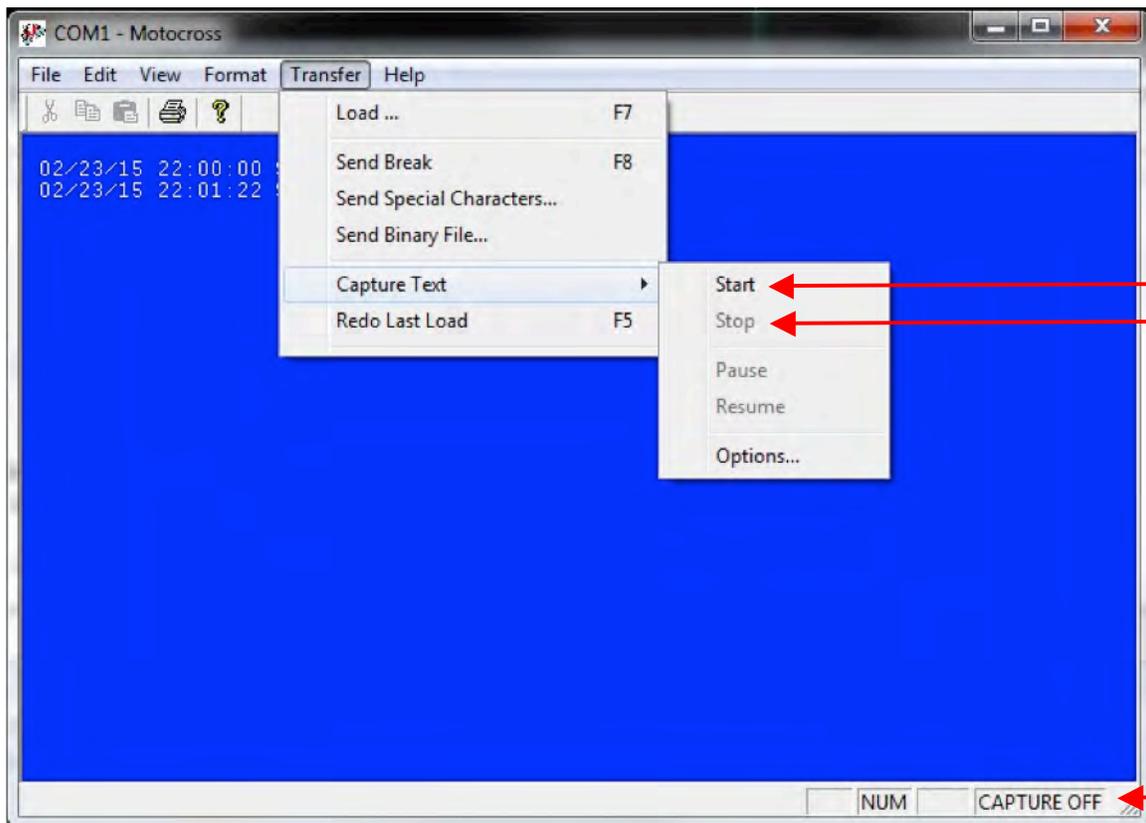


Figure 2-5: Communication Settings Configuration

## Capturing instrument output to a text file

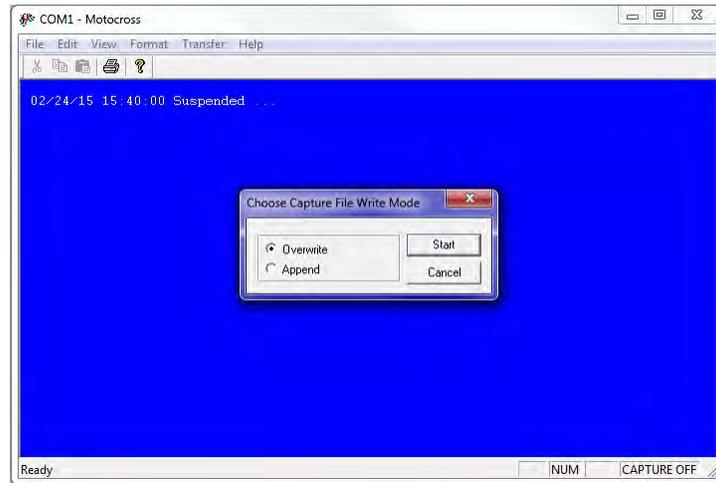
A built-in Motocross feature will log all communications to a capture file located on the connected host computer. This capture file is a very useful troubleshooting tool. McLane recommends setting up a capture file while running any bench tests or setting up a deployment.

1. Click the Transfer Menu.
2. Select “Capture Text”.
3. Enter a file name and location for the capture file.
4. Click “Start”.



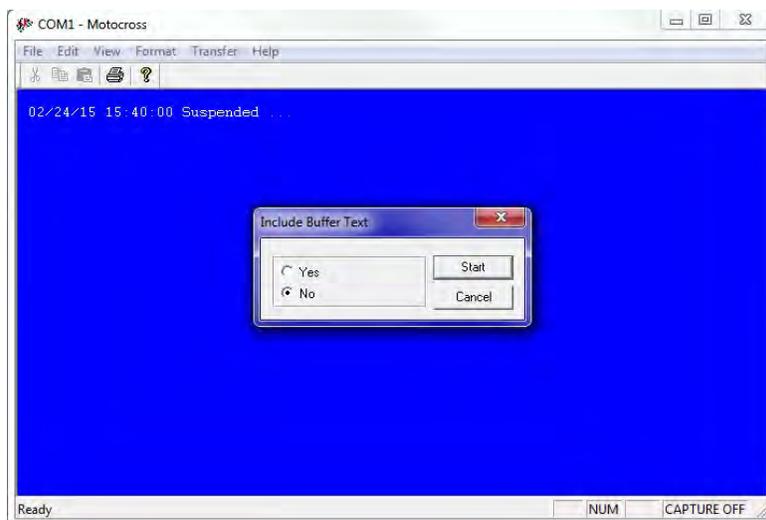
*Figure 2-6: Start and Stop Capture File*

5. Select whether to Append or Overwrite the file (Figure 2-7). Use caution when making this selection. Overwrite replaces any information in the log file. Append adds new information to the file.



*Figure 2-7: Overwrite or Append Capture File*

6. Click “No” when prompted whether or not to include the Buffer text (Figure 2-8).



*Figure 2-8: Include Buffer Text?*

7. To finish capturing to file, select “Capture Text” from the Transfer menu (Figure 2-6) and then click “Stop” in the Transfer menu.

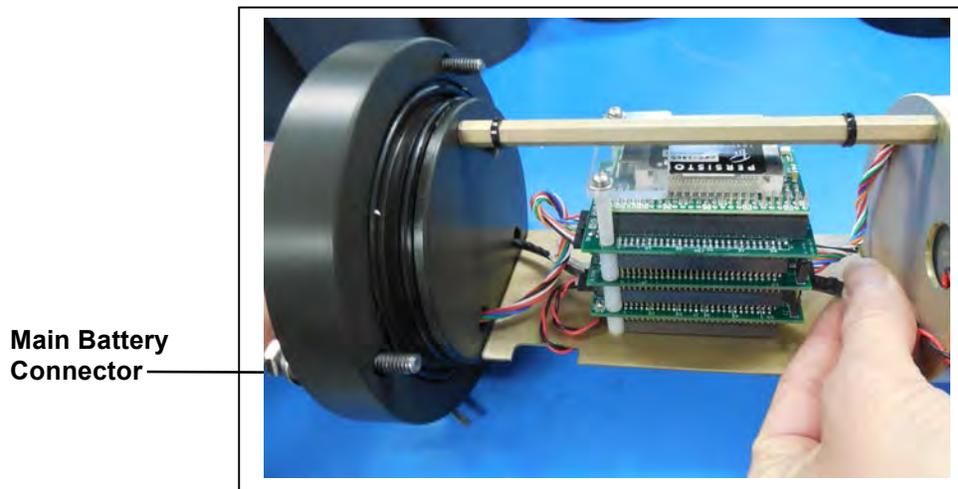
## Connecting COM Cable and Battery, Starting Firmware

### Connecting COM Cable

1. Place the RAS in a dry area.
2. With Motocross running, remove the dummy plug from the COM connector on the controller housing end cap.
3. Connect the COM cable to the computer serial communication port (use the USB to RS232 Adaptor, if the computer does not have a built-in serial port). Make this connection before connecting to the COM connector on the controller end cap.
4. Connecting to the COM bulkhead connector on the controller end cap.

### Connecting Battery

1. Open the controller housing by unscrewing the three (3) bolts from the end cap (the cap on which the connectors are mounted).
2. Pull the end cap straight out from the cylinder (the electronics stack is mounted to this cap).
3. Grasp the main battery connector.



*Figure 2-9: Connecting Main Battery to the Electronics Stack*

4. Connect the main battery to the 2-pin connector on the middle board of the electronics stack.
5. The system initialization will begin (see Chapter 3, “User Interface” for details on the system initialization and firmware menus).

## Activating the Firmware

1. After system initialization, the Main Menu displays.
2. Press [CTRL]-C three times (with one second pauses between each) to display the Main Menu. Only one [CTRL]-C is needed to control the firmware if the device is not in Suspend mode.



Disconnect the main battery before shipping to prevent electrical system damage during transit. Before disconnecting power, press [CTRL]-[C], to return to the Main Menu and put the sampler in Suspend mode.

## **Troubleshooting Communication with your Instrument**

### Troubleshooting: Confirm correct Port # defined

If the instrument firmware does not respond when connected to Motocross, use these steps to troubleshoot:

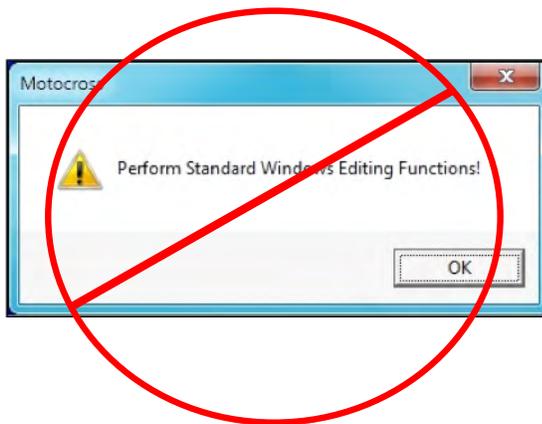
- Confirm the battery is connected to the instrument.
- Verify the correct Port # is defined (Figure 2-5).
- Ensure that character transmission mode is set (Figure 2-4).
- Read below for information on the toggle that changes Transmission mode.

## Troubleshooting: Transmission Mode Toggle

It is possible to mistakenly switch between Control Character mode, and standard Windows Editing functions by holding down the [CTRL] key and pressing the Shift key. If Motocross does not respond as expected, press [CTRL]-Shift to toggle back to Character Transmission mode if needed.



*Figure 2-10: Configured for Character Transmission Mode*



*Figure 2-11: Configured for Windows Editing Mode – Do Not Use*

## Troubleshooting: USB Adaptor

The USB adaptor has LED indicator lights for transmitting and receiving data. Typing any key in Motocross terminal emulation should be indicated by the LED. If no LED light flashes on keystrokes, you may have selected the incorrect COM Port. Refer to the section that follows for instructions on Motocross setup.

## Notes

## Chapter 3 User Interface

This chapter describes firmware menus, commands, and screens and provides steps to program a RAS deployment.



McLane recommends starting a capture file when operating the firmware. The Motocross Terminal Emulator (included on the media shipped with the instrument) has a built-in feature that logs communications to a capture file located on the connected Host computer. See Chapter 2 in this User Manual for detailed information about Motocross.

### Power-Up Sequence

Connecting the main battery automatically starts the firmware (and is the only way to power on the RAS). When the power-up sequence begins, a time and date prompt displays.



If time/date do not display after the battery is connected, pressing [CTRL]-[C] three times (pausing three seconds between each keystroke) wakes the firmware from Suspend mode. If date/time still do not display, see Chapter 2 in this User Manual to troubleshoot operation with the Motocross terminal emulator.

```
Clock reads 02/08/70 02:20:25. Change [N] ? y
Format is mm/dd/[yyyy or yy] hh:mm:ss
Enter correct time [02/08/1970 02:21:25] ? 03/04/2015 11:29:11
Clock reads 03/04/2015 11:29:11. Change [N] ?
Initializing data array .....
```

*Figure 3-1: Power-Up Sequence*

## The Main Menu

The RAS Main Menu provides the user interface to control all system operations. To select an option, type the appropriate alphanumeric character and press [ENTER].

```
-----  
Configuration: RAS-125M500                CF2 V3_04 of Mar 17 2015  
              McLane Research Laboratories, Inc.  
              Remote Access Sampler  
              ML12345-05  
-----  
              Main Menu  
-----  
              Wed Mar 18 10:24:58 2015  
              Port=00 (home)  
  
      <1> Set Time           <5> Create Schedule  
      <2> Diagnostics       <6> Deploy System  
      <3> Manual Operation  <7> Offload Data  
      <4> Sleep             <8> Contact McLane  
      <C> Configure  
  
              Selection [] ?
```

*Figure 3-2: RAS-500 Main Menu*

## <1> Set Time

This option sets the real time clock (RTC).



McLane recommends that the RTC be set during the power-up sequence. When the RAS is powered on, the clock defaults to January 1, 1970, 00:00:00. The clock can be set to any date and time in the allowed range and the count will continue from the new value.

```
Clock reads 02/08/70 02:20:25.  Change [N] ? y
Format is mm/dd/[yyyy or yy] hh:mm:ss
Enter correct time [02/08/1970 02:21:25] ? 03/04/2015 11:29:11
Clock reads 03/04/2015 11:29:11.  Change [N] ?
Initializing data array .....
```

*Figure 3-3: Set Time*

## <2> Diagnostics

Diagnostics is a scrolling display of system status including date, time, battery voltage (in Vb), temperature (in °Celsius), and valve status. A sample diagnostics display is shown in Figure 3-3. Type [X] or [CTRL]-[C] to exit from Diagnostics and return to the Main Menu. Toggle the scrolling on and off without exiting by pressing any other alphanumeric key.

```
-----
Selection [ ] ? 2
Press ^C to exit - any other key to pause/continue.

  Date      Time      Battery  Temp    Port
03/18/15  10:25:08  29.7 Vb  17.4°C  00 (home)
03/18/15  10:25:09  29.7 Vb  17.4°C  00 (home)
03/18/15  10:25:10  29.6 Vb  17.4°C  00 (home)
03/18/15  10:25:11  29.6 Vb  17.4°C  00 (home)
03/18/15  10:25:12  29.6 Vb  17.4°C  00 (home)
03/18/15  10:25:13  29.6 Vb  17.4°C  00 (home)
```

*Figure 3-4: Diagnostics*

## Low Battery Messages

Low battery voltage triggers warning messages during the exit from Diagnostics. If the main battery pack falls below 28 V, a message displays to replace the battery before deployment.

```
WARNING: Battery voltage is abnormally low.  
Check/replace main battery before deploying.  
Press any key to continue.
```

*Figure 3-5: Low Battery Voltage*

If the main battery pack falls below 18 V, the Diagnostics program terminates and displays the message below before returning to the Main Menu.

```
Main battery is extremely low and should be replaced
```

*Figure 3-6: Critically Low Battery Voltage*

If a critically low battery is detected and a data file exists in memory that has not been offloaded, an additional warning will be displayed before returning to the Main Menu.

```
A data set exists in memory that has not been offloaded.  
Offload the data now, before replacing battery, or the  
data may be lost.
```

*Figure 3-7: Critically Low Battery Voltage - Offload Data*



Confirm that offloaded data is accurate before disconnecting the battery. The firmware detects only the successful execution of the Offload Data option and not whether the data file was successfully logged by Motocross.

### <3> Manual Operation

The Manual Operation option allows direct control of the valve and pump for bench testing, port alignment and deployment preparation.



Do not run the pump dry. If conducting a bench test, submerge the RAS in water before using these options.

```
Configuration: RAS-125M500                CF2 V3_03 of Aug  4 2014
-----
Manual Operations Menu
-----
Wed Mar  4 11:31:49 2015
Port=00 (home)

<1> Find port      : home
<2> Find port      : J
<3> Next port      : advance
<4> Next port      : retreat
<5> Run pump       : forward      (100 ml)
<6> Run pump       : reverse      (100 ml)
<7> Run pump       : programmable
<8> System Flush  : programmable

<M> Main Menu

Selection [ ] ?
```

← **Fill volume set to 20% of bag capacity**

*Figure 3-8: Manual Operation Menu*



Port =99 indicates an unknown valve position. The valve must first find the Home Port (Port=00). Select <1> (Figure 3-9) to find Home Port. Contact McLane if the valve cannot locate Home Port.

### Option <1> Find Port: home

This option moves the valve to a reference position located at the water flush port, also known as the Home Port or Port 0.

```
Selection [] ? 1
Seeking home port...
Port 00
Port 01
Home port located. Aligning... Confirmed
```

*Figure 3-9: Find Port: Home*

### Option <2> Find Port:

This option moves the valve to a specified port.

### Option <3> Next port:advance

This option moves the valve forward one port position (for example, from Home Port 00 to Port 01).

```
Selection [] ? 3
Seeking port 01...
Port 00
Port 01
Port 01 located. Aligning... Confirmed
```

*Figure 3-10: Next Port: Advance*

### Option <4> Next port:retreat

This option moves the valve backwards one port position (for example, from Port 01 to Home Port 00).

```
Selection [] ? 4
Seeking home port...
Home port located. Aligning... Confirmed
```

*Figure 3-11: Next Port: Retreat*

### Option <5> Run pump: forward

This option pumps 500 ml of water at 75 ml/min. in the forward direction. The pump can be stopped at any time before the operation is complete by pressing [CTRL]-[C]. Each row of the display shows the pump speed control value; the instantaneous pump speed in Hertz, the average pump speed in Hertz, the cumulative volume pumped, the instantaneous flow rate in ml/min, and the elapsed time in seconds.

```
Selection [] ? 5

Counts |Hall Count |Hall Avg |Volume Pumped |FlowRate   |Elapsed Seconds |Batt. V |Pump Current
2121 h  119 I_Hz   29 A_Hz   0.8 ml        49.8 ml/min 1 secs       31.5    62 mA
2192 h  144 I_Hz   65 A_Hz   1.8 ml        60.2 ml/min 2 secs       31.5    66 mA
2240 h  155 I_Hz  104 A_Hz   2.9 ml        64.8 ml/min 3 secs       31.5    59 mA
2275 h  162 I_Hz  145 A_Hz   4.0 ml        67.7 ml/min 4 secs       31.5    64 mA
. . . ←————— Display shortened to save space
1912 h  118 I_Hz   120 A_Hz  100.7 ml      49.3 ml/min 95 secs      31.5    49 mA

Volume reached

Total volume pumped      = 101 ml
Elapsed time of event    = 96 sec
Lowest battery detected  = 31.4 V
```

Figure 3-12: Run Pump Forward

### Option <6> Run pump: reverse

This option pumps 500 ml of water at 75 ml/min. in the reverse direction. The pump can be stopped at any time before the operation is complete by pressing [CTRL]-[C].

```
Selection [] ? 6

Counts |Hall Count |Hall Avg |Volume Pumped |FlowRate   |Elapsed Seconds |Batt. V |Pump Current
2115 h  122 I_Hz   120 A_Hz   0.9 ml        51.0 ml/min 1 secs       31.5    55 mA
2182 h  146 I_Hz   127 A_Hz   1.9 ml        61.0 ml/min 2 secs       31.5    57 mA
2226 h  157 I_Hz   137 A_Hz   3.0 ml        65.6 ml/min 3 secs       31.5    61 mA
2265 h  160 I_Hz   146 A_Hz   4.1 ml        66.9 ml/min 4 secs       31.5    50 mA
. . . ←————— Display shortened to save space
1906 h  120 I_Hz   121 A_Hz  100.8 ml      50.2 ml/min 95 secs      31.5    50 mA

Volume reached

Total volume pumped      = 101 ml
Elapsed time of event    = 96 sec
Lowest battery detected  = 31.4 V
```

Figure 3-13: Run Pump Reverse

### Option <7> Run pump: programmable

Use this option to enter the volume, time limit and direction for pumping. The pump can be stopped at any time before the operation is complete by pressing [CTRL]-[C].

The various software features controlling and safeguarding pump operation are in effect whenever the pump is running.

### Option <8> System flush: programmable

Use this option post deployment to assist in flushing the system's plumbing with fresh water. This procedure is recommended before each deployment. See Chapter 8, "Maintenance and Storage" in this User Manual for information about using this option.

## **<4> Sleep**

Use this option to place the RAS in Suspend mode to conserve battery power. When the RAS is not running a schedule, Suspend mode automatically triggers after 20 minutes of inactivity.

Prior to Suspend mode, the current time will display. During Suspend mode, the system will wake every 20 minutes to check system status, display the time and then return to Suspend mode. This is also the operation mode after the last event of a schedule is completed and during the intervals between events. To wake the system and return to the Main Menu, press [CTRL]-[C] three times (with three second pauses between each keystroke).

```
Selection [] ? 4
03/04/15 11:40:10 Suspended ...
```

*Figure 3-14: Suspend Mode*

## **<5> Create Schedule**

Use this option to create a sampling schedule before the actual deployment. The schedule specifies the number of samples to be taken (from 1 through 48), and consists of preprogrammed dates and times that will trigger pumping events.



Creating a new schedule overwrites data in memory.



Specific steps for using this option to create a RAS sampling schedule are provided in the section “Programming a Schedule and Deploying the RAS” at the end of this Chapter.

```
-----  
Configuration: RAS-125M500                CF2 V3_04 of Mar 17 2015  
  
-----  
                          Schedule Menu  
-----  
  
Wed Mar 18 10:25:37 2015  
  
<1> Enter each event time  
<2> Enter start date & interval  
<3> Enter start date & end date  
  
<M> Main menu  
  
Selection [2] ?
```

*Figure 3-15: Schedule Menu*

## <6> Deploy System

Once the sampling schedule is created, Deploy System does the following:

- Checks EEPROM and requires a reboot if data is stored there.
- Confirms that the valve is aligned to Home Port (00).
- Warns if there is data ready to be offloaded.
- Confirms the date and time.
- Changes or keeps the existing sampling schedule.
- Displays a final sampling parameter check with options to make changes.

After the date, time and schedule are confirmed, the final check is performed and a final prompt is displayed. If backup batteries are not detected during the check, the firmware will not accept the ‘Y’ entry to start the deployment.

Typing *Y* at the final prompt commits the firmware to the deployment. The firmware enters Suspend mode only a [CTRL]-[C] entry is allowed.



Specific steps for using this option to deploy a RAS are provided in the section “Programming a Schedule and Deploying the RAS” at the end of this Chapter.

## <7> Offload Data

This option works with the “Capture to file” feature of Motocross. After recovering the RAS, and re-establishing the communications link with the computer, select <7> Offload Data to capture data to a text file. Confirm that Motocross “Capture to File” is ON during offload. Offload data before disconnecting the battery to prevent data loss.



Specific steps for using this option to offload data are provided in Chapter 7 “Deployment and Recovery” in this User Manual.

Figures 3-16, 3-17 and 3-18 show the screens when the offload for All Data is selected.

```
-----  
Configuration: RAS-125M500                CF2 V3_04 of Mar 17 2015  
  
-----  
                        Offload Menu  
-----  
                Thu Mar 19 13:01:44 2015  
                Port=00 (home)  
                <1> Display ALL data  
                <2> Display event summary data  
                <3> Display pump data  
                <4> EEPROM data backup cache  
                <M> Main menu  
                Selection [M] ? 1  
  
Start the capture file now.  
Then, press any key to start the transfer. The data  
file will remain in memory and is not erased by this  
offload procedure.  
  
Software version:  RAS-3_04.c  
Compiled:          Mar 17 2015 12:32:34  
Electronics S/N:  ML13278-05  
Temperature probe: Internal  
  
Data recording start time = 03/18/15 10:29:55  
Data recording stop time  = 03/19/15 10:27:13
```

*Figure 3-16: Display All Data (1 of 3)*

HEADER

System test 10/18/15  
12345-04  
MDS

SAMPLE PARAMETERS

Pre-sample acid:  
Acid flush volume [ml] = 10  
Acid flush time limit [minutes] = 1  
Acid exposure delay [minutes] = 1  
Water Flush:  
Water flush volume [ml] = 100  
Water flush time limit [minutes] = 5  
Sample:  
Sample volume [ml] = 500  
Sample time limit [minutes] = 25  
Post-sample acid:  
Acid flush volume [ml] = 0  
Acid flush time limit [minutes] = 0

SCHEDULE

Event 1 of 48 @ 03/18/15 10:45:00  
Event 2 of 48 @ 03/18/15 11:15:00  
Event 3 of 48 @ 03/18/15 11:45:00  
Event 4 of 48 @ 03/18/15 12:15:00  
.  
.  
.  
Event 47 of 48 @ 03/19/15 09:45:00  
Event 48 of 48 @ 03/19/15 10:15:00

← Display shortened to save space

DEPLOYMENT DATA

1 03/18/15 10:45:02 29.6 Vbat 17.0 °C PORT = 00  
Pre-sample acid flush 11 ml 9 sec LB 28.9 V Volume reached  
Flush port = 49  
Intake flush 102 ml 82 sec LB 28.5 V Average I 102.0 mA Highest I  
108.0 mA Volume reached  
Flush port = 00  
Sample 502 ml 402 sec LB 28.3 V Average I 105.0 mA Highest I  
117.0 mA Volume reached  
Sample port = 01  
03/18/15 10:54:46 29.0 Vbat 19.6 °C PORT = 01  
Post-sample acid flush 0 ml 0 sec LB 0.0 V . . .  
Flush port = 49  
2 03/18/15 11:15:02 29.5 Vbat 17.1 °C PORT = 00  
Pre-sample acid flush 11 ml 9 sec LB 28.8 V Volume reached  
Flush port = 49  
Intake flush 101 ml 81 sec LB 28.5 V Average I 89.0 mA Highest I  
94.0 mA Volume reached  
Flush port = 00  
Sample 502 ml 402 sec LB 28.3 V Average I 100.0 mA Highest I  
110.0 mA Volume reached  
Sample port = 02  
03/18/15 11:24:47 29.0 Vbat 19.7 °C PORT = 02  
Post-sample acid flush 0 ml 0 sec LB 0.0 V . . .  
Flush port = 49

← Display shortened to save space

Figure 3-17: Offload/Display Data File – Display All (2 of 3)

PUMPING DATA

Sample interval = 15 [seconds]

[event#]	[ml/min]	[ml]	[Vbat]	[Av. Cur]	[High Cur]
1	75	19	28.4	114.0	118.0
1	75	37	28.4	113.0	117.0
1	75	56	28.4	113.0	115.0
1	75	75	28.4	111.0	113.0
1	75	94	28.4	111.0	114.0
1	75	112	28.4	111.0	114.0
1	75	131	28.4	110.0	112.0
1	75	150	28.4	109.0	112.0
1	75	169	28.4	108.0	112.0
1	74	187	28.4	107.0	110.0
1	75	206	28.4	107.0	110.0
1	75	225	28.4	106.0	111.0
1	75	244	28.4	106.0	110.0
1	75	262	28.4	105.0	110.0
1	75	281	28.4	106.0	112.0
1	75	300	28.4	106.0	110.0
1	75	319	28.3	106.0	111.0
1	75	337	28.4	105.0	109.0
1	75	356	28.3	106.0	112.0
1	75	375	28.3	106.0	111.0
1	75	394	28.3	106.0	110.0
1	75	412	28.3	106.0	110.0
1	75	431	28.3	105.0	110.0
1	75	450	28.3	106.0	110.0
1	75	469	28.3	106.0	110.0
1	75	487	28.3	106.0	110.0
2	75	19	28.4	105.0	110.0
2	75	37	28.4	104.0	109.0
2	75	56	28.4	104.0	110.0
2	75	75	28.4	104.0	109.0

← Display shortened to save space

48	76	18	27.0	103.0	110.0
48	75	37	27.0	104.0	109.0
48	74	56	27.0	104.0	107.0
48	75	75	27.0	103.0	109.0
48	75	93	27.0	104.0	108.0
48	75	112	27.0	103.0	108.0
48	75	131	27.0	104.0	108.0
48	75	150	27.0	104.0	109.0
48	75	169	27.0	104.0	107.0
48	75	187	26.9	103.0	108.0
48	75	206	26.9	103.0	107.0
48	75	225	26.9	103.0	107.0
48	75	244	26.9	103.0	109.0
48	75	262	26.9	103.0	108.0
48	75	281	26.9	103.0	106.0
48	75	300	26.9	103.0	106.0
48	75	319	26.9	103.0	108.0
48	75	337	26.9	103.0	107.0
48	75	356	26.9	103.0	108.0
48	75	375	26.9	103.0	106.0
48	75	394	26.9	103.0	108.0
48	75	412	26.9	103.0	109.0
48	75	431	26.9	103.0	108.0
48	75	450	26.9	103.0	108.0
48	75	469	26.9	103.0	106.0
48	75	487	26.9	103.0	106.0

End of instrument data file.  
 Terminate file logging operation now  
 Press any key to continue.

Figure 3-18: Offload/Display Data File – Display All (3 of 3)

## Option <4> EEPROM Data Backup Cache

Option 4 accesses a back-up copy of critical data written to non-volatile memory during deployment. In an unlikely system malfunction, EEPROM provides limited data recovery. Make backup copies of the capture file.

```
Selection [M] ? 4

During deployments a backup copy of the most important
information in the datafile is also written to EEPROM.

The EEPROM data cache contains the start and stop time for
each sampling event that occurred, the volume of water pumped
through the filter during the event, and the port number of
the valve.

To copy the EEPROM cache file to a disk file:
Start the capture file, now.
Then, press any key to start the transfer.

The cache file remains in EEPROM until overwritten during the
next deployment.

Event:          1
Start time:     03/04/15 10:15:02
Volume pumped: 101 ml
Elapsed time:   81 sec
Lowest battery: 31.6 V
Start temp:     22.8 C
Port used:      01
Stop time:      03/04/15 10:19:22
Status:         Volume reached

Event:          2
Start time:     03/04/15 10:30:02
Volume pumped: 101 ml
Elapsed time:   81 sec
Lowest battery: 31.6 V
Start temp:     23.2 C
Port used:      02
Stop time:      03/04/15 10:34:24
Status:         Volume reached
. . . ←----- Display shortened to save space
End of EEPROM data backup cache.

Terminate file logging operation now
```

*Figure 3-19: EEPROM Data Backup Cache*

## <8> Contacting McLane

This option displays McLane contact information and includes the software version and serial number of your instrument.

```
Selection [] ? 8

      McLane Research Laboratories, Inc.
      Falmouth Technology Park
      121 Bernard E. Saint Jean Drive
      East Falmouth, MA 02536-4444 USA

      Email: McLane@McLaneLabs.com
      Web: http://www.McLaneLabs.com
      Tel: 508-495-4000 Fax: 508-495-3333

      Configuration: RAS-125M500
      Source file: CF2-3_03.c
      Electronics S/N: ML12345-02
      Compiled: Aug 4 2014 13:07

Press any key to continue.
```

*Figure 3-20: McLane Contact Information*

## Configuration Menu

The Configuration menu sets the controls for the pump type, sample bag capacity and options. A new RAS sampler ships with these settings complete. Using the Configuration menu could be necessary if hardware changes are made or if the firmware is upgraded.

From the Main Menu, type *C* and enter the password *con* or *configure*.

```
Selection [ ] ? c Password: ***

-----
Configuration: RAS-125M500                CF2 V3_04 of Mar 17 2015
-----
                Configuration Menu
-----
                Wed Mar 18 10:25:22 2015

<A> External Temperature Sensor    [No]
<B> Pressure Sensor                [No]
<C> Pump                           [Maxon 125 mL/Min.]
<D> Sample Bag Capacity            [500]

<X> Save & Exit                    <^C> Cancel & Exit

Selection [ ] ? x

                Configuration successfully stored
```

*Figure 3-21: Configuration Menu*



The firmware sample bag capacity must match the actual sampler (500mL for the RAS-500 and 100mL for the RAS-100).

## Programming a Schedule and Deploying the RAS

This section provides steps for programming a schedule and deploying the RAS. A new battery pack should be installed before every deployment. While programming a schedule, use the file capture utility available in Motocross to log all communication with the RAS. Chapter 2 in this User Manual has more information about using Motocross.



Remove the intake cap from the valve intake just prior to deploying the RAS so that the pump can operate.



*Figure 3-22: Intake Cap*

### Sample Schedule

To program the sampling schedule and parameters, complete the following steps.

1. Power on the computer and start Motocross.
2. Remove the dummy plug from the COM connector on the end cap and connect the COM cable to the computer.
3. Connect the COM cable to the computer serial port.
4. Connect the battery.
5. From the Main Menu select <5> 'Create Schedule'.

The first step for creating a schedule is setting the number of sample events, date and time of the sample schedule. Specific controls can be programmed for each sample event at deployment time.

6. Type *Y* at the prompt to enter a new schedule.
7. Enter the number of desired sampling events.

This prompt will be preceded by warnings if previous deployment records (a data file) or a deployment schedule exist. The system requires a reboot to clear EEPROM before saving a new schedule if there is at least one file in memory. If a reboot is needed, a message displays.

```
Selection [ ] ? 5
Existing deployment data file will be erased. Continue [N] ? y
Enter new deployment schedule [N] ? y
```

*Figure 3-23: Existing Data File will be Erased*

There are three options for creating the sample schedule. The collection schedule can begin at a specific date and time or via a count-down timer. Each option is described in the sections that follow.

```
-----
Configuration: RAS-125M500                CF2 V3_04 of Mar 17 2015
-----
                          Schedule Menu
-----
Wed Mar 18 10:25:37 2015

<1> Enter each event time
<2> Enter start date & interval
<3> Enter start date & end date

<M> Main menu

Selection [2] ?
```

*Figure 3-24: Schedule Menu*

8. Enter the number of events to program and press [ENTER].

```
Current value of number of events to program: 48
Enter number of events to program (0-48) [48] ?
```

*Figure 3-25: Enter Number of Events to Program*

9. Select Option <1>, <2> or <3> from the Schedule Menu to define the schedule start date and time and sample intervals.

**Option <1> Enter each event time**

This option enters events one at a time (month, day, year, hour, minute, and second). The events do not have to be entered in chronological order and will be automatically sorted.

**Option <2> Enter start date & interval**

This option enters a start date and a desired interval between the event start times. The interval is entered in units of days, hours and minutes.

```
Selection [2] ? 2
Enter START date and time [03/18/2015 10:25:45] ? 03 18 15 10 45 00
Enter interval
Days      (0-365) [ 0] ?
Hours     (0- 23) [ 0] ?
Minutes   (0- 59) [ 0] ? 20

Schedule Verification

Event 1 of 48 at 03/18/15 10:45:00
Event 2 of 48 at 03/18/15 11:05:00
Event 3 of 48 at 03/18/15 11:25:00
Event 4 of 48 at 03/18/15 11:45:00
. . . ← Display shortened to save space
Event 47 of 48 at 03/19/15 02:05:00
Event 48 of 48 at 03/19/15 02:25:00

Modify an event [N] ?
```

Figure 3-26: Schedule – Option 2

### Option <3> Enter start date & end date

This option schedules events at regular intervals between the entered start and end dates.

```
Selection [2] ? 3
Enter START date and time [03/17/2015 13:15:14] ? 03/17/2015 13:21:00
Enter END date and time   [03/17/2015 13:15:31] ? 03/18/2015 07:48:00
Schedule Verification
Event  1 of 48 at 03/17/15 13:21:00
Event  2 of 48 at 03/17/15 13:44:33
Event  3 of 48 at 03/17/15 14:08:06
Event  4 of 48 at 03/17/15 14:31:39
. . .
Event 47 of 48 at 03/18/15 07:24:18
Event 48 of 48 at 03/18/15 07:47:51
Modify an event [N] ?
```

*Figure 3-27: Schedule – Option 3*

1. Review to confirm correct dates and times (press any key to scroll the display forward).

```
Schedule Verification
Event  1 of 48 at 03/17/15 13:21:00
Event  2 of 48 at 03/17/15 13:44:33
Event  3 of 48 at 03/17/15 14:08:06
Event  4 of 48 at 03/17/15 14:31:39...
. . . ←————— Display shortened to save space
Event 47 of 48 at 03/18/15 07:24:18
Event 48 of 48 at 03/18/15 07:47:51
Modify an event [N] ?
```

*Figure 3-28: Schedule Verification*

2. Type *Y* to change an event date or time.

## Deployment

The steps that follow describe setting up the deployment.



Do not run the pump dry. If conducting a bench test, submerge the pump in water before committing to the deployment.

1. From the Main Menu, select <6>, Deploy System.
2. The system requires a reboot to clear EEPROM for a new deployment if there is at least one data file in memory. If a reboot is needed, the message shown in Figure 3-29 displays with a reminder to offload data.

```
Selection [] ? 6

Records show that the system requires a post-deployment
reboot before proceeding with deployment setup.

A data set exists in system memory that has
not been offloaded. Existing data will be lost
if the system is rebooted.
```

*Figure 3-29: System Reboot Required*

3. The firmware confirms the valve is aligned with Home Port (00).

```
Searching for home port . . . done
```

*Figure 3-30: Confirming Home Port Alignment*

- If the valve cannot be aligned with Home Port, the warning message shown next is displayed, the deployment is terminated, returning to the Main Menu.

```
WARNING -- Unable to find home port!!!
This problem must be resolved before deploying the system.
Begin by checking external connections and exercising
the multiport filter valve using the tools found in the
"Manual Operation" menu.
```

*Figure 3-31: Unable to Locate Home Port*

4. The real time clock setting displays. Type *Y* to change the time.

The Schedule Menu is displayed next to create or change an event schedule. For an actual deployment and not a bench test, it is typical that the event schedule is created previously with the Create Schedule option. This schedule can be adjusted as needed using this option.

The number of events to program can be accepted or changed. Type Y to make changes or N to continue.

```

Configuration: RAS-125M500                CF2 V3_04 of Mar 17 2015

-----
                        Schedule Menu
-----
                        Tue Mar 17 13:15:07 2015
<1> Enter each event time
<2> Enter start date & interval
<3> Enter start date & end date
<M> Main menu
Selection [2] ? 3

Enter START date and time [03/17/2015 13:15:14] ? 03/17/2015 13:21:00
Enter END date and time   [03/17/2015 13:15:31] ? 03/18/2015 07:48:00

                        Selection [] ? 6

Clock reads 03/18/15 10:27:24.  Change [N] ?
Existing deployment data file will be erased. Continue [N] ? y
Enter new deployment schedule [N] ?
Schedule Verification
Event  1 of 48 at 03/18/15 10:45:00
Event  2 of 48 at 03/18/15 11:15:00
Event  3 of 48 at 03/18/15 11:45:00
Event  4 of 48 at 03/18/15 12:15:00
. . . .
Event 46 of 48 at 03/19/15 09:15:00
Event 47 of 48 at 03/19/15 09:45:00
Event 48 of 48 at 03/19/15 10:15:00
Modify an event [N] ?
Header A|
      B|
      C|
Acid   D| Pre-sample acid flush:   Enabled
      E| Flushing volume      =    10 [ml]
      F| Flushing time limit =     1 [min]
      G| Exposure time delay =     1 [min]
Water  H| Flushing volume      =   100 [ml]
      I| Flushing time limit =     5 [min]
Sample J| Sample volume        =   500 [ml]
      K| Sample time limit   =    25 [min]
Acid   L| Post-sample acid flush: Disabled
      M| Flushing volume      =     NA [ml]
      N| Flushing time limit =     NA [min]
Timing P| Pump data period    =    15 [sec]
V| Verify and proceed.
      Selection [] ?

```

**Number of Events in Schedule** ←

Figure 3-32: Sample Events and Parameters

5. The number of events to program can be accepted or changed. Type *Y* to make changes or *N* to continue.



A Quick Reference overview of each sampling parameter is provided in Appendix A of this User Manual.

6. Select *V* to proceed with the deployment when the sample parameters are complete.
7. The firmware performs a series of checks as explained in the sections that follow.

## Optional Acid Flush

The RAS can perform an acid flush before and after sample events (in an acid/sample/acid pattern). Enable this option by typing *D* from the Sampling Parameters (See Figure 3-32). The Exposure time delay (Option <G>) is the acid exposure time in the valve intake. This selection is not needed for the Post-sample acid flush because the acid remains in the valve and tubing until the next sample event.

If an acid flush option is active, the firmware performs checks in the Deployment programming process. The total acid volume available is 480mL (the amount of acid in the sample bag). If more acid is requested than available, a warning message displays after *V* is selected. Typing *Y* ignores the warning and proceeds with deployment.

```
WARNING: The total acid requested for pre & post sample flushes
         exceeds the total acid volume available

Proceed with the deployment (Yes/No) [N] ? n
```

*Figure 3-33: Pre & Post Sample Flush Exceeds Available Acid Volume*

## Checking for Event Overlap

After a schedule is accepted, the RAS firmware checks for potential problems, such as expired or overlapping events.

If an overlap occurs during deployment, the start of the next event is delayed until the current event is completed (an overlap condition does not terminate the deployment).

Event overlap is calculated after the sampling parameters have been entered and is based on the acid exposure delay and the duration of the combined flushing and sample volumes at their minimum flow rates. The system compares the time limit of each event to the scheduled start time of each subsequent event.



The warning message indicates that an overlap could occur, not that it will. Entering a schedule with intentionally short intervals can be a technique to secure rapid, sequential samples. The overlap message is only a reminder and can be ignored if tight scheduling is intended.

```
The following event(s) overlap previous event(s):  
  
    2   3   4   5  
  
The listed events may begin later than their scheduled start.  
Any events that are actually delayed will start as soon as  
earlier events are completed.  
  
Press any key to continue.
```

*Figure 3-34: Overlap Reminder*

One line of system status information displays followed by a message reminder to offload data written to the EEPROM backup during a previous deployment. Disregard the message if the data has already been recovered.



The pre-deployment process checks to confirm that backup batteries are correctly installed. If backup batteries are not detected, the firmware will not accept the 'Y' entry to start the deployment.

The data offload reminder and battery check will be followed by and a prompt to proceed with or terminate the deployment (a final chance to check the settings prior to deployment).

```
Selection [] ? D

System status:

  Date      Time      Battery      Temp Port
03/17/15 13:18:27 30.8 Vb 18.0°C 00 (home)

Caution: Deployment will overwrite the EEPROM data backup cache.

Performing 6 second Backup Battery test...

!!! CANNOT CONTINUE - CHECK BACKUP BATTERY !!!
```

*Figure 3-35: Deploy System*

If the main battery voltage is too low to support the deployment, warnings will display (see Figures 3-5, 3-6, and 3-7) for more information about battery warnings.

### Proceeding with the Deployment

After the status line (and battery warnings if any), a final prompt displays. Type *Y* to commit to the deployment (or *N* to cancel and return to the Main Menu). Prior to submerging the sampler, disconnect the communications cable from the controller housing. Reconnect the dummy plug to the communications connector on the controller housing and deploy the RAS.

```
Proceed with the deployment [N] ? y

Erasing EEPROM entries .....

>>> Remove communication cable and attach dummy plug. <<<
>>> System is ready to deploy. <<<

03/17/15 13:18:38 Waiting for event 01 of 48 @ 03/17/15 13:21:00

03/17/15 13:18:38 Suspended until 03/17/15 13:21:00 ...
```

*Figure 3-36: Proceed with Deployment*

The RAS enters a Suspend mode until the time of the first scheduled event. The RAS automatically wakes up and begins sampling at the scheduled time of the first pumping event.

```
>>> Remove communication cable and attach dummy plug. <<<

>>> System is ready to deploy. <<<

03/06/15 10:38:46 Waiting for event 01 of 05 @ 03/06/15 11:30:00
03/06/15 10:38:46 Suspended until 03/06/15 11:30:00 ....
```

*Figure 3-37: Deploy System*

For a bench test, leave the communications cable attached to the RAS electronics to observe the operation of the instrument in the Motocross window.



Pumping begins whether or not the RAS is on station. Reconnecting the COM cable and typing [CTRL]-[C] will terminate the deployment.

# Chapter 4

## Mechanical Description

### Frame

RAS-500 components are secured in an electro-polished stainless steel welded frame (a titanium frame is optional). The frame was designed to be an inline component on a high-tension (up to 2,200 kg) ocean mooring and has a built-in top bridle and four mooring eyes at the bottom for a chain or cable bridle. Each mooring eye accommodates a 5/8" shackle, and has an insulator to protect the frame from corrosion. The frame provides extra mounting space near the controller housing for other instruments.

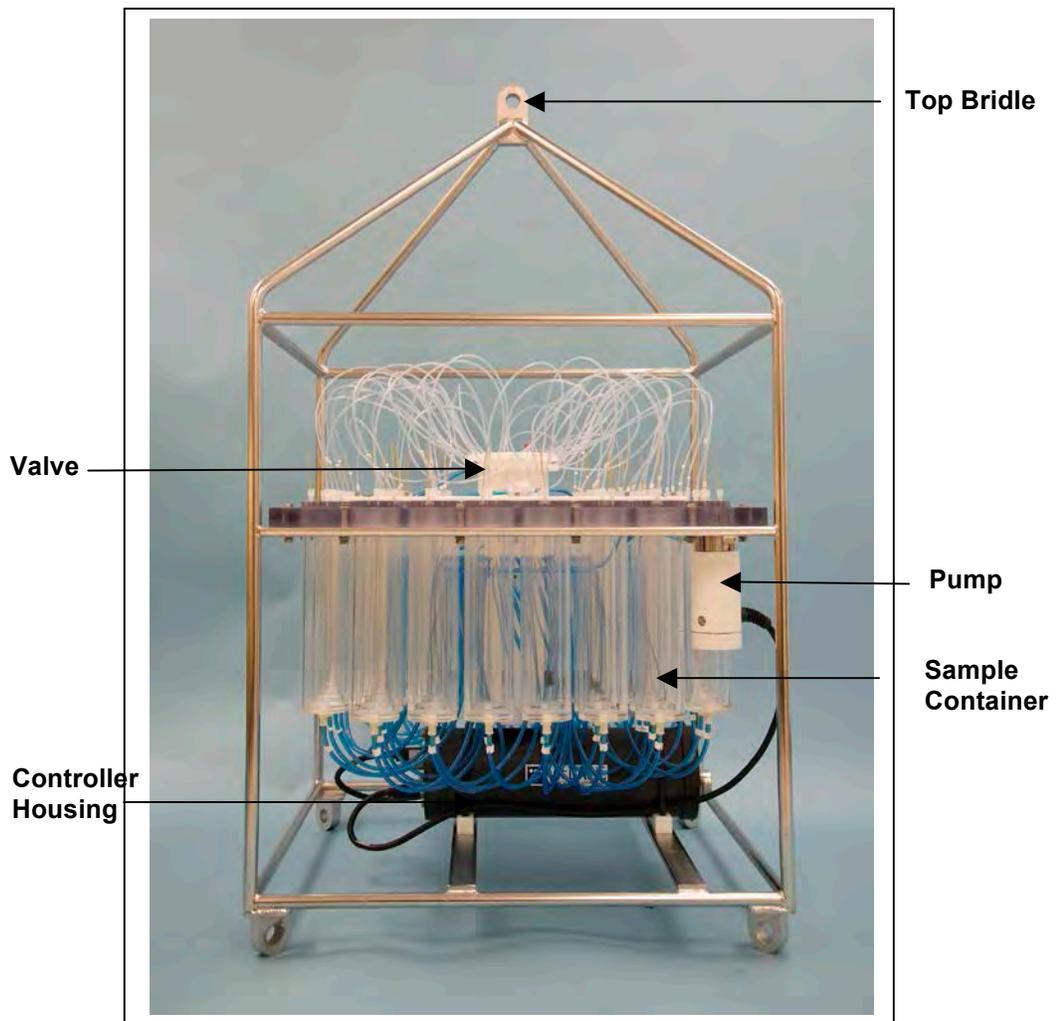


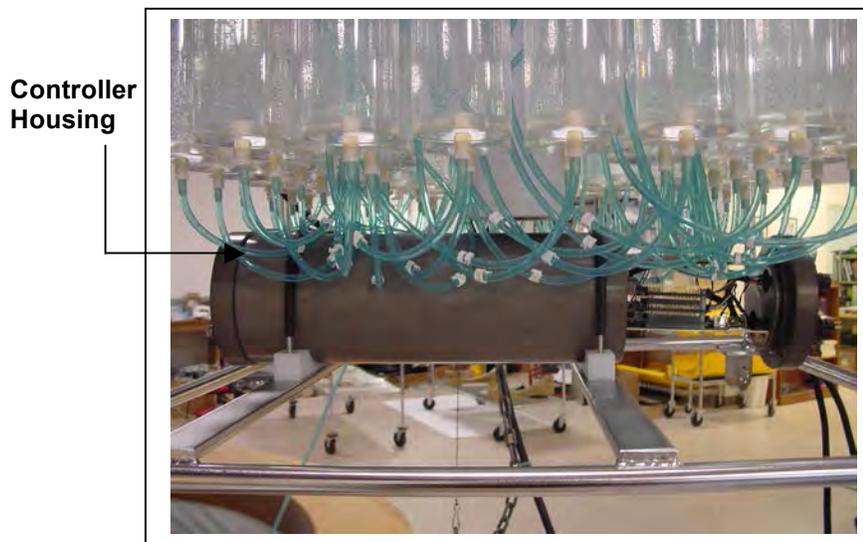
Figure 4-1: RAS-500 Full View



Attach zinc or steel anodes to the frame when deploying the RAS in a highly corrosive environment.

## Controller Housing

The controller housing, which is pressure resistant to 5,500 meters, is a cylindrical pressure housing fastened to the RAS frame by two latex rubber-insulated 316 stainless steel U-bolts. The battery pack, a micro-controller, a 3-phase pump-motor driver and a stepper-motor driver (for the multi-port valve) are contained in the controller housing. Two sacrificial zinc anodes (one attached to each end of the controller housing) provide galvanic protection from corrosion.



*Figure 4-2: Controller Housing*

The micro-controller, which starts automatically when the main or backup battery is connected, directs the programmed sampling settings and controls the pump and valve actions. The RAS firmware on the microcontroller allows system testing, entry of deployment schedules and offloading recovered data.

## Pressure Relief Valve

Attention and care should be taken in maintaining, operating, and opening the pressure housing. As of Summer 2015, McLane includes Pressure Relief valves (PRV) on all new controller housings.



Though unlikely, an unsafe internal controller housing pressure is possible, resulting from the chemical reaction between alkaline electrolyte and anodized aluminum due to battery failure with or without the intrusion of seawater. There can be enough pressure to cause the endcap bolts to fail, especially when one or more are loosened or removed.

As with all pressure housings, special care should be taken with O-rings and associated surfaces. O-rings and surfaces should be cleaned with isopropyl alcohol. O-rings should be lubricated with provided Parker O-Lube and replaced when necessary. Spare O-rings are included in the toolkit, and more can be purchased from McLane.

The sections that follow provide procedures for detecting and relieving pressure build-up in the controller housing, both with and without the PRV installed.



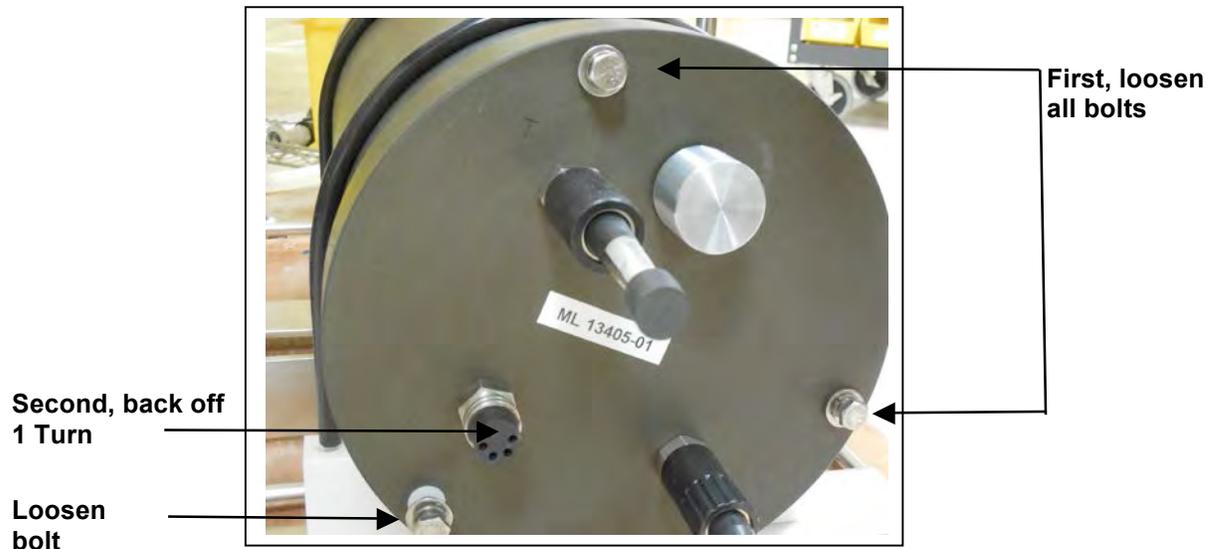
Observe safety precautions including removing personnel and objects from the path of the end-cap when performing either of these procedures.

## Relieving Pressure in a Controller Housing not Equipped with the PRV

1. Loosen all end cap bolts slightly. Do not completely remove the bolts.



Do not remove any individual bolts until pressure has equalized.

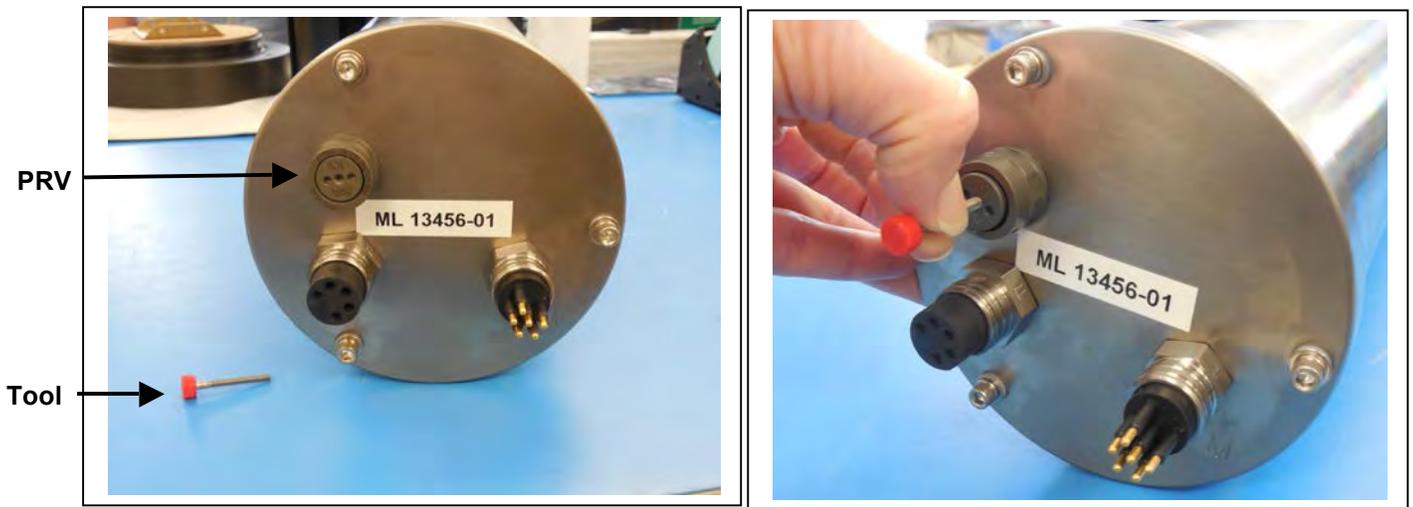


2. Observe whether the end cap moves once the bolts are loosened. Movement could indicate a pressure build-up inside the controller housing.
3. If a pressure build-up is suspected, loosen a bulkhead connector only one turn (do not remove the bulkhead connector). Loosening the bulkhead connector allows the pressure to equalize.
4. Let the controller sit undisturbed to allow pressure to equalize before attempting to further loosen the end-cap bolts.

## Relieving Pressure in a Controller Housing Equipped with the PRV

Controller housings manufactured after Summer 2015 include a Pressure Relief valve. This valve releases automatically at a pressure differential greater than 10psi. As an additional measure, the valve should be manually released prior to opening the controller housing by following the steps below.

1. Locate the threaded PRV release tool included in the toolkit.
2. Thread the PRV release tool into the center hole of the Pressure Relief valve.
3. Slowly pull the valve out to equalize pressure.



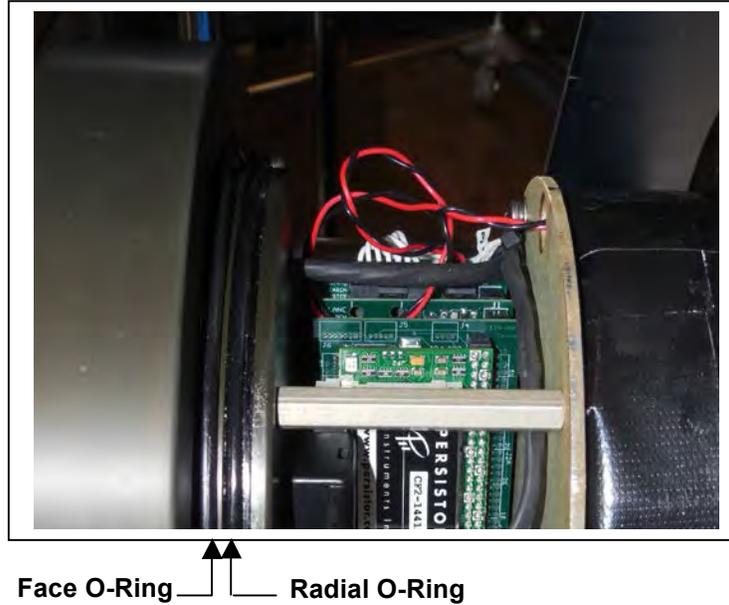
*Figure 4-4: Controller End Cap, with PRV*



McLane also offers a Pressure Relief valve upgrade to retrofit to all controller housings (including installation by McLane but excluding shipping and insurance costs). The controller end-cap and anodizing must be in suitable condition for PRV retrofits. Contact [mclane@mclanelabs.com](mailto:mclane@mclanelabs.com) for more information about the retrofit.

## Top and Bottom End Caps

The battery pack and electronics (a micro-controller, 3-phase pump motor driver and stepper motor driver) are fastened to the inside of the top end cap. Both the top and bottom end caps have a face o-ring and a radial o-ring (with a radial back-up ring) to seal the controller housing against water intrusion.



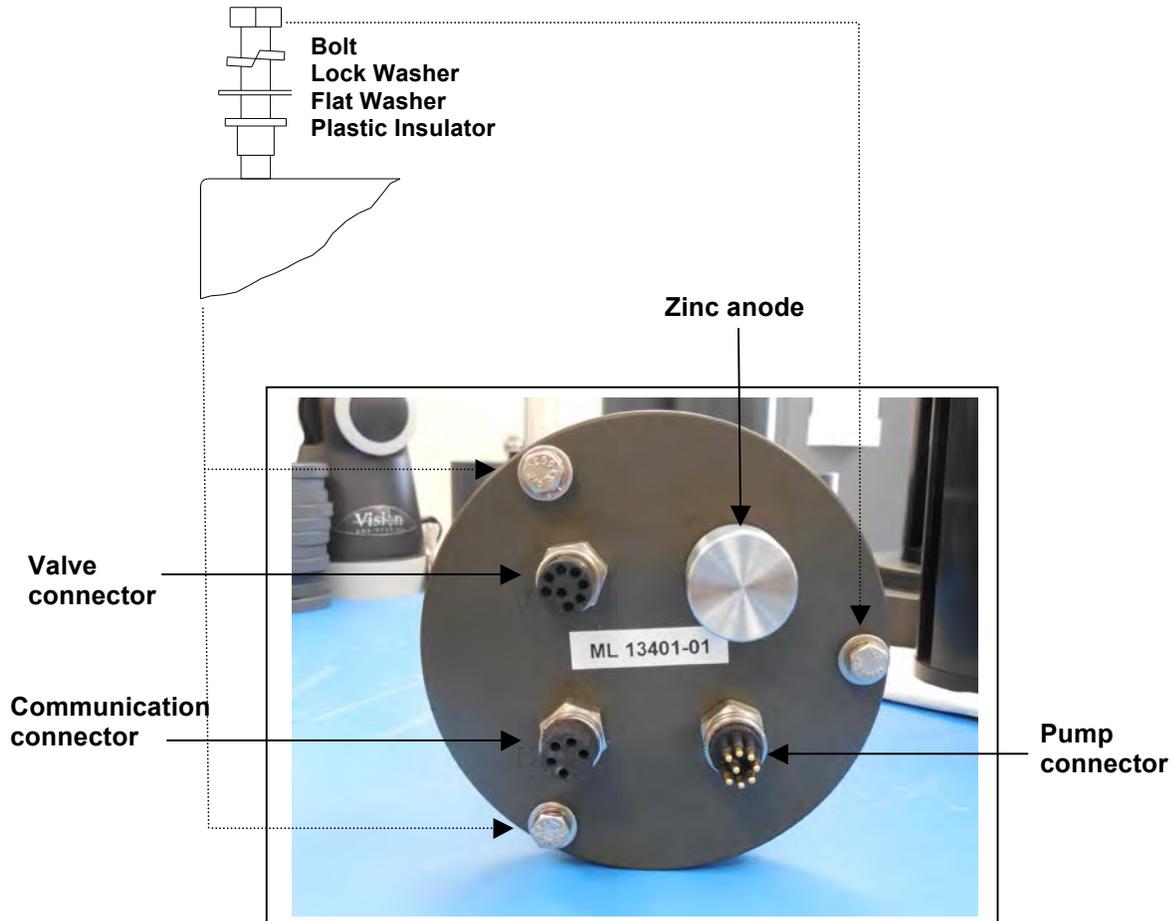
*Figure 4-5: Controller Housing Top End Cap with O-Ring Seals*



O-ring maintenance is important to keep the controller housing end caps from water intrusion. See Chapter 8 “Maintenance and Storage”, for details about o-ring maintenance.

## End Cap Bulkhead Connectors

The end cap has bulkhead connectors for the COM Port, Pump, Belt Motor, and Proximity Sensor (Figure 4-6).



*Figure 4-6: Controller Housing End Cap Bulkhead Connectors*

## End Cap Bolts, Plastic Inserts and Screw Holes

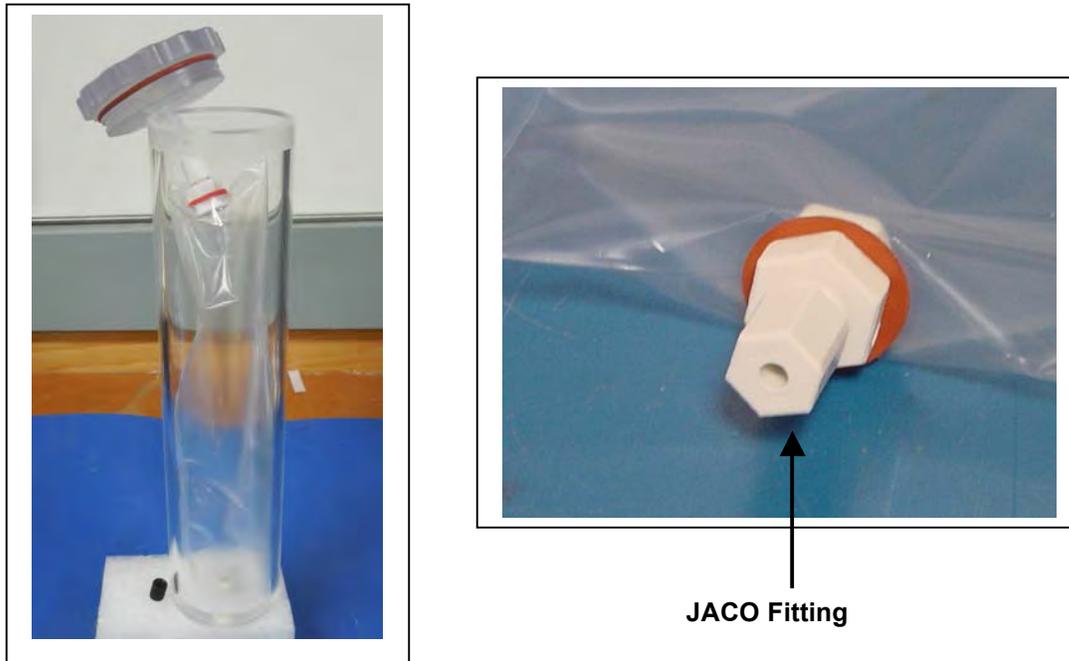
Three bolt/washer assemblies hold the controller housing end cap in place. A white plastic insert first goes into the screw hole of the controller housing, then a flat washer, spring (lock) washer, and lastly, the bolt. Tighten the bolts until the lock washers become flattened (20 in./lb.). All hardware is stainless-steel-type 316 (do not replace with any other type of material). A 7/16" nut driver is included in the toolkit.



Do not over- tighten the end cap bolts.

## Sample Tubes and Sample Bag Types

The RAS holds 48 individual CAST acrylic sample tubes. A bleed hole in the tube cap releases air during priming and provides pressure compensation during deployment. Each sample tube is connected in series between the intake head (top half of valve) and the exhaust head (lower half of valve). Each sample tube holds a 500mL clear or opaque bag attached to the tube cap.



*Figure 4-7: Sample Tube with Bag Installed, JACO Fitting*

Sample bags have a JACO fitting, ferrule, short tubing and threaded male connector (Figure 4-7). The pump draws water out of the sample tube holding the collapsed sample bag the pressure gradient drives the flow of ambient seawater through the intake and into the sample bag. After sampling, the multi-port valve returns to Home Port (00) sealing the sample in the bag.

## Filter Holders

A 47mm filter holder on each sample is an available option for the RAS-500. A 25mm filter holder is available for the RAS-100. Membrane or GFF filters with a 0.4 $\mu$ m pore size are recommended. Filters with pore sizes less than 0.4 $\mu$ m may require testing to confirm proper operation.

### Optional Filter Holders



*Figure 4-8: RAS-500 with Optional Filter Holder on each Sample*



Remove only the blue collar from the filter holder. The cap of the filter holder should remain attached to the top of the sample tube.

## Pumping, Acid, and System Flush

The valve heads are a HYDEX plastic stator and a Kynar plastic rotor. The stator is held stationary, while a stepper motor with a 100:1 planetary gear head turns the rotor. An optical sensor and slotted disk determine rotor position. The motor, gear head, and optical sensor are in a pressure compensated PVC plastic housing filled with Dow Corning 200 fluid (20cSt.).

### Gear Pump

A positive displacement gear pump creates the pressure gradient for sampling. The pump head is type 316 stainless steel and the motor housing is white PVC plastic. The pump head has user replaceable carbon gears and a replaceable magnet. A brushless DC 3-phase servo-motor is magnetically coupled to the pump head. Hall-effect encoders provide feedback to the controller for shaft speed control.



*Figure 4-9: Pump Head Gear and Replaceable Magnet*



After pumping 100 L of seawater, examine the pump head carbon gears and replace if worn.

A dual-head, 50-port rotary valve directs seawater to each sample bag. The top head has a single intake port and 50 exhaust ports; the bottom head has 50 intake ports and a single exhaust port. The valve top shows the port numbers and the tubing is also tagged with numbers to further

identify the port and valve connections. The sample containers and water flush option are connected between the two heads of the valve. Only one port is open on each head at one time.

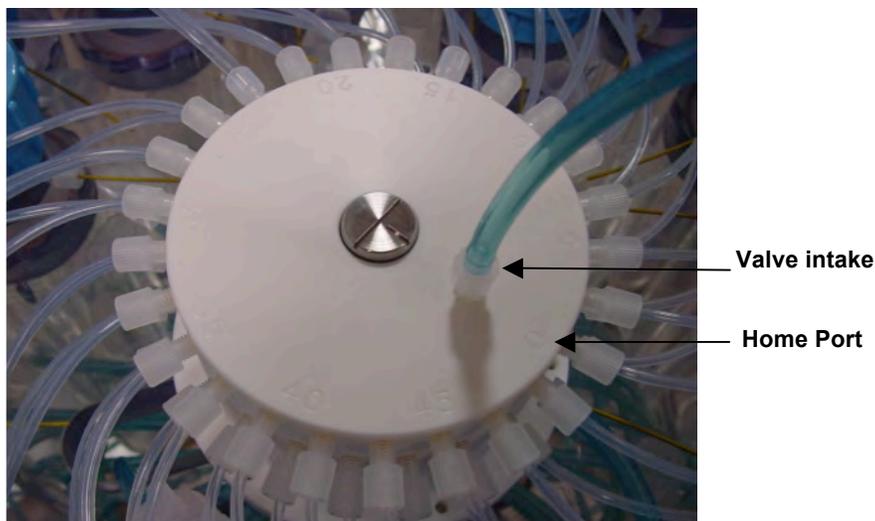


Figure 4-10: Multi-Port Valve

### Port Assignments

The Port/Designation table shown next illustrates how the water flush and acid flush keep the intake path clear of contaminants. Sample collection occurs in an acid flush/water flush/sample/acid flush order.

Port #	Designation
00/Home	Water Flush
01	Sample #1
02	Sample #2
...	...
47	Sample #47
48	Sample #48
49	Optional Acid Flush

## Acid Flush Assembly

Pre-and post sample acid cleaning cycles occur at Port 49. Acid cleaning loosens bio-fouling growth along the intake path for removal by the water flush. The acid flush reservoir is located in the corner of the sample tube assembly as shown in Figure 4-11. The reservoir contains a sample bag filled with acid or other bio fouling cleaner.

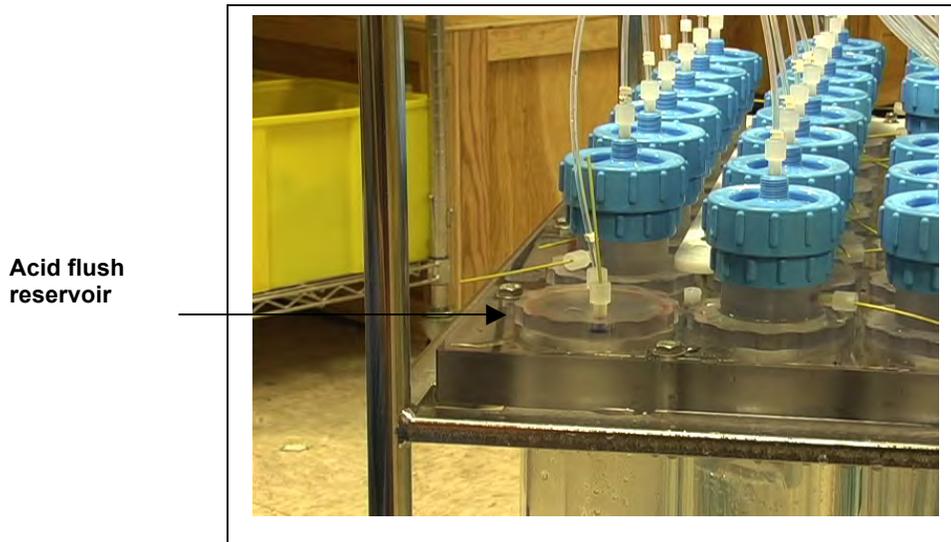


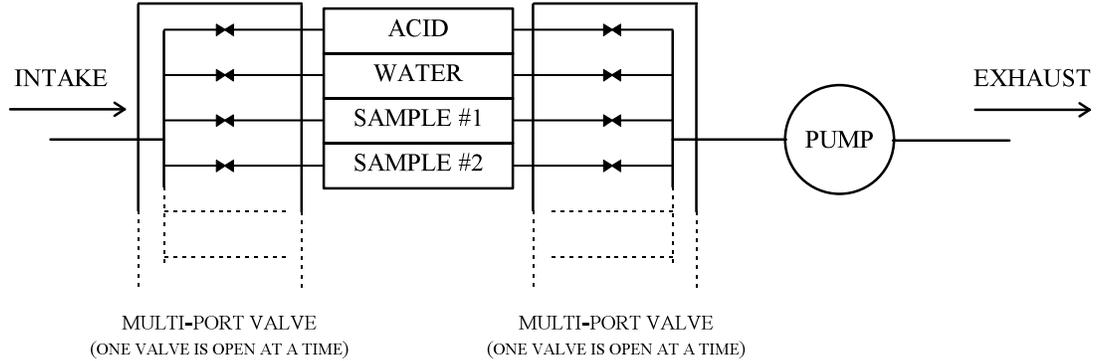
Figure 4-11: Acid Flush Reservoir

Acid cleaning cycles are user programmable as shown in Figure 4-12. The Pre-sample acid flush can include an acid exposure time delay to leave the acid standing in the valve intake. For details about sampling and flushing parameters, see Chapter 3, ‘User Interface’. For details about filling the acid reservoir, you can also view the RAS-500 Priming video.

Acid	D  Pre-sample acid flush:	Enabled
	E  Flushing volume =	10 [ml]
	F  Flushing time limit =	1 [min]
	G  Exposure time delay =	1 [min]
Water	H  Flushing volume =	100 [ml]
	I  Flushing time limit =	5 [min]
Sample	J  Sample volume =	500 [ml]
	K  Sample time limit =	25 [min]
Acid	L  Post-sample acid flush:	Disabled
	M  Flushing volume =	NA [ml]
	N  Flushing time limit =	NA [min]
Timing	P  Pump data period =	1 [min]
	V  Verify and proceed.	

Figure 4-12: Sampling and Flushing Parameters

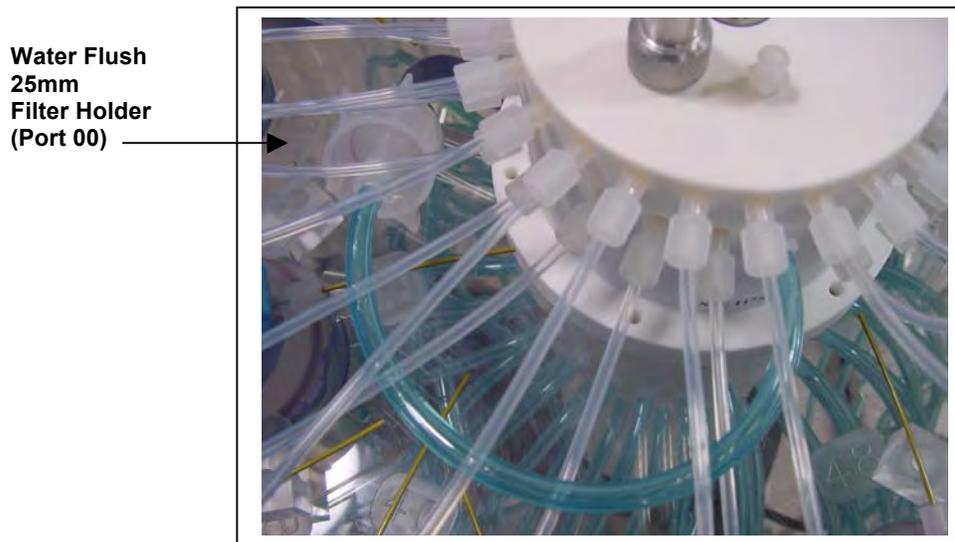
As illustrated next, the samples and the pump are isolated from each other.



*Figure 4-13: Pumping Operation Schematic*

### Water Flush Assembly

The water flush occurs at Port 00 before the sample is pumped. This is a forward pumping event. The water flush assembly consists of a 25mm filter holder (for a filter with pore size between 3 and 20 microns) connected to 'Home' port (Port 00) of the multi-port valve. The filter prevents large particles from entering the pump during flushing. Water is flushed from the intake tube, through the top valve stator, 25mm filter, bottom valve stator and pump.



*Figure 4-14: Water Flush Filter Holder*

## Serial Number

The base plate contains a serial number label. The controller housing end cap, pump assembly, valve assembly and firmware menu also display the serial number.



*Figure 4-15: RAS-500 Serial Number Label*

# Chapter 5

## Electronics Description

The RAS controller electronics is a four board stack mounted on the chassis plate between the controller housing end cap and the battery holder. Each board is described below.

Board	Use
CF2 Microcontroller Board	Low power data logging.
CF2 Interface Board	Controls the signals from the Microcontroller to the AUX Stepper.
AUX Stepper Board	Powers communications and Sample Belt.
Three Phase Board	Runs the pump. As material collects, a pump speed algorithm adjusts differential pressure across the active sample window. Flow rate adjusts to prevent sample or mesh damage and lower battery drain. If rapid intake clogging occurs, pumping stops to protect the sample.

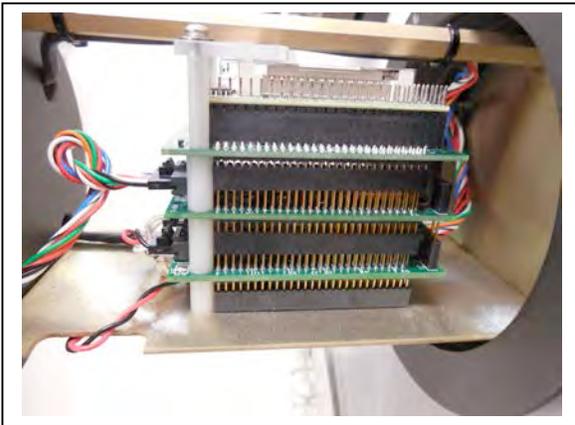


Figure 5-1: CF2 Four Board Stack



Figure 5-2: Microcontroller & Interface Board



Figure 5-3: Three Phase Board



Figure 5-4: AUX Stepper Board



Take standard electrostatic discharge (ESD) precautions when handling the electronics.

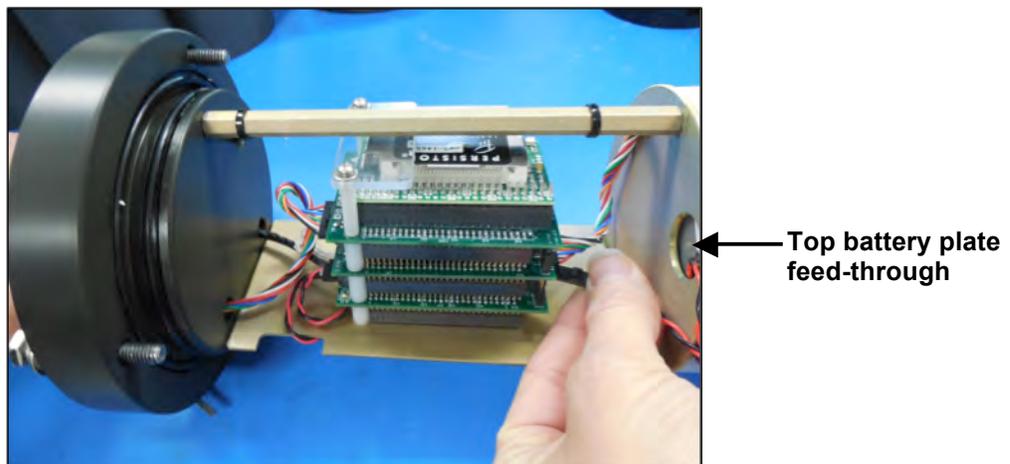
## Battery Connection

Connecting and disconnecting the main battery is the only way to switch the RAS on and off. The firmware starts automatically when the main battery is connected.



The backup batteries will not power on the sampler.

When new, the A21-1000 alkaline battery pack delivers approximately 10,000 mAh. The main battery positive and negative terminators are fed through the top battery plate for connection to the 2-pin connector on the middle board of the electronics stack. The main and back-up connectors are different to prevent misconnection.



*Figure 5-5: Battery Connection*

# Chapter 6

## Operations

Several operational steps are required before deploying the RAS. This chapter also provides current consumption values to estimate battery life for a deployment. These steps include installing the water flush filter and sample bags and clearing trapped air from the sample tubes (a process called ‘priming’). If programmable acid cleaning cycles will be used, the acid reservoir is also prepared during priming.

### Predeployment Preparation and Priming

Priming and other predeployment steps are critical to ensure successful sample collection and protect the sample tubes from damage. Priming always starts at Port 01 and should be performed sequentially at each port.

- Step 1 – Preparing the pump
- Step 2 – Installing the water flush filter
- Step 3 – Installing sample bags and priming sample tubes
- Step 4 – Preparing the acid reservoir
- Step 5 – Completing priming



These processes are completed using the RAS firmware. See Chapter 2 in this User Manual “Communicating with your McLane Instrument”, for steps to connect the RAS to a computer and use the terminal emulation program MotoCrossML.exe.

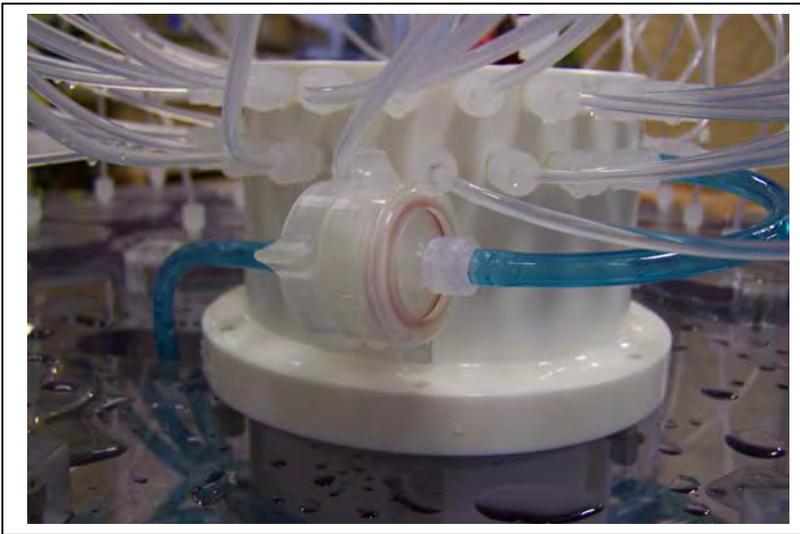


Priming is a wet process. Ensure the electronics housing is sealed to keep the electronics dry.

### Priming Step 1 – Preparing the Pump

Complete these steps to prepare for priming.

1. Prepare a container or bucket of clean water.
2. Using the syringe and exhaust tube supplied in the toolkit, inject clean water into the pump to prime it for operation.
3. After the pump cavity and exhaust are filled with clean water, remove the syringe and submerge the exhaust tube in the clean water container.



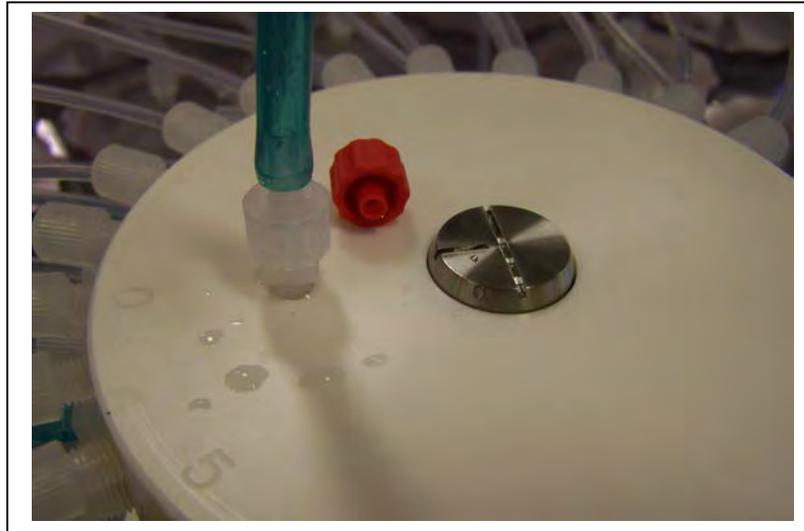
### Priming Step 2 – Installing the Water Flush Filter

The water flush filter is placed inline to Home Port (Port 00) and holds a 25mm disc filter with a pore size from 3 to 20 microns. The filter protects the pump from damage by large particles during flushing. Complete these steps to install the water flush filter.

*Figure 6-1: Water Flush Filter Holder*

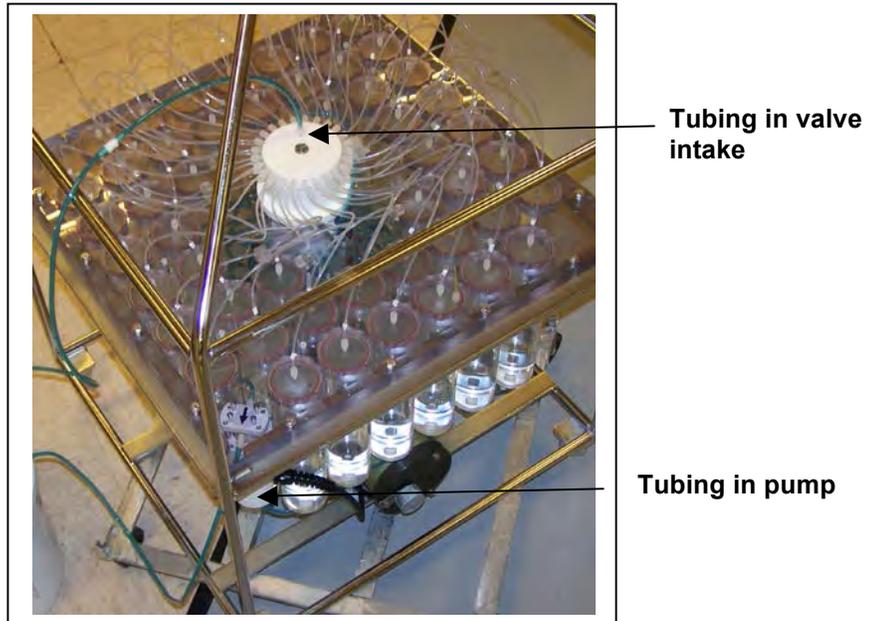
1. Disconnect the Luer Lock fittings at both ends of the water flush filter holder and remove the filter holder from the system.
2. Unscrew the locking ring to disassemble the filter holder halves.

3. Wet the bottom frit of the filter holder and install a 25mm disc filter (nominal pore size from 3 to 20 microns).
4. Wet the filter with clean water using a wash bottle and replace the top half of the filter holder and locking ring.
5. Reinstall the filter holder by connecting the Luer Lock connectors at both ends.



*Figure 6-2: Water Flush Filter Holder Disconnected*

6. Remove the cap from the valve intake and replace with the supplied intake tube.
7. Place the end of the intake tube into the container filled with clean water.



*Figure 6-3: Tubing Connections for Priming*

8. If the valve is not at Home Port (00) locate this position using Option <1> from the Manual Operation menu (if the valve is already at Home Port, skip this Step).
9. Using option <6> from the Manual Operation Menu, reverse pump to draw in clean water and remove air bubbles from Home Port and its associated plumbing.
10. Run the pump in reverse until water flows through the water flush filter holder, removing any remaining air bubbles.
11. When pumping has finished, remove the intake tube and replace the intake cap.



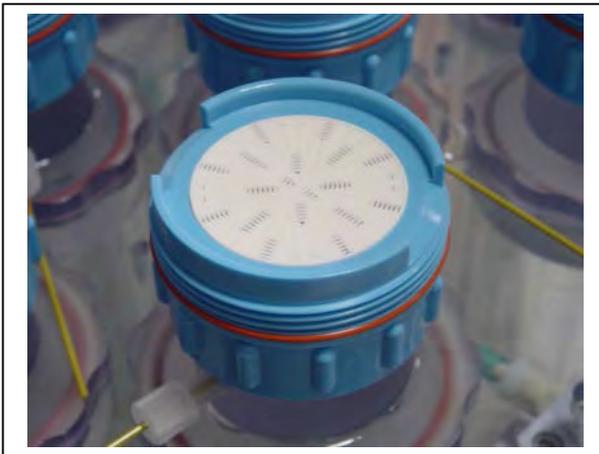
Remove the intake cap from the valve intake just prior to deploying the RAS so that the pump can operate.



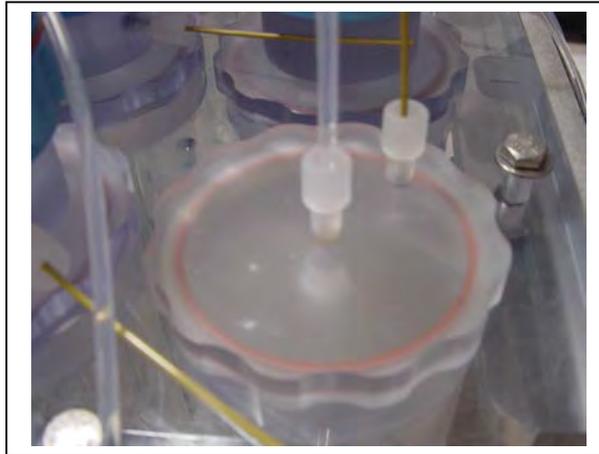
*Figure 6-4: Intake Cap*

### Priming Step 3 – Installing Sample Bags and Priming Sample Tubes

Sample tubes can be installed with or without filter holders as shown in Figures 6-7 and 6-8. The priming steps in this section show photos of sample tubes with and without filter holders installed.

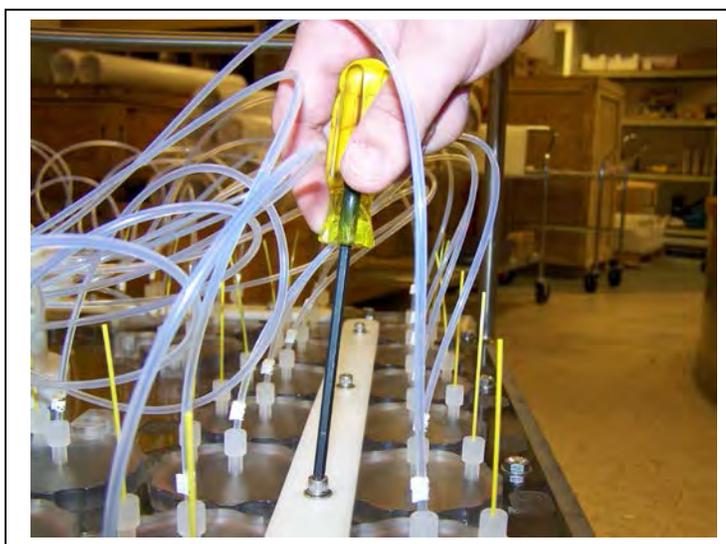


*Figure 6-5: Sample Tube with Filter Holder*



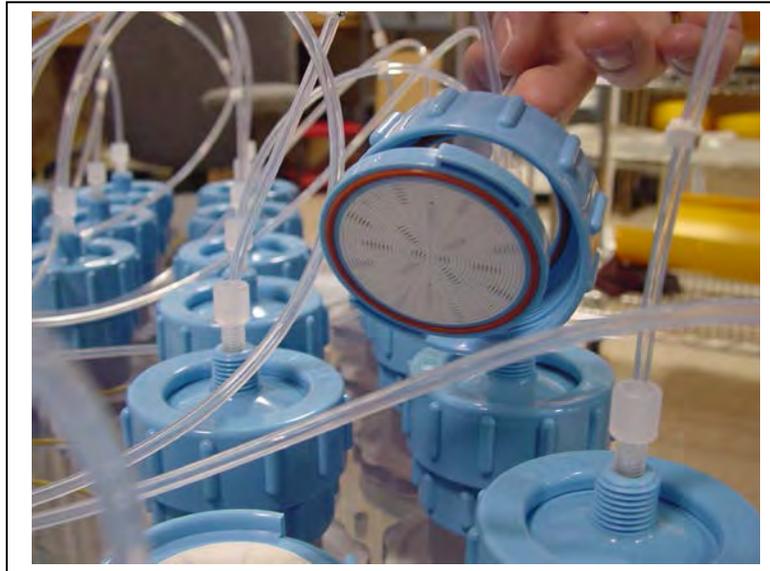
*Figure 6-6: Sample Tube without Filter Holder*

1. Before installing sample bags and priming sample tubes, check that the bottom and top tubing is securely connected in the correct order. Tubing is labeled by sample number. Sample numbers should match the numbers on the clear base plate.
2. Remove the screws from the four hold-down brackets and slide the brackets out from in between the sample tube caps. This step provides access to the sample tubes for bag installation.



*Figure 6-7: Removing Hold Down Brackets*

3. Remove the 8 individual hold-down clamps that secure the four innermost tubes.
4. Priming is sequential and starts at Port 1. At the appropriate sample tube, remove the locking ring and separate the top half of the filter holder (if filters are used).



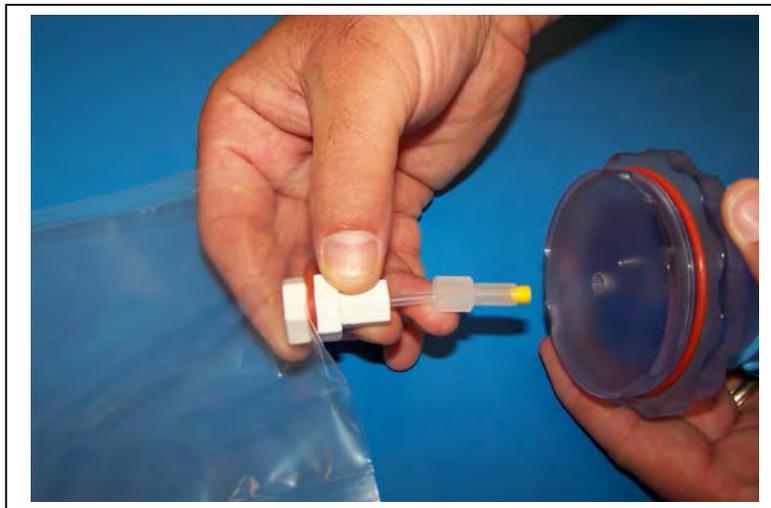
*Figure 6-8: Removing Filter Holder Tops*

5. Remove the pressure compensation tube and set it aside.



*Figure 6-9: Pressure Compensation Tube*

6. Prepare a new sample bag by removing the cap and attaching an empty syringe using the fittings supplied in the toolbox. Confirm there is a ferrule on the JACO bag tubing before use.



*Figure 6-10: JACO Bag with Ferrule*

7. Draw in excess air from the sample bag using the syringe. If using a sample bag with Luer Lock fittings, close the valve.
8. If using a preservative, use a separate syringe to inject the preservative into the bag before installing it into the sample tube.



Before adding preservative, check the “RAS Specifications” section in Chapter 1 of this User Manual to confirm chemical compatibility.

9. Remove the sample tube cap and attach the prepared sample bag.



*Figure 6-11: Attaching a Sample Bag*

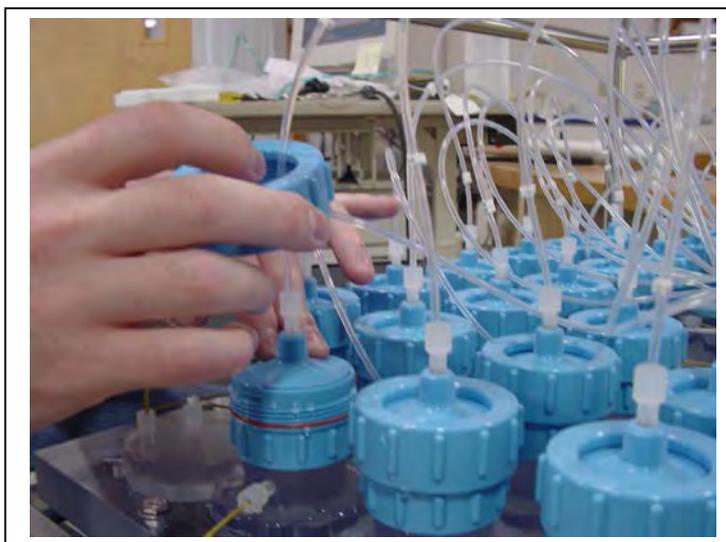
10. Gently fold the sample bag and slide it into the sample tube.
11. Using clean fresh water, fill the sample tube until almost full and secure the cap.
12. Using option <6>, reverse pump into the sample tube to purge the remaining volume of air.
13. When water drips from the bleed hole stop pumping by pressing [CTRL]-[C].
14. After pumping has stopped, reinstall the pressure compensation tube (the fitting can be tightened using the supplied wrench but do not over-tighten).
15. If using filter holders, remove air bubbles from beneath the filter holder frit by forcing water into the frit holes with a wash bottle.
16. Install a 47mm disc filter onto the frit and wet with clean water.
17. Remove the cap from the valve intake and attach a syringe of clean water.

18. Inject clean water into the valve intake until it fills the tubing and the filter holder top (if filter holders are installed as shown in figure 5-12). If filter holders are not installed inject clean water until the top tubing is filled.



*Figure 6-12: Injecting Water into the Valve Intake*

19. Carefully secure the top half to the filter holder using the locking ring and push down on the filter cap to displace air bubbles.



*Figure 6-13: Closing the Filter Holder Cap*

20. This completes priming for a single sample tube. Using option <3> from the Manual Operation menu, advance to the next port and repeat this process for each sample tube, ending at port 48.

#### Priming Step 4 – Preparing the Acid Reservoir

Acid provides an optional, programmable bio-fouling flush that further cleans the intake tube. Port 49 is the valve position used for acid cleaning. The acid flush reservoir is located in the corner of the sample tube assembly. After installing sample bags and priming sample tubes, add acid as follows:

1. Using option <3> from the Manual Operation menu, advance to Port 49, the position used for acid cleaning.
2. Remove the pressure compensation tube and top tubing from the acid reservoir cap.
3. Remove the acid cap and attach a new sample bag.
4. Gently fold the bag, slide it into the reservoir and secure the cap.
5. Install the supplied Luer Lock fitting to the acid cap.
6. Fill a clean syringe with an acid solution and inject acid into the bag. The acid bag will hold just over 500ml of acid, so filling will require multiple injections from the syringe. Keep track of the volume of acid injected. Overfilling could cause the bag to burst.
7. Remove the Luer Lock fitting and reconnect the top tubing.
8. Remove the clean water syringe from the valve intake and replace the intake cap.
9. From the Manual Operation menu, select <6> Run pump: reverse. Perform a reverse pump to fill the remaining volume of the acid reservoir with clean water.
10. Filling the entire volume may require a few restarts of the pumping routine.
11. Press [CTRL]-[C] to stop the pump manually when water emerges from the bleed hole at the top of the acid cap.
12. Reinstall the pressure compensation tube onto the acid cap.
13. Remove the intake cap and attach a syringe of acid solution.

14. Disconnect the top tubing from the acid cap and inject acid into the intake until the top tubing is filled.
15. Reattach the top tubing to the acid reservoir cap.
16. Remove the acid syringe from the intake and replace the intake cap.

### Priming Step 5 – Completing Priming

After priming each tube and filling the acid reservoir, complete these additional steps.

1. Secure the sample tubes by reinstalling all hold-down brackets and individual clamps.
2. Using option <1> from the Manual Operation menu, position the valve to the Home Port (Port 0).
3. Using option <4> from the Main Menu, put the system into Suspend mode.
4. This completes the priming process. Deployment programming instructions are in Chapter 3, “User Interface”.

## Instrument Current Consumption

The values for pumping or moving the valve include the current drain of the controller, which is awake during valve rotation and pumping. Battery life for a planned deployment schedule can be estimated using the instrument current consumption values provided here. An example of an estimate for a one-year deployment is shown next.

Controller unit	3.0 mA
Controller unit in low power mode	0.30 mA
Pumping	160 mA
Moving the valve from one port to the next	0.23 mAh (2.7 seconds)

### Example of Determining Battery Life – RAS-500 One Year Deployment

<b>Pre-deployment (loading sample bags)</b>	
Controller unit (3 hours)	3 h x 3.00 mA = 9.0 mAh
Moving valve (twice around)	100 ports x 0.23 mAh = 23.0 mAh
Running the pump (1.0 hour)	1.0 h x 160 mA = 160.0 mAh
	<b>Subtotal = 192.0 mAh</b>
<b>Deployment</b>	
Controller (1year)	8760 h x 0.30 mA = 2628.0 mAh
Move valve (48 samples)	1300 ports x 0.23 mAh = 299.0 mAh
Pumping (8 minutes per port)	6.4 h x 160 mA = 1024 mAh
	<b>Subtotal = 3951 mAh</b>
<b>Recovery (offload data/remove samples)</b>	
Controller unit (2 hours)	2 h x 3.00 mA = 6.0 mAh
Move valve (once around)	50 ports x 0.23 mAh = 11.5 mAh
	<b>Subtotal = 17.5 mAh</b>
<b>Total Current Consumption</b>	<b>3951 + 3183 + 17.5 = 4160.5 mAh</b>

In the previous example, the total energy consumed is less than the 10,000 mAh capacity of the battery and the proposed deployment plan will not exceed battery life.

## Notes

# Chapter 7

## Deployment and Recovery

### Attaching to a Mooring

The RAS can be deployed on different mooring types. As part of a mooring, the RAS can be used as a bottom tethered or floating “in-line” instrument. For profiling applications in depths less than 5,500m, the RAS can be lowered from a ship by winch. After the RAS is recovered, data is offloaded using the firmware.



If possible, do not deploy or recover the RAS through an oil slick (oil can damage the pump and valve). If this condition is unavoidable, pour clean, fresh water over the spot where the RAS will enter or break the water surface through the slick, and rinse the instrument thoroughly after recovery..

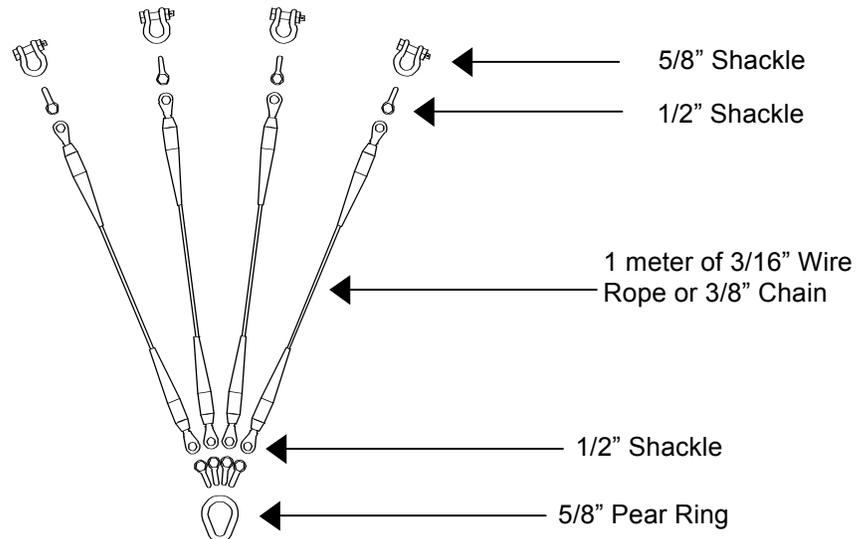


Figure 7-1: Four-to-One Bridle Connection

## Deployment Preparation

Preparing and deploying the RAS requires the following (in order of completion):

- Connect the battery.
- Close the end cap.
- Connect the COM cable.
- Program the deployment.
- Disconnect the COM cable and attach the dummy plug.
- Deploy the RAS.



Remove the intake cap used during priming before deploying the RAS. If the cap is used during the deployment, samples will not be collected properly.

## Recovery Procedure

Post-recovery steps include the following:

- Offload the deployment data.
- Remove the sample bags for storage and later analysis.
- Remove the sample bags.

### Removing the Sample Bags

This explains removal of the sample bags. When the deployment schedule completes,

1. Remove the bag from Port 1 by twisting the sample tube cap counter-clockwise through one third of a revolution (do not remove the bag by pulling on the cap or the intake tube on the bag).



Disconnect the tubing at the bottom of the acrylic sample tube to reduce the force required to remove a full sample (pressure on the bag can cause some of the sample to flow back through the intake tube valve, potentially contaminating the sample).

2. Lift the cap gently and firmly grasp the sample bag just below the bag's intake tube using the thumb and index finger.

3. Gently pull the bag out of the sample container by gripping the bag just below the intake tube.
4. Disconnect the sample bag from the cap and install a 1/4-28 threaded female cap on the tubing. Store the sample safely and replace the cap on the acrylic sample tube.
5. Repeat steps 1-4 for all sample bags.

## Offloading Data

Once the steps are completed to recover the RAS, data can be offloaded. This section contains instructions for running the data offload. The deployment data will display on screen and a log file can be created for use in analysis.

This procedure can be repeated because deployment data remains in memory until a new deployment schedule is created or the batteries are drained and/or removed.



Do not disconnect the battery (which erases the data) until checking the capture files to confirm that the data offload was successful.

Before offloading data, see post-deployment steps in Chapter 6 “Operations”. To use the Offload Data option, complete the following steps:

1. Start Motocross on the host computer (see Chapter 2 in this User Manual for Terminal emulation details).
2. Within Motocross, specify a “Capture file” for the offloaded data.
3. If necessary, turn the capture On.

4. Connect the COM cable to a computer and then connect the COM cable to the RAS.



The computer should be on and Motocross running before connecting to the RAS electronics.

5. From the Offload/Display Data File Menu select option <1>, <2>, <3>, or <4> to display recorded data.

```
Configuration: RAS-125M500                CF2 V3_03 of Aug  4 2014
-----
                        Offload Menu
-----
Wed Mar  4 11:23:06 2015

      Port=00 (home)
<1> Display ALL data
<2> Display event summary data
<3> Display pump data
<4> EEPROM data backup cache

<M> Main menu

Selection [M] ? 1
```

*Figure 7-2: Offload/Display Data File Menu*

The screens that follow show Option <1> ‘Display ALL Data’.

6. Press any key to offload the data and display to the screen (the data is saved to the Capture filename specified in Step 2). An example data offload file is shown next.

---

Configuration: RAS-125M500                      CF2 V3\_04 of Mar 17 2015

---

Offload Menu

---

Thu Mar 19 13:01:44 2015

Port=00 (home)

- <1> Display ALL data
- <2> Display event summary data
- <3> Display pump data
- <4> EEPROM data backup cache

<M> Main menu

Selection [M] ? 1

Start the capture file now.  
Then, press any key to start the transfer. The data  
file will remain in memory and is not erased by this  
offload procedure.

Software version: RAS-3\_04.c  
Compiled: Mar 17 2015 12:32:34  
Electronics S/N: ML13278-05  
Temperature probe: Internal

Data recording start time = 03/18/15 10:29:55  
Data recording stop time = 03/19/15 10:27:13

*Figure 7-3: Display All Data*

HEADER

System test 10/18/15  
12345-04  
MDS

SAMPLE PARAMETERS

Pre-sample acid:  
Acid flush volume [ml] = 10  
Acid flush time limit [minutes] = 1  
Acid exposure delay [minutes] = 1  
Water Flush:  
Water flush volume [ml] = 100  
Water flush time limit [minutes] = 5  
Sample:  
Sample volume [ml] = 500  
Sample time limit [minutes] = 25  
Post-sample acid:  
Acid flush volume [ml] = 0  
Acid flush time limit [minutes] = 0

SCHEDULE

Event 1 of 48 @ 03/18/15 10:45:00  
Event 2 of 48 @ 03/18/15 11:15:00  
Event 3 of 48 @ 03/18/15 11:45:00  
Event 4 of 48 @ 03/18/15 12:15:00  
.  
.  
.  
Event 47 of 48 @ 03/19/15 09:45:00  
Event 48 of 48 @ 03/19/15 10:15:00

DEPLOYMENT DATA

1 03/18/15 10:45:02 29.6 Vbat 17.0 °C PORT = 00  
Pre-sample acid flush 11 ml 9 sec LB 28.9 V Volume reached  
Flush port = 49  
Intake flush 102 ml 82 sec LB 28.5 V Average I 102.0 mA Highest I  
108.0 mA Volume reached  
Flush port = 00  
Sample 502 ml 402 sec LB 28.3 V Average I 105.0 mA Highest I  
117.0 mA Volume reached  
Sample port = 01  
03/18/15 10:54:46 29.0 Vbat 19.6 °C PORT = 01  
Post-sample acid flush 0 ml 0 sec LB 0.0 V . . . .  
Flush port = 49  
2 03/18/15 11:15:02 29.5 Vbat 17.1 °C PORT = 00  
Pre-sample acid flush 11 ml 9 sec LB 28.8 V Volume reached  
Flush port = 49  
Intake flush 101 ml 81 sec LB 28.5 V Average I 89.0 mA Highest I

Figure 7-4: Offload/Display Data File – Display All (2 of 3)

PUMPING DATA

Sample interval = 15 [seconds]

[event#]	[ml/min]	[ml]	[Vbat]	[Av. Cur]	[High Cur]
1	75	19	28.4	114.0	118.0
1	75	37	28.4	113.0	117.0
1	75	56	28.4	113.0	115.0
1	75	75	28.4	111.0	113.0
1	75	94	28.4	111.0	114.0
1	75	112	28.4	111.0	114.0
1	75	131	28.4	110.0	112.0
1	75	150	28.4	109.0	112.0
1	75	169	28.4	108.0	112.0
1	74	187	28.4	107.0	110.0
1	75	206	28.4	107.0	110.0
1	75	225	28.4	106.0	111.0
1	75	244	28.4	106.0	110.0
1	75	262	28.4	105.0	110.0
1	75	281	28.4	106.0	112.0
1	75	300	28.4	106.0	110.0
1	75	319	28.3	106.0	111.0
1	75	337	28.4	105.0	109.0
1	75	356	28.3	106.0	112.0
1	75	375	28.3	106.0	111.0
1	75	394	28.3	106.0	110.0
1	75	412	28.3	106.0	110.0
1	75	431	28.3	105.0	110.0
1	75	450	28.3	106.0	110.0
1	75	469	28.3	106.0	110.0
1	75	487	28.3	106.0	110.0
2	75	19	28.4	105.0	110.0
2	75	37	28.4	104.0	109.0
2	75	56	28.4	104.0	110.0
2	75	75	28.4	104.0	109.0
. . .					
48	76	18	27.0	103.0	110.0
48	75	337	26.9	103.0	107.0
48	75	356	26.9	103.0	108.0
48	75	375	26.9	103.0	106.0
48	75	394	26.9	103.0	108.0
48	75	412	26.9	103.0	109.0
48	75	431	26.9	103.0	108.0
48	75	450	26.9	103.0	108.0
48	75	469	26.9	103.0	106.0
48	75	487	26.9	103.0	106.0

End of instrument data file.

Terminate file logging operation now

Press any key to continue.

Figure 7-5: Offload/Display Data File – Display All (3 of 3)

7. After the data is offloaded, stop the Motocross file capture.



The Offload option can be repeated if necessary (the data file remains in memory until a new deployment schedule is created or the batteries are disconnected).

8. From the Main Menu, select <4> Sleep to put the firmware into Suspend mode.
9. Disconnect the COM cable from the controller and reinstall the dummy plug.

## Chapter 8

# Maintenance and Storage

Several maintenance procedures before and after each deployment provide smooth operation and long instrument life for the RAS. Rinsing the entire instrument assembly with clean fresh water after every deployment is critical to prevent corrosion. Also clean and flush the valve, tubes, and pump before storage as described in this Chapter. Before and after each deployment inspect the following:

- O-rings
- Pump gears
- Pressure compensation tubes on each sample container
- Bolts
- Fluid lines and sample containers

### Cleaning and Inspecting the Controller Housing

Prior to each deployment, inspect, and if necessary, replace the zinc anodes attached to the controller housing end caps. When installing new zincs, use 316 stainless steel hardware and include the plastic insulator bushings.



Keep hard objects such as tools or shackles away from the controller housing. Scratches from these objects will localize galvanic action and can cause deep crevices or pitting.

### O-Rings

The RAS ships with a set of o-rings in the end caps at both ends of the controller housing. Each set includes 3 o-rings, 2 round-section o-rings (BN70-2-244/BN70-2-240) and one back up ring (BN90-8-240). O-rings must be installed properly and kept in place at all times.

Positioning the larger o-ring (2-244) in the axial groove provides a seal against the face end of the pressure housing. Fit the smaller o-ring (2-240) and the backup ring (8-240) in the radial groove. Position the backup ring on the low pressure side of the radial groove (toward the interior of the controller housing). The backup ring concave side faces toward the round o-ring. The accompanying o-ring is seated on the concave side (high pressure side) of the backup ring.

Inspect o-rings for signs of wear and the presence of any foreign material (which can cause leaks). Look for small cracks and feel for grit, sand, or hair. O-rings should be cleaned with alcohol and lubricated with a thin coating of o-ring grease as necessary.



When inserting the end cap into the controller housing, ensure that the face o-ring remains seated in its groove and that the radial o-rings enter the housing uniformly without pinching.

## Pump Gears

Periodically examine the graphite pump gears and replace them if there are any visible signs of wear or cracks. To inspect the gears, complete the following steps:

1. Remove the pump from the RAS.
2. Remove the four screws that hold the pump head to the pump housing.
3. Lift the pump head up off the pump housing (the gears are mounted on the bottom of the pump head).



Never remove the metal magnet cavity from the pump motor housing (the area under the metal cavity is filled with oil).

## Pressure Compensation Tubes

The pressure compensation tube assembly in each sample container must be kept clean and clear of obstructions to remain effective. This assembly allows a small exchange of fluid volume between the sample cylinders and the seawater to prevent the sample containers from cracking in deep deployments. The ID of the compensation tube is ~0.18mm which is sufficient for effective pressure compensation without compromising the volume accuracy of the pump.

## Battery Maintenance

The capacity of a new RAS A21-1000 alkaline battery pack is approximately 10,000 mAh. The 31.5 volt battery will last up to 18 months. This is a mildly conservative figure assuming a low temperature environment and standard current drain.



Use a new battery pack for each deployment.

## Battery Replacement

Diagnostics, (Option <2> from the Main Menu) displays the no-load battery voltage. A warning message displays if the battery voltage is below 28 volts. Replace a battery below 28 volts if a full deployment is planned.



Before replacing the battery, offload all data. Disconnecting the main and backup batteries erases all deployment data stored in memory.

## Backup Battery

The backup battery consists of two AAA alkaline batteries. This backup can sustain the non volatile controller memory for many months in the event of a main battery failure. However, the backup batteries will not power on the sampler.



Do not make contact with battery terminals reversed. Install the backup battery with the battery terminals to correctly fit the holder terminals.

## Storage

The shipping crate is a reusable international freight container that is ISPM-15 compliant for international transport.



To prevent instrument damage during transport or storage, crate should remain upright. Avoid excessive vibration and extreme temperatures for prolonged periods of time.

There are several procedures to complete before packing the RAS in the crate for storage longer than one month:

- Offload all data from memory.
- Rinse all instrument components with fresh water.
- Use the System Flush firmware option (explained in the section that follows) to flush the valve with fresh water.
- Remove main and backup batteries. If the main battery is still usable, first cover the connector with insulation tape and then store the battery in a refrigerator.
- Reassemble the main battery holder and insert the electronics package back into the controller housing.
- Replace all bolts and apply a small amount of anti-seize to the threads.

## System Flushing Process

Option <8> from the Manual Operations menu provides a way to flush the pump with fresh water following a deployment. Flush the RAS system before storage.

All ports are flushed including Port 49 (the location of optional pre- and post-sample acid cleaning). You can program the length of the system flush from a range of 2-60 seconds. The flow rate is fixed at 75mL/min.

Flushing the system is a two part process. The top and bottom of the valve are flushed in separate operations as shown in Figure 8-1. The sections that follow list the steps for each flushing process.

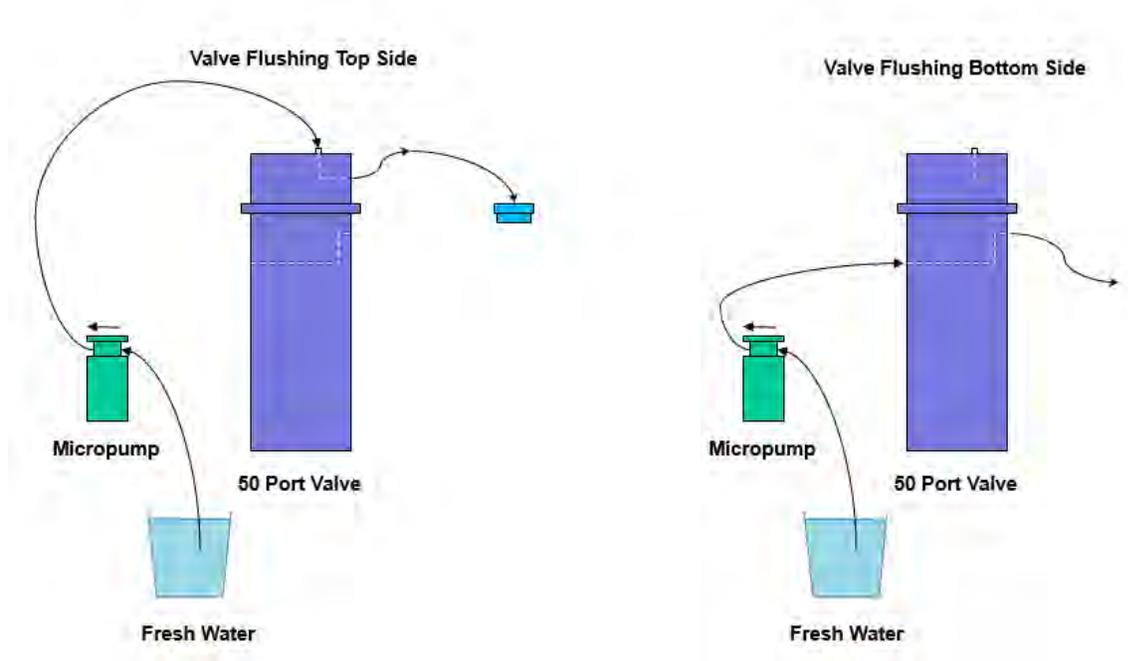


Figure 8-1: System Flushing Process



Flushing the system is a wet process. Ensure the electronics housing is sealed to keep the electronics dry. Water will overflow during this process.



When flushing a Port, the system pumps forward, pushing clean water through the valve and tubing.

### Flushing the Top Valve

After all of the sample tubes are disassembled, the top side of the valve can be flushed with spare tubing and fittings that are included in the toolkit. Use the steps that follow to complete the top valve flush.

1. Connect the pump exhaust to the valve intake.
2. Connect the pump intake to a fresh water reservoir (such as a clean bucket of fresh water).
3. Select option <8> from the Manual Operation Menu to run the system flush.

```
Configuration: RAS-125M500                CF2 V3_03 of Aug  4 2014
-----
Manual Operations Menu
-----
Wed Mar  4 11:31:49 2015
Port=00 (home)

<1> Find port      : home
<2> Find port      : J
<3> Next port      : advance
<4> Next port      : retreat
<5> Run pump       : forward      (100 ml)
<6> Run pump       : reverse      (100 ml)
<7> Run pump       : programmable
<8> System Flush  : programmable

<M> Main Menu
```

*Figure 8-2: Option <8> System Flush Settings*

4. Type a flush time from 2 to 60 seconds (10 seconds is the default).
5. Type *Y* to continue.

```

Selection [ ] ? 8
How long do you want to flush each port for? (2-60) [10] ?
Continue with system flush? [Y] ? Y
Seeking home port...
Home port located. Aligning... Confirmed
Already aligned to port 00
Flushing port 0

Counts |Hall Count | Hall Avg | Volume Pumped | FlowRate | Elapsed Seconds | Batt. V | Pump Current
2071 h  144 I_Hz   36 A_Hz   1.0 ml         60.2 ml/min   1 secs        26.2   118 mA
2112 h  159 I_Hz   75 A_Hz   2.1 ml         66.5 ml/min   2 secs        26.2   132 mA
2136 h  167 I_Hz  117 A_Hz   3.3 ml         69.8 ml/min   3 secs        26.2   130 mA
2149 h  173 I_Hz  160 A_Hz   4.5 ml         72.3 ml/min   4 secs        26.2   147 mA
. . . ← Display shortened for space

Time limit reached

Total volume pumped      = 12 ml
Elapsed time of event    = 11 sec
Lowest battery detected  = 26.2 V
Average Pump Current     = 141.0 mA
Highest Pump Current     = 149.0 mA

Seeking port 01...

```

*Figure 8-3: System Flush*

### Flushing the Bottom Valve

Use the steps that follow to complete the bottom valve flush.

1. Connect the bottom valve common intake to the pump exhaust.
2. Connect the pump intake to the fresh water reservoir.
3. Select option <8> from the Manual Operation Menu to run the system flush.
4. Type a flush time from 2 to 60 seconds (10 is the default).
5. Type *Y* continue.

## Notes

# Appendix A

## Quick Reference to Sampling Parameters

### RAS Sampling Parameters - Quick Reference

**Header:** Three lines of file header text (up to 65 characters per line), offloaded with the data.

**Pre-sample acid flush:** Status of pre-sample flush (Enabled or Disabled).

**Pre-sample flushing volume:** Amount of acid flushed through the intake, determined by the number of samples, post-acid flush volume and acid bag volume (480 mL). Example: 48 samples, no post-acid flush equals maximum allowed pre-sample flush volume of 10 mL.

**Pre-sample flushing time limit:** Time limit for flush before the pump is turned off.

**Exposure time delay:** Time delay during which acid remains in the valve intake removing growth. Automatically set to zero when the acid flushing volume is set to zero.

**Water Flushing Volume:** Amount of water flushed through the water port before sampling to remove bio-growth loosened by the acid flush.

**Water Flushing Time Limit:** Maximum time for the system flush prior to sampling. Allowed value depends on the flushing volume and maximum and minimum flow rates (75 mL/min and 20 mL/min). Defaults to maximum value, and allows a smaller value.

**Sample Volume:** Amount of water to be sampled before the pump is turned off. Adjust flow rate with the control system to reduce differential pressure across the sampling apparatus.

**Sample Time Limit:** The maximum sample time limit before pumping stops. Allowed value depends on the sample volume and the maximum and minimum flow rates (75 mL/min and 20 mL/min). Defaults to maximum value, and allows a smaller value.

**Post-sample Acid Flush:** Status of post-sample flush (Enabled or Disabled).

**Post-sample Flushing Volume:** Amount of acid flushed through the intake, determined by the number of samples, pre-acid flush volume and acid bag volume (480 mL). Example: 48 samples, no pre-acid flush equals maximum allowed pre-sample flush volume of 10 mL.

**Post-Sample Flushing Time Limit:** Maximum time for the acid flush prior to sampling. Allowed value depends on flushing volume and the maximum and minimum flow rates (75 mL/min and 20 mL/min). Defaults to maximum value, and allows a smaller value.

**Pump Data Period:** Sampling period stored during each event (pump flow rates / volumes).

## Detailed Descriptions of Sampling Parameters

### Option <A>, <B>, and <C> Header

Enter a header or a personalized title for each deployment. Each header line may contain up to 65 characters.

### Option <D> Pre-sample Acid Flush

This option enables or disables the pre-sample acid flush.

### Option <E> Acid Flushing Volume

This option specifies the volume of acid (or other bio-fouling fluid) to flush through the valve intake before taking a sample. Acid flushing loosens any bio-fouling growth along the intake path so that it can be removed by the water flush. The maximum volume is the capacity of the nominally 100 mL acid reservoir (the actual volume is assumed to be 480 mL) divided by the number of samples in the schedule.

### Option <F> Acid Flushing Time Limit

This option specifies the acid flush time limit. The maximum time limit is determined from the selected flushing volume and the fixed minimum flow rate of 20 mL/min.

### Option <G> Acid Exposure Time Delay

This option specifies a time delay during which the acid will be left standing in the valve intake. This allows the acid sufficient time to act upon any growth that may be present. The acid will be removed by the water flush. If the acid flushing volume is zero, the delay cannot be set to a value other than zero and will not be executed. The exposure delay is automatically set to zero when the acid flushing volume is set to zero. Exposure time delay is unnecessary for the post-sample acid flush because the acid remains in the valve and tubing until the next sample event.

### Option <H> Water Flushing Volume

This option specifies the volume of water to flush through the water port before taking a sample. This is done to clear out any debris in the valve and intake hose, and to ensure that the sample is taken entirely from current ambient water.

### Option <I> Water Flushing Time Limit

This option specifies the maximum time limit for the system flush prior to sampling. This time is determined from the selected flushing volume and the fixed minimum flow rate of 20 mL/min.

### Option <J> Sample Volume

This option specifies the volume of water to be pumped for each sample.

### Option <K> Sample Time Limit

This option specifies the time limit for the samples. The maximum time limit is determined from the selected flushing volume and the fixed minimum flow rate of 20 mL/min.

### Option <L> Post-Sample Acid Flush

This option enables or disables the post-sample acid flush.

### Option <M> Acid Flushing Volume

This option specifies the amount of water flushed through the water port before sampling.

### Option <N> Post-Sample Acid Flushing Time Limit

This option specifies the post-sample acid flush time limit. The maximum time limit is determined from the selected flushing volume and the fixed minimum flow rate of 20 mL/min.

### Option <P> Timing Pump Data Period

This option establishes the instantaneous flow rates and volumes for each sample, that are logged in the data file at a user selectable interval. The minimum setting is 15 seconds which corresponds to the 100L samples of the RAS-100.

### Option <V> Verify and Proceed

Select this option when finished changing the pumping parameters. Prompts will display to change parameters that are in conflict with other parameters.

## Notes

## Appendix B Training Videos

There is a priming and pre-deployment training video available for the RAS. This video is included on the media that ships with a new sampler and can also be downloaded from the McLane website at:

<http://www.mclanelabs.com/product-type/samplers/ras-videos>.

A description of each video and content is provided below for reference.

<b>Video</b>	<b>Content</b>
RAS-500 Pre-deployment and Priming	Reviews pre-deployment procedures and priming on the RAS.

## Notes

## Appendix C

### External Temperature Sensor

The RAS internal Thermistor temperature sensor can optionally be extended from its standard location on the electronics card to a specially-manufactured aluminum block mounted into the top end cap. External temperature readings are recorded in RAM and EEPROM and reported to one-tenth degrees.



*Figure C-1: Thermistor External Temperature Sensor*



**External  
Temperature  
Sensor Location  
in Controller**

*Figure C-2: External Temperature Sensor Installed in Controller Housing*

## Configuring to External Temperature Mode

If using the external temperature probe, the firmware must be configured accordingly. To configure the probe, complete the following steps:

1. From the Main Menu type *c* and type the password *con* to display the Configuration menu.

```
Configuration: RAS-125M500          CF2 V3_04 of Mar 17 2015
                McLane Research Laboratories, Inc.
                Remote Access Sampler
                ML999999-01

                -----
                Main Menu
                -----
                Wed May 20 14:26:10 2015
                Port=00 (home)

                <1> Set Time          --- Create Schedule
                <2> Diagnostics      --- Deploy System
                --- Manual Operation <7> Offload Data
                <4> Sleep            <8> Contact McLane

NOTICE: Configure sampler before continuing!
Selection [C] c Password: con
```

*Figure C-3: Main Menu*

```
Configuration: RAS-125M500          CF2 V3_04 of Mar 17 2015

                -----
                Configuration Menu
                -----
                Wed Mar 18 10:25:22 2015

                <A> External Temperature Sensor [Yes]
                <B> Pressure Sensor           [No]
                <C> Pump                       [Maxon 125 mL/Min.]
                <D> Sample Bag Capacity       [500]
                <X> Save & Exit                 <^C> Cancel & Exit
```

*Figure C-4: Configuration Menu - Temperature*

2. Select <A> to enable an External Temperature Probe .
3. Type *y* at the ‘Enable Temperature Probe?’ prompt and type *x* to exit and save the change.

The Temperature Probe configuration is stored in EEPROM, and used the next time the firmware is started.

## Appendix D

### Heavy Duty Frame Packing Crate and Stand

The RAS with heavy-duty frame is shipped in a custom-designed crate with extra structural support and an integrated stand.



*Figure D- 1: RAS-500 with Heavy-Duty Frame in Custom Crate*

For reusability, the top and side panels are secured with screws. Remove the screws to open the crate.

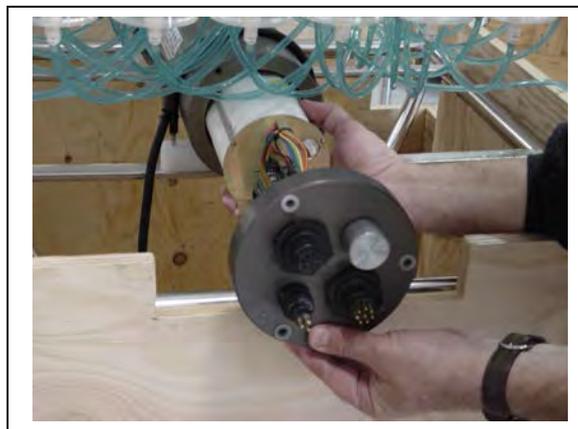
Do not remove the metal brackets or disassemble the lower section of the crate.

The integrated stand includes a reinforced plywood base with a notch for sliding out the controller housing while leaving the RAS-500 frame upright in the crate for stability.



*Figure D-2: Controller Housing Notch in Stand*

When the RAS-500 is re-packed for shipment, place the controller housing facing towards the notch as shown in Figure D-2.



*Figure D-3: Remove Controller Housing through Notch in Stand*

# Appendix E

## Adaptive Sampling Firmware

RAS Adaptive Sampling firmware (ARS-3\_01 and higher) provides a command line interface and a set of commands. Commands can be sent and received to change and control sample collection while the sampler is deployed.



This option requires a continuous RS-232 connection from the RAS to a computer.

### What happens in a Deployment?

Adaptive RAS firmware (ARS) has a command line as shown in Figure E-1. As with the standard firmware, some configuration commands are password protected to prevent unintended changes. The commands list can be displayed by typing *? or help* at the command line.



A list of valid commands is also provided at the end of this Appendix.

```
CF2-ARS-3.04 R2 L2.3 | ARS-3_04.c compiled Mar 13 2015 at 08:55
ARS-125M100 S/N ML?????-?? Adaptive Remote Sampler
© 2010-2015 McLane Research Laboratories. All rights reserved.

Seeking home port ...
Seeking home port...
Port 00
Port 01

Home port located. Aligning... Confirmed
McLane Research Laboratories, Inc.
CF2 Adaptive Remote Sampler
Version 3.04 of Mar 13 2015 08:55
Pump type: Maxon 125ml
Bag capacity: 100

Type "Help" or "?" at the prompt, or with a command.
03/16/15 10:54:00 Suspended ... ?
Enter ^C now to wake up ... [^C]
03/16/15 10:54:48 RAS ML12345-67> ← Command line
```

Figure E-1: ARS Adaptive Sampling Interface

## SET Parameters

Deployment programming is performed with the SET commands:

- SET PREACID
- SET WATER
- SET SAMPLE

When the deployment settings are complete, launch the deployment with the STARTDEPLOY command. To collect samples, use the SAMPLE command. Complete the following steps to use the command line and SET commands.

1. Type <CTRL>-C three times (with a three second pause between each press) to wake the controller.

Command to Controller	Response from Controller
<CTRL>-C	?
<CTRL>-C	Enter ^C now to wake up ...
<CTRL>-C	03/16/15 11:06:50 RAS ML12345-67> Sampler is now ready to receive commands

2. Type SET PREACID if the pre-acid flush will be used.

```
03/13/15 00:01:06 RAS ML00000-00>set preacid 1 10 1 2  
  
Pre-sample acid:  
Acid flush volume      [ml]      = 10  
Acid flush time limit  [minutes] = 1  
Acid exposure delay    [minutes] = 2  
03/13/15 00:01:35 RAS ML00000-00>
```

*Figure E-2: Setting Pre-Acid Flush*

3. Type SET WATER for the pre-sample water flush volume and time limit.

```
03/13/15 00:02:09 RAS ML00000-00>set water 100 25  
  
Water Flush:  
  
Water flush volume      [ml]      = 100  
  
Water flush time limit  [minutes] = 6
```

*Figure E-3: Setting Pre-Sample Water Flush*

4. Type SET POSTACID to set an optional post sample acid flush/

```
03/13/15 10:44:25 RAS ML12345-67>set postacid 10 10 3000  
  
Post-sample acid:
```

*Figure E-4: Setting Post Acid Flush Parameters*

5. Type SET SAMPLE to set the sample volume and time limit.

```
03/13/15 10:43:48 RAS ML12345-67>set sample 99 499  
  
Sample:  
  
Sample volume          [ml]      = 99  
  
Sample time limit      [minutes] = 5
```

*Figure E-5: Setting Sample Parameters*

## STARTDEPLOY and SAMPLE Commands

When the deployment settings are complete the STARTDEPLOY command starts the deployment. The SAMPLE command triggers sample collection.

1. From the command line, type STARTDEPLOY to execute the following steps:

```
03/13/15 10:54:03 RAS ML12345-67>startdeploy.....  
<MESSAGE>  
  
Deployment started.  
  
</MESSAGE>  
<END_MESSAGE/>
```

*Figure E-6: STARTDEPLOY Command*

The following process occurs:

- If PREACID wash is enabled, the Valve is moved to Port 49.
- The pump runs in reverse to draw acid from the acid bag into the valve.
- The controller suspends and waits the programmed acid delay time.
- The valve is set to the Home Port (0).
- The pump is run forward to flush the valve with ambient water.
- The valve is set to the next sample Port.
- The pump is run forward to collect the sample in the sample bag.
- The controller waits for a pre-programmed two minutes to allow any differential pressure to equilibrate.
- The valve is returned to the Home Port.
- If POSTACID was is enabled, the Valve is moved to Port 49.
- The pump runs in reverse to draw acid from the acid bag into the valve.
- The valve is returned to the Home Port.
- The Sample is completed.
- The controller is put into Suspend mode.

	<p>The controller returns to Suspend mode after 2 minutes of inactivity. Type CTRL-C three times (with a three second pause between each keystroke) to wake the controller from Suspend mode.</p>
---	---

## 2. Type SAMPLE to trigger sampling.

```
03/13/15 10:54:17 RAS ML12345-67>sample
<MESSAGE>
03/13/15 10:54:25 Event [ 1 ] starting:
</MESSAGE>
<END_MESSAGE/>
Seeking port 49...
<MESSAGE>
Port 00
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Port 49
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Port 49 located. Aligning...
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>Confirmed
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Performing acid flush.
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Volume reached
  Total volume pumped      = 11 ml
  Elapsed time of event    = 10 sec
  Lowest battery detected  = 31.8 V
  Average Pump Current     = NA
  Highest Pump Current     = NA
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
03/13/15 10:54:42 Acid exposure delay, 1 minutes
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
03/13/15 10:54:43 Suspended until 03/13/15 10:55:42 ...
<END_MESSAGE/>
<MESSAGE> Awake
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
```

*Figure E-7: SAMPLE Command (1 of 3)*

```

Seeking home port...
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Port 49
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Port 00
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Port 01
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Home port located. Aligning...
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>Confirmed
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
  Flushing intake port.
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Volume reached
Total volume pumped      = 50 ml
Elapsed time of event    = 43 sec
Lowest battery detected  = 31.7 V
Average Pump Current     = 227.0 mA
Highest Pump Current     = 227.0 mA
</MESSAGE>
<END_MESSAGE/>
Seeking port 01...
<MESSAGE>
Port 00
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Port 01
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>
Port 01 located. Aligning...
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>Confirmed
</MESSAGE>
<END_MESSAGE/>
<MESSAGE>

```

*Figure E-8: SAMPLE Command (2 of 3)*

```
Pumping sample 1
</MESSAGE>
<END_MESSAGE/>

<MESSAGE>

Volume reached

Total volume pumped      = 100 ml
Elapsed time of event     = 94 sec
Lowest battery detected  = 31.6 V
Average Pump Current     = 227.0 mA
Highest Pump Current     = 227.0 mA

</MESSAGE>
<END_MESSAGE/>

<MESSAGE>

Programmed pause to reduce pressure differential
before rotating valve, 2 minutes

</MESSAGE>
<END_MESSAGE/>

<MESSAGE>

03/13/15 10:58:24 Suspended until 03/13/15 11:00:23 ...
```

*Figure E-9: SAMPLE Command (3 of 3)*

	The samples are taken in order.
---	---------------------------------

3. Return to step 2 to take next and subsequent samples.
4. To end the deployment, type ENDDEPLOY.

## Data Offload

Type OFFLOAD to view the deployment data.

```
03/13/15 10:44:56 RAS ML12345-67>
03/13/15 10:45:00 RAS ML12345-67>soffload

SAMPLE PARAMETERS
-----
03/13/15 10:45:18
Pre-sample acid:
Acid flush volume      [ml]      = 10
Acid flush time limit  [minutes] = 1
Acid exposure delay    [minutes] = 20
Water Flush:
Water flush volume     [ml]      = 50
Water flush time limit [minutes] = 3
Sample:
Sample volume          [ml]      = 99
Sample time limit      [minutes] = 5
Post-sample acid:
Aid flush volume       [ml]      = 10
Acid flush time limit  [minutes] = 1

DEPLOYMENT DATA
-----

      No events in memory.

PUMPING DATA
-----
Sample interval = 15 [seconds]

[event#]  [ml/min]  [ml]  [Vbat]  [Av. Cur]  [High Cur]

End of instrument data file.
```

*Figure E-10: OFFLOAD Command*

## Using Help

ARS firmware has detailed help available. Typing HELP displays the information. Typing COMMAND HELP (where COMMAND is a command such as FORWARD) displays detailed help and syntax for a specific function.

```
03/13/15 00:05:23 RAS ML00000-00>help
Help screen:
Commands and arguments are not case-sensitive.
Arguments within [...] brackets are optional.
-N recalls the Nth previous command; -1 to -25.
Recalled commands can be edited before submitting.
^C abandons or cancels any current operation.
Type "help" or "?" at the prompt to display this screen.
Type "help" or "?" with any command for individual descriptions.
Example: "result ?"
For commands that REQUIRE arguments, a bare command also displays help.
Example: "forward" or "clock"
03/13/15 09:48:38 RAS ML00000-00>exit help
03/13/15 00:00:00 RAS ML00000-00>forward help ←
-----
FORWARD
-----
Description:
-----
Start a forward pump operation
-----
Syntax:
-----
FORWARD volume flowrate minflow timelimit
```

*Figure E-11 Help*

## VERBOSE Command

The VERBOSE command provides detailed messages messaging feedback on operations. Setting this parameter to ON is recommended. Figures E-13 and E-14 show examples of detailed and non-detailed messaging.

```
05/03/12 10:49:25 ML12345-01>verbose
Verbose: OFF
05/03/12 10:50:03 ML12881-03>verbose on
Configuration successfully stored
Verbose: ON
FORWARD volume flowrate minflow [time]      Start a forward pump operation
FORWARD 10-100 50-125 20-flowrate [1-(volume/minflow)]
05/03/12 10:41:46 ML12881-03>forward 20 100 50
      | --- command --- | ----- result ----- |
      port  vol flo min  tl   vol flowr minfl sec mmddyy hhmss  batt code
Status 00 | 20 100 50  1 | 1.9 114.1  0.0  1 050312 104200 | 31.0 0
Status 00 | 20 100 50  1 | 3.9 119.2  0.0  2 050312 104201 | 31.0 0
Status 00 | 20 100 50  1 | 5.7 107.5  0.0  3 050312 104202 | 31.0 0
. . .
Volume reached
Result 00 | 20 100 50 60 | 21.3 106.7 99.9 12 050312 104211 | 31.0 1
```

*Figure E-12 (Detailed Messages On)*

```
05/03/12 10:41:46 ML12881-03>forward 20 100 50
Result 00 | 20 100 50 60 | 21.3 106.7 99.9 12 050312 104211 | 31.0 1
```

*Figure E-13 (Detailed Messages Off)*

## TAGS Command

The TAGS command is a mostly internal messaging start and stop messaging protocol that can be useful for added detail.

## ARS Commands

The table that follows lists ARS commands included in firmware ARS-3\_05 and higher. Some parameters are password protected to prevent accidental configuration changes. Where passwords are required, the entry is *mclane*.

Command	Syntax	Description	Example
BATTERY	BATTERY	Display the battery voltage.	03/20/15 09:57:10 RAS ML12345-67>battery Battery: 32.1V [Alkaline, 18V minimum]
CAPACITY password required	CAPACITY <i>mclane</i> 100 500	Display or set the bag capacity.	03/20/15 09:57:16 RAS ML12345-67>capacity Bag capacity: 100  03/20/15 10:02:06 RAS ML12345-67>capacity <i>mclane</i> 500 Setting sample-bag capacity to 500 ml Configuration successfully stored Bag capacity: 500
CLOCK	CLOCK mm/dd/yy hh:mm:ss	Set the date and time.	03/20/15 10:02:45 RAS ML12345-67>clock 03/20/2015 10:04:06 Clock: 03/20/15 10:04:06
CODES	CODES	Display the pumping termination code table. Printed at the end of a pumping operation.	03/20/15 10:04:06 RAS ML12345-67>codes Termination Codes: # description 0 = Pumping in progress 1 = Volume reached 2 = Time limit reached 3 = Min flow reached 4 = Low battery 5 = Stopped by user 6 = Pump would not start

Command	Syntax	Description	Example
COPYRIGHT	COPYRIGHT	Display the firmware copyright notice.	
DATE	DATE mm/dd/yy	Set the date.	03/20/15 10:46:20 RAS ML12345-67>date 03/20/15 Clock: 03/20/15 10:47:04
EXIT <b>password required</b>	EXIT <i>mclane</i>	Exit the program to operating system. Restart the program by entering "app" at the prompt.	03/20/15 10:47:04 RAS ML12345-67>exit mclane
FORWARD	FORWARD volume   flow rate   min. flow rate   time limit	Start a forward pump operation. If zero is entered for time limit, time limit will automatically be calculated based on the volume and the minimum allowable flow rate.	03/20/15 10:41:10 RAS ML12345-67>forward 10 75 20 0
HELP	HELP	Display help text	
HISTORY	HISTORY	Display the command history list	
HOME	HOME	Set the valve to the home position	
ID	ID	Display identification information.	
MCLANE	MCLANE	Display McLane contact information.	
PORT	PORT port #	Display or set the valve position.	03/20/15 10:51:20 RAS ML12345-67>port 1

<b>Command</b>	<b>Syntax</b>	<b>Description</b>	<b>Example</b>
PUMPTYPE <b>password required</b>	PUMPTYPE mclane Maxon Pittman	Display or set the pump type.	03/20/15 10:52:39 RAS ML12345-67>pumptype mclane maxon Configuration successfully stored Pump type: Maxon 125ml
QUIT <b>password required</b>	QUIT mclane	Quit the program.	quit mclane
RESULT	RESULT	Report results for last PUMPING operation. Format: Result port   vol flow minf tlim   vol flow minf secs date-time   batt code	03/20/15 10:52:56 RAS ML12345-67>result Result 00   10 100 20 1   12.4 93.2 93.7* 8 032015 105036   32.1 1
REVERSE	REVERSE volume flowrate minflow timelimit\Example: REVERSE 100 100 50 2	Start a reverse pump operation. If zero is entered for time limit, time limit will automatically be calculated based on the volume and the minimum allowable flow rate.	03/20/15 10:41:10 RAS ML12345-67>reverse 10 75 20 0
SERIAL <b>password required</b>	SERIAL mclane #####-##	Set the sampler serial number.	
SLEEP	SLEEP	Invoke suspend mode.	
TIME	TIME hh:mm:ss	Set the time.	
VERBOSE	VERBOSE on off	Enable/disable additional messages. Default is on.	

<b>Command</b>	<b>Syntax</b>	<b>Description</b>	<b>Example</b>
VERSION	VERSION	Display version information	
?	(Command name) ?  OR  (Command name) HELP	Display help text for command the command.	
STARTDEPLOY	STARTDEPLOY	Starts an adaptive deployment.	
PAUSEDEPLOY	PAUSEDEPLOY	Pauses an adaptive deployment. This command is built in because certain commands cannot be executed while there is an active deployment, and while it is not suggested to enter these commands mid-deployment, if for some reason you absolutely have to, this allows you to.	
RESUMEDEPLOY	RESUMEDEPLOY	Resumes an adaptive deployment.	
STOPDEPLOY	STOPDEPLOY	Stops an adaptive deployment.	
SAMPLE	SAMPLE	Sample next position in deployment. The system must be in an active deployment.	
OFFLOAD	OFFLOAD	Offload sample data.	

<b>Command</b>	<b>Syntax</b>	<b>Description</b>	<b>Example</b>
OFFLOADEEP	OFFLOADEEP	Offload sample data in EEPROM.	
PRINTPARAMS	PRINTPARAMS	Print the sample parameters that are currently programmed.	
SYSTEMFLUSH	SYSTEMFLUSH flush time (2-60 seconds)	Automatic system flush.	
SAMPLERESULT	SAMPLERESULT	Display results of last sample.	

Command	Syntax	Description	Example
SET	SET   procedure name   Procedure parameters (see examples)	Set sample parameters for an adaptive deployment.	<p>Auto calculate time limits by entering zero for time limit value.  Example: SET PREACID 1 10 1 2</p> <p>If disabling acid or water flushes you only need to type the procedure name followed by a zero.  Example: SET PREACID 0</p> <p>PRE-SAMPLE ACID FLUSH PARAMETERS:  SET PREACID   ENABLED/DISABLED   VOLUME   TIME LIMIT (Minutes)    EXPOSURE TIME (Minutes)\n\  Example: SET PREACID 1 10 1 2</p> <p>PRE-SAMPLE WATER FLUSH PARAMETERS:  SET WATER   VOLUME (mL)   TIMELIMIT (Minutes)  Example: SET WATER 100 1</p> <p>SAMPLE PARAMETERS:  SET SAMPLE   VOLUME (mL)   TIMELIMIT (Minutes)  Example: SET SAMPLE 100 1</p> <p>POST-SAMPLE ACID FLUSH PARAMETERS:  SET POSTACID   ENABLED/DISABLED   VOLUME (mL)   TIMELIMIT (Minutes)  Example: SET POSTACID 1 10 2</p>

Command	Syntax	Description	Example
TAGS	TAGS ON   OFF	Turn descriptive parsing tags ON or OFF	Parsing tags provided to help with messages and errors.  <MESSAGE> //Start of a message </MESSAGE> //End of a message <ERROR> </ERROR> <WARNING> //I don't think the adaptive RAS will print these, but just incase. </WARNING>

## Notes