

Profilers **Samplers** Flotation



mclanelabs.com

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.
- Establish communications between the RAS-500 and a PC, and see Chapter 3 in this User Manual, “User Interface” to program the deployment.
- 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
- 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, and flowrate. This data is offloaded by the user 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 major components of the RAS-500 sampler are shown below.

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

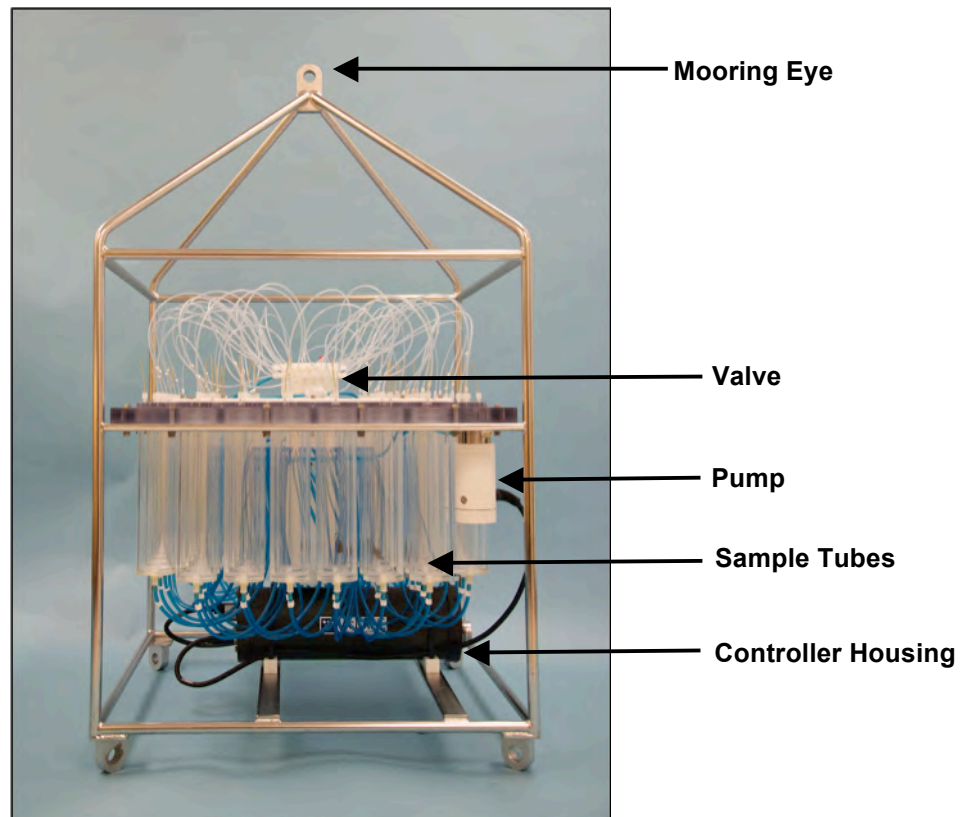


Figure 1-1: RAS-500 Full View

RAS-500 Components

The RAS-500 components are further described below.

Component	Description
Controller Housing	The controller housing is a sealed pressure housing tested to 5,500 m. The housing has a battery holder for user-replaceable, “D” cell alkaline batteries, 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 customer-supplied, 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 McLaneTerm 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. 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 East 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_08.c
      Electronics S/N: ML14615-02
      Compiled: Jan 23 2017 14:26
```

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 McLaneTerm 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.

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 McLaneTerm terminal emulation program on your computer.

Topics Covered:

- Connecting to a computer.
- Installing and configuring terminal emulation software on a computer.
- Powering up a McLane Sampler.
- Communicating with a McLane Sampler.
- Waking a McLane Sampler from low power sleep mode.

Connecting the Sampler to a Computer

Communicating with your instrument requires connecting the communications cable to a computer running terminal emulation, and configuring the terminal emulation software.

Connecting a Computer

Connect to the instrument by plugging the communications cable from the communications bulkhead on the end cap to a computer RS-232 serial port (the toolkit includes a USB to RS-232 adapter for computers without the built-in RS-232 port). Plug the adapter into the USB port, wait for the drivers to install, and then check the computer's Device Manager for the new USB Serial Port. Windows typically downloads and installs the necessary drivers automatically when the USB to RS-232 adapter is plugged into a USB port.

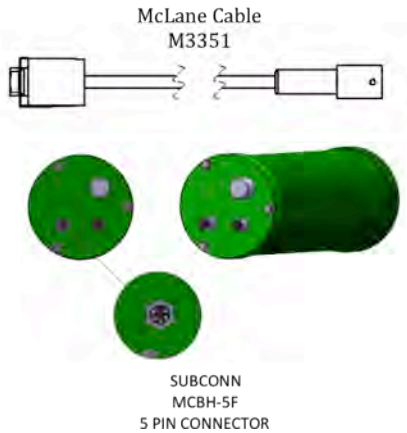


Figure 2-1: Communications Cable

The COM bulkhead connector is a 5-pin MCBH style. Some instruments may have a 3-pin XSG style bulkhead connector (Figure 2-2). 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.

COM Cable Setup

Cable Style 1: Subconn 5-pin connector



Cable Style 2: Impulse 3-pin connector

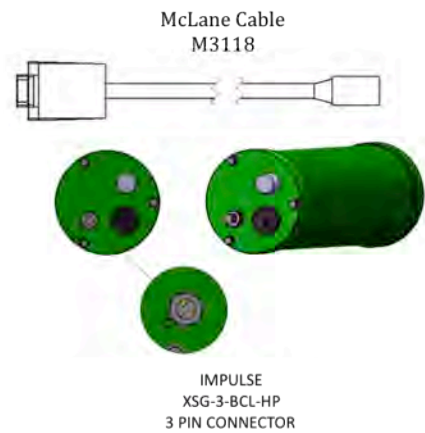


Figure 2-2: Cable Connector Styles

Computer COM Setup

Connection Style 1: Computers with Built-in Serial Port



Connection Style 2: Computers with USB, no Serial Port



Figure 2-3: Computer COM Setup Styles

Troubleshooting the USB Adaptor

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

Installing McLaneTerm

McLaneTerm is a terminal emulator that replaces the previously provided terminal emulation tools Motocross (for CF2) and CrossCut (for TT8). A copy of McLaneTerm is included with a new instrument. This software and the User Manual can also be downloaded at our website www.mclanelabs.com.

Follow the steps in the McLaneTerm User Manual to install and configure this terminal emulation software. When communication with your McLane instrument is established, Proceed to the section that follows next in this User Manual “Powering up the Sampler”.



McLaneTerm system requirements: Windows® 7 or higher / Mac OS X version 10.7 (Lion) or higher.

Powering up the Sampler

Connecting the battery is the only way to power on the sampler electronics. This step requires opening the controller housing. Be sure to perform this procedure in a dry area and familiarize yourself with steps for using the Pressure Relief Valve.

Opening the Controller Housing

Attention and care should be taken in maintaining, operating, and opening the pressure housing. All samplers shipped after summer 2015 have a pressure relief valve (PRV) on the controller housing. This valve releases automatically at a pressure differential greater than 10psi. The PRV style may have a center hole and release tool, or the style may have a flat relief valve that must be manually pulled out.



Observe safety precautions including removing personnel and objects from the path of the end-cap when removing the controller housing.



Figure 2-4: Releasing Pressure Relief Valve (Flat Style)

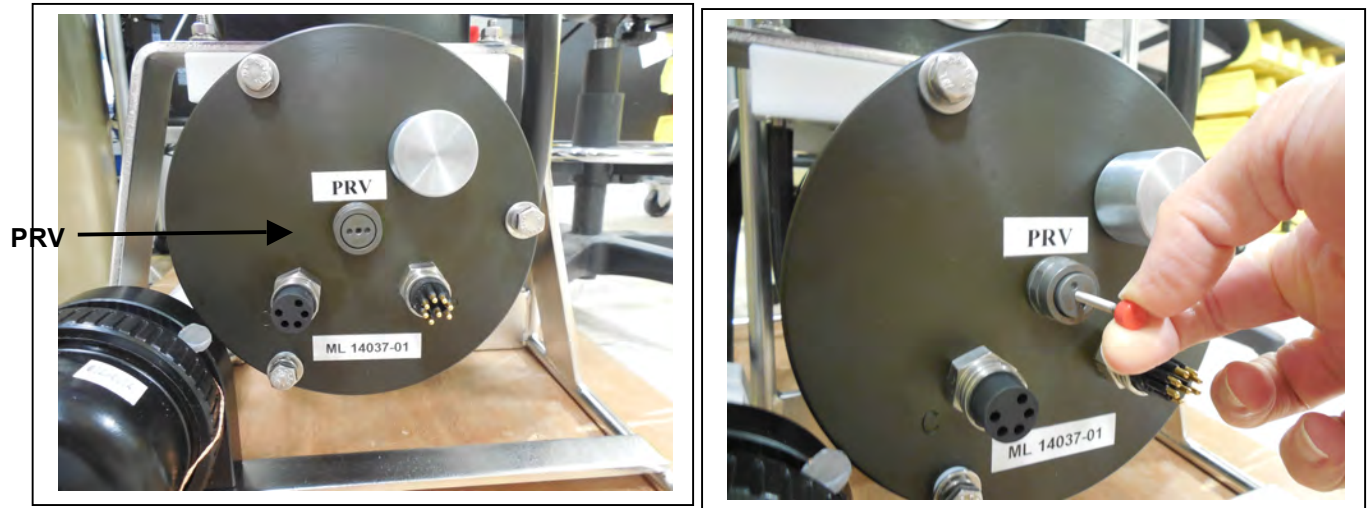


Figure 2-5: Releasing Pressure Relief Valve (Style with Release Tool)

1. Disconnect the cables from the end cap (if connected).
2. Slowly pull on the pressure relief valve to release any vacuum or built up pressure in the housing.
3. Loosen each end cap bolt a few turns at a time in a star pattern.
4. If the end cap separates from the housing as you loosen the bolts, this could indicate a possible pressure buildup inside of the housing. Stop loosening bolts and continue to gently pull on the pressure relief valve.
5. Remove and place the end cap hardware somewhere safe. Typically plastic inserts have a snug fit and will remain in the end cap.
6. Grasp the end cap lip with fingertips and pull the end cap out of the housing (Figure 2-3). The end cap to housing seal is tight and sometimes difficult to open. Do not use a tool to pull open the housing. The end cap o-rings can be damaged if objects are used to separate the end cap from the housing.

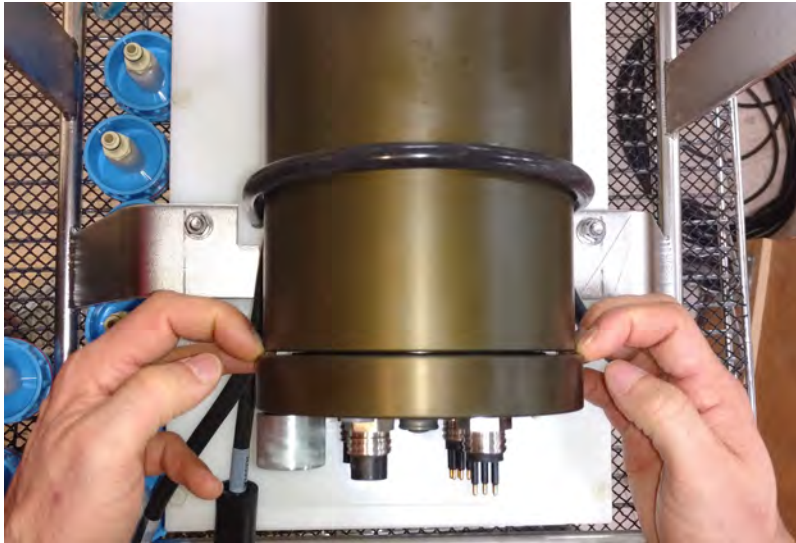


Figure 2-6: Separating the Housing and End Cap

Connecting the Batteries

Locate the battery conductors. The black two pin MTE connector will only fit into one connector on the electronics stack. Find the two pin female connector that mates with the battery connector on the Aux / Stepper board and plug in the batteries.

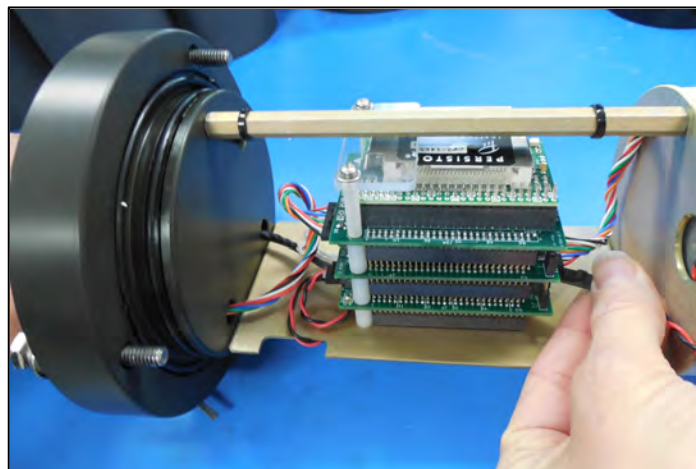


Figure 2-7: Connecting the Battery



Backup batteries are not installed with firmware v2.05 and higher. Electronics hardware changes made the backup battery unnecessary and it was eliminated. If deploying a RAS that still has a backup battery, install a fresh battery before every deployment.

Establishing Communication

1. Find the communication cable provided in the toolkit.
2. Connect the communications cable to the computer serial communication port before connecting to the communications connector on the controller end cap.

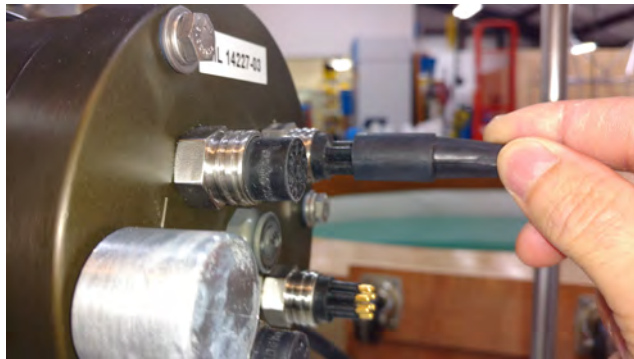


Figure 2-8: Connecting the COM Cable

3. Align the bulkhead connection pins, and push the bulkhead in place on the controller end cap.
4. On the computer, open a properly configured McLaneTerm window.
5. Connect the DB9 end of the communication cable to the computer communication port configured in McLaneTerm.
6. Enter [CTRL]-[C] in McLaneTerm. If the computer setup procedures were completed correctly, the Main Menu, a system clock confirmation message, or a message that indicates the system is Suspended will print to the screen.

Waking the Sampler from Low Power Sleep Mode

The sampler will enter a low power mode if it sits idle for more than 20 minutes. To wake the system from this suspended state, hold down [CTRL]-[C]. After three seconds of holding down [CTRL]-[C], the Main Menu will display (Figure 2-9).

If [CTRL]-[C] is held down for more than 5 seconds and nothing happens, check the previous sections of this chapter to make sure procedures were followed correctly. If your system has backup batteries, confirm they are properly seated in the backup battery housing, and make sure they are plugged into the electronics.

```
CF2-RAS-3.08 R2 L2.3 | RAS-3_08.c compiled Jan 23 2017 at 14:26

      RAS-125M500 S/N ML?????-?? Remote Access Sampler
      © 1996-2017 McLane Research Laboratories. All rights reserved.
-----

Clock reads 01/01/70 00:00:00. Change [N] ? y
Format is mm/dd/[yyyy or yy] hh:mm:ss
Enter correct time [01/01/1970 00:01:37] ? 08/20/2018 12:30:26
Clock reads 08/20/18 12:30:26. Change [N] ?
Initializing data array .....

-----

Configuration: RAS-125M500                CF2 V3_08 of Jan 23 2017

      McLane Research Laboratories, Inc.
      Remote Access Sampler
      ML?????-??
-----
                        Main Menu
-----
      Mon Aug 20 12:30:30 2018
      Port=99 unknown

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

      <C> Configure

NOTICE: Configure sampler before continuing!
```

Figure 2-9: Main Menu

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 McLaneTerm 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 McLaneTerm.

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 low power sleep mode. If date/time still do not display, see Chapter 2 in this User Manual to troubleshoot using the McLaneTerm 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_08 of Jan 23 2017

      McLane Research Laboratories, Inc.
      Remote Access Sampler
      ML12345-02

      -----
      Main Menu
      -----
      Mon Aug 20 12:31:32 2018
      Port=99 unknown

<1> Set Time           <5> Create Schedule
<2> Diagnostics       <6> Deploy System
<3> Manual Operation  <7> Offload Data
<4> Sleep             <8> Contact McLane
<C> Configure
```

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 3-4. 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
08/20/18  14:52:39  35.6 Vb   25.5°C 00 (home)
08/20/18  14:52:40  35.6 Vb   25.5°C 00 (home)
08/20/18  14:52:41  35.6 Vb   25.5°C 00 (home)
08/20/18  14:52:42  35.6 Vb   25.5°C 00 (home)
08/20/18  14:52:43  35.5 Vb   25.5°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 McLaneTerm.

<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_08 of Jan 23 2017

-----
Manual Operations Menu
-----
Mon Aug 20 12:32:11 2018
Port=99 unknown

<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 [] ? 1
```

← **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
1717 h   121 I_Hz   30 A_Hz   0.8 ml         50.6 ml/min   1 secs       35.5       52 mA
1708 h   184 I_Hz   76 A_Hz   2.1 ml         76.9 ml/min   2 secs       35.5       46 mA
1686 h   190 I_Hz  123 A_Hz   3.4 ml         79.4 ml/min   3 secs       35.5       44 mA
1687 h   179 I_Hz  168 A_Hz   4.7 ml         74.8 ml/min   4 secs       35.5       45 mA. . .
. . . ← Display shortened to save space
1686 h   179 I_Hz  179 A_Hz 101.0 ml         74.8 ml/min   81 secs       35.5       49 mA

Volume reached

Total volume pumped      = 101 ml
Elapsed time of event     = 82 sec
Lowest battery detected  = 35.5 V

Average Pump Current     = 47.0 mA
Highest Pump Current     = 56.0 mA
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
1719 h   120 I_Hz   164 A_Hz   0.8 ml         50.2 ml/min   1 secs       35.5       54 mA
1722 h   178 I_Hz   164 A_Hz   2.1 ml         74.4 ml/min   2 secs       35.5       56 mA
1700 h   190 I_Hz   167 A_Hz   3.4 ml         79.4 ml/min   3 secs       35.5       47 mA
1691 h   184 I_Hz   168 A_Hz   4.7 ml         76.9 ml/min   4 secs       35.5       48 mA
. . . ← Display shortened to save space
1684 h   178 I_Hz   179 A_Hz 101.0 ml         74.4 ml/min   81 secs       35.5       48 mA

Volume reached

Total volume pumped      = 101 ml
Elapsed time of event     = 82 sec
Lowest battery detected  = 35.5 V

Average Pump Current     = 48.0 mA
Highest Pump Current     = 55.0 mA
```

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 Sleep/Suspend mode, the current time will display. During this 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
08/20/18 14:30:42 Suspended ...
```

Figure 3-14: Sleep 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.

```
-----  
Configuration: RAS-125M500                CF2 V3_08 of Jan 23 2017  
  
-----  
                          Schedule Menu  
-----  
                          Mon Aug 20 14:54:13 2018  
  
                          <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



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.

<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 McLaneTerm. 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 McLaneTerm “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-125M100                CF2 V3_08 of Jan 23 2017
-----
                        Offload Menu
-----
                Fri May 18 08:11:17 2018
                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 3-16: Display All Data (1 of 3)

HEADER

system test
12345-01
MDS 05-17-18

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] = 100
Sample time limit [minutes] = 5
Post-sample acid:
Acid flush volume [ml] = 0
Acid flush time limit [minutes] = 0

SCHEDULE

Event 1 of 48 @ 05/17/18 16:00:00
Event 2 of 48 @ 05/17/18 16:20:00
Event 3 of 48 @ 05/17/18 16:40:00
Event 4 of 48 @ 05/17/18 17:00:00

... ← **Display shortened to save space**
Event 47 of 48 @ 05/18/18 07:20:00
Event 48 of 48 @ 05/18/18 08:00:00

DEPLOYMENT DATA

1 05/17/18 16:00:02 35.1 Vbat 18.4 °C PORT = 00
Pre-sample acid flush 11 ml 10 sec LB 34.7 V Volume reached
Flush port = 49
Intake flush 101 ml 82 sec LB 34.5 V Average I 67.0 mA Highest I
76.0 mA Volume reached
Flush port = 00
Sample 101 ml 82 sec LB 34.4 V Average I 60.0 mA Highest I
67.0 mA Volume reached
Sample port = 01
05/17/18 16:04:28 34.8 Vbat 21.2 °C PORT = 01
Post-sample acid flush 0 ml 0 sec LB 0.0 V . . .
Flush port = 49

2 05/17/18 16:20:01 35.1 Vbat 18.3 °C PORT = 00
Pre-sample acid flush 11 ml 9 sec LB 34.6 V Volume reached
Flush port = 49
Intake flush 101 ml 82 sec LB 34.4 V Average I 61.0 mA Highest I
68.0 mA Volume reached
Flush port = 00
Sample 101 ml 82 sec LB 34.3 V Average I 67.0 mA Highest I
74.0 mA Volume reached
Sample port = 02
05/17/18 16:24:29 34.7 Vbat 21.1 °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	18	34.4	59.0	66.0
1	75	37	34.4	60.0	67.0
1	75	56	34.4	60.0	66.0
1	75	74	34.4	60.0	66.0
1	75	93	34.4	60.0	66.0
2	75	18	34.4	66.0	74.0
2	75	37	34.3	66.0	71.0
2	75	56	34.4	66.0	71.0
2	75	74	34.3	67.0	74.0
2	75	93	34.3	67.0	73.0
3	75	18	34.3	63.0	73.0
3	75	37	34.3	64.0	74.0
3	75	56	34.3	64.0	70.0
3	75	74	34.3	64.0	70.0
3	75	93	34.3	64.0	69.0
4	75	18	34.2	66.0	71.0
4	75	37	34.2	66.0	70.0
4	75	56	34.2	65.0	68.0
4	75	74	34.2	65.0	73.0
4	75	93	34.2	65.0	71.0

. . .

← Display shortened to save space

46	75	18	33.1	67.0	68.0
46	75	37	33.1	67.0	75.0
46	75	56	33.1	67.0	73.0
46	75	74	33.1	67.0	73.0
46	75	93	33.1	67.0	73.0
47	75	18	33.1	64.0	68.0
47	75	37	33.1	64.0	68.0
47	75	56	33.1	64.0	71.0
47	75	74	33.1	64.0	68.0
47	75	93	33.1	64.0	73.0
48	75	18	33.2	64.0	68.0
48	75	37	33.2	64.0	69.0
48	75	56	33.2	65.0	69.0
48	74	74	33.2	64.0	71.0
48	75	93	33.2	64.0	71.0

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:     08/20/18 15:01:04
Volume pumped: 201 ml
Elapsed time:   162 sec
Lowest battery: 35.5 V
Average current: 46.0 mA
Highest current: 54.0 mA
Start temp:     24.2 C
Port used:      01
Stop time:      08/20/18 15:06:50
Status:         Volume reached

Event:          2
Start time:     08/20/18 15:20:09
Volume pumped: 201 ml
Elapsed time:   162 sec
Lowest battery: 35.5 V
Average current: 46.0 mA
Highest current: 54.0 mA
Start temp:     23.4 C
Port used:      02
Stop time:      08/20/18 15:25:56
Status:         Volume reached
. . . ← Display shortened to save space

Terminate file logging operation now
Press any key to continue.
```

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 East 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_08.c
      Electronics S/N: ML12345-02
      Compiled: Jan 23 2017 14:26
```

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_08 of Jan 23 2017
-----
                        Configuration Menu
-----
                        Mon Aug 20 12:31:23 2018
<A> Integral Temperature Sensor    [No]
<B> Integral 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 McLaneTerm to log all communication with the RAS. Chapter 2 in this User Manual has more information about using McLaneTerm.



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 McLaneTerm.
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_08 of Jan 23 2017
-----
                          Schedule Menu
-----
                          Mon Aug 20 14:54:13 2018

<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.

```
Enter START date and time [08/20/2018 14:54:18] ? 08 20 2018 15 01 02
Enter END date and time   [08/20/2018 14:54:31] ? 08 21 2018 06 00 03

Schedule Verification

Event  1 of 48 at 08/20/18 15:01:02
Event  2 of 48 at 08/20/18 15:20:09
Event  3 of 48 at 08/20/18 15:39:16
Event  4 of 48 at 08/20/18 15:58:23
. . . ← Display shortened to save space

Event 47 of 48 at 08/21/18 05:40:24
Event 48 of 48 at 08/21/18 05:59:31

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
. . . ← 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 3-27: 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.

Reboot now? [N] ? y
Resetting...
```

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_08 of Jan 23 2017

-----
                        Schedule Menu
-----
                        Mon Aug 20 14:54:13 2018

<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 [08/20/2018 14:54:18] ? 08 20 2018 15 01 02
Enter END date and time   [08/20/2018 14:54:31] ? 08 21 2018 06 00 03

Schedule Verification

Event 1 of 48 at 08/20/18 15:01:02
Event 2 of 48 at 08/20/18 15:20:09
Event 3 of 48 at 08/20/18 15:39:16
Event 4 of 48 at 08/20/18 15:58:23
. . .
Event 47 of 48 at 08/21/18 05:40:24
Event 48 of 48 at 08/21/18 05:59:31

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 [] ?

```

← Display shortened to save space

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 3-33). 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.



After spring of 2015, new McLane CF2-based instruments no longer require a backup battery. If backup batteries are installed in your system, 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 (see Figure 3-35).

The data offload reminder (and battery check, if applicable) 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.

```
Performing 6 second low-power sleep mode test...

System status:

  Date      Time      Battery    Temp Port
  08/20/18  14:55:49  35.6 Vb   25.8°C 00 (home)

Caution: Deployment will overwrite the
          EEPROM data backup cache.

Proceed with the deployment [N] ? y

Erasing EEPROM entries .....

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

08/20/18 14:55:54 Waiting for event 01 of 48 @ 08/20/18 15:01:02
08/20/18 14:55:54 Suspended until 08/20/18 15:01:02 ...
```

Figure 3-36: Proceed with Deployment



Waking the sampler after this point will cancel the deployment. If the user is curious whether the system is still working DO NOT wake the device. Instead connect to the device, and press any key. The system will print the system time and “Suspended until” the start time of the next scheduled event.

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.

For a bench test, leave the communications cable attached to the RAS electronics to observe the operation of the instrument in the McLaneTerm 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. Attach zinc or steel anodes to the frame when deploying the RAS in a highly corrosive environment.

Controller Housing

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

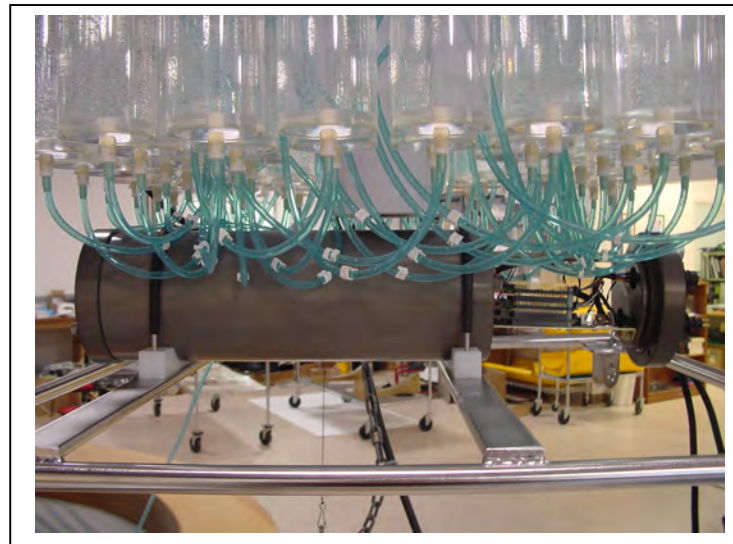


Figure 4-1: Controller Housing

The micro-controller, which starts automatically when the 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.

End Caps and O-Rings

The battery and electronics are fastened to the inside of the controller housing top end cap. Each end cap includes two 70 durometer Buna-N round section o-rings (2-246 and 2-242) and one 90 durometer backup ring (8-242). O-rings and surfaces should be regularly cleaned with isopropyl alcohol. O-rings should be lubricated with provided Parker O-Lube and replaced when necessary. The toolkit has spare O-rings. More o-rings can be purchased from McLane.

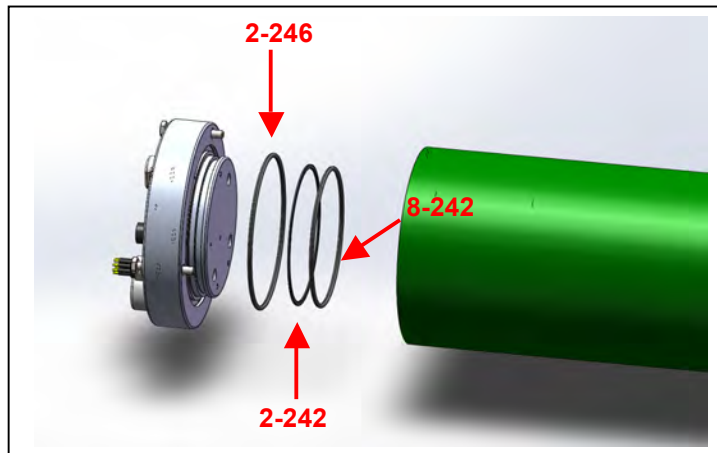


Figure 4-2: Sampler O-Ring Installation – Correct Placement is Critical



O-ring maintenance and correct placement is critical to keep the controller housing sealed from water intrusion. Incorrect o-ring placement results in cracks or splits that could affect the o-ring seal and cause water damage to the controller. Water damage from incorrectly placed or maintained o-rings could void the sampler warranty.

End Cap Bulkhead Connectors

The end cap has bulkhead connectors for the COM Port, Pump, Belt Motor, and Proximity Sensor (Figure 4-3).

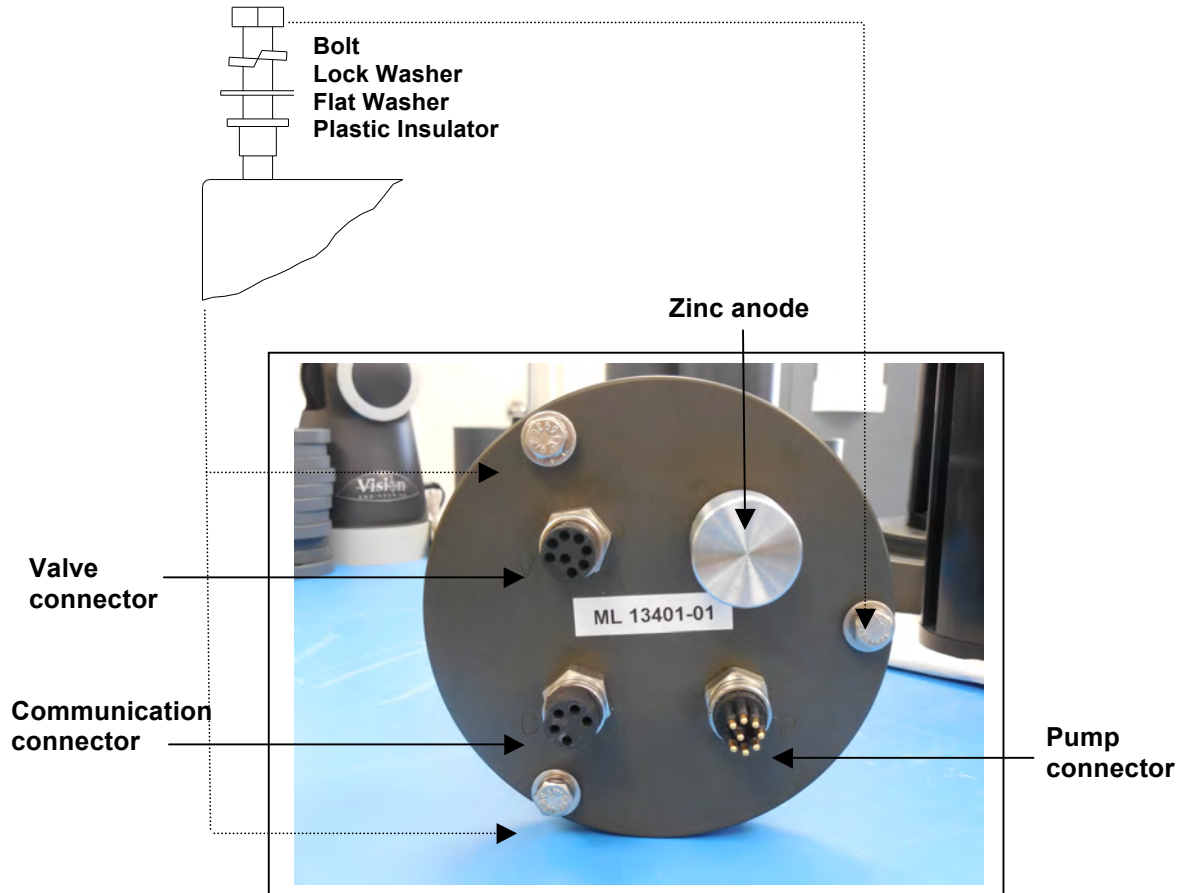


Figure 4-3: Controller Housing End Cap Bulkhead Connectors

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.

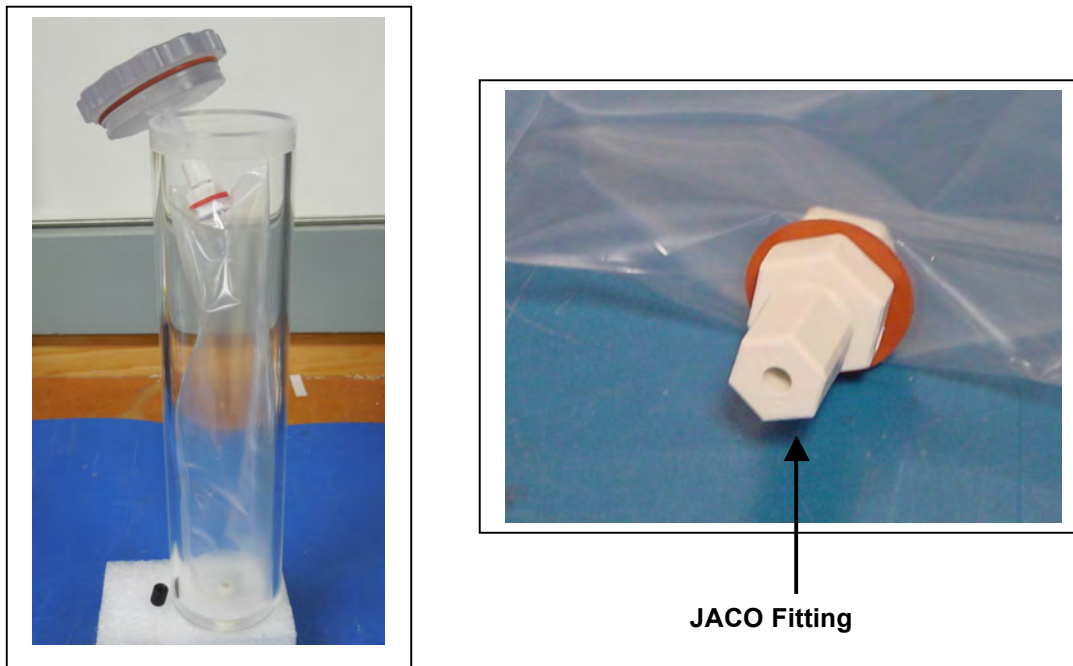


Figure 4-4: Sample Tube with Bag Installed, JACO Fitting

Sample bags have a JACO fitting, ferrule, short tubing and threaded male connector (Figure 4-4). 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 μ m pore size are recommended. Filters with pore sizes less than 0.4 μ m may require testing to confirm proper operation.

Optional Filter Holders



Figure 4-5: 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 4-6: 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.

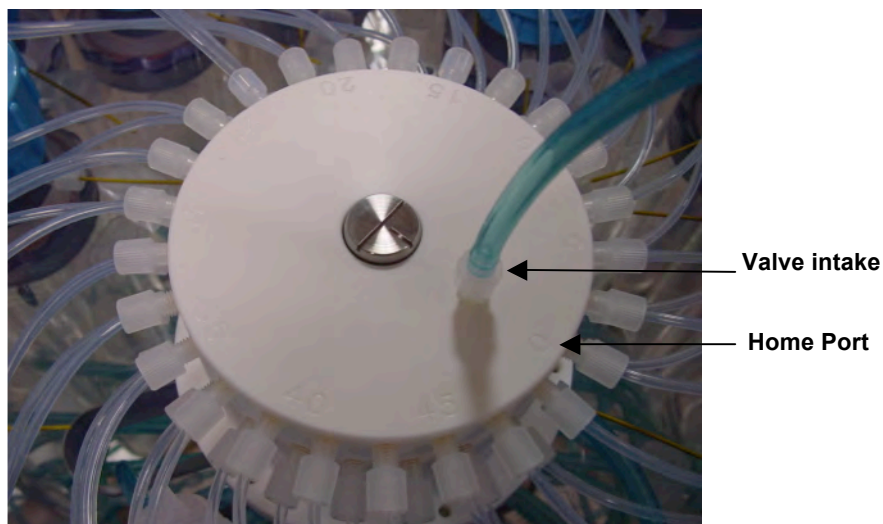


Figure 4-7: Multi-Port Valve

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 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 4-8. The reservoir contains a sample bag filled with acid or other bio fouling cleaner.

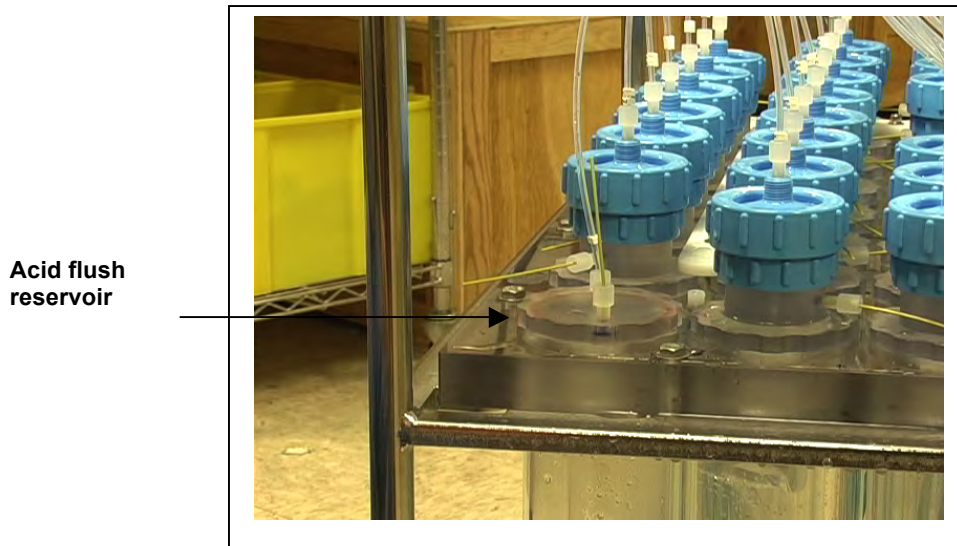


Figure 4-8: Acid Flush Reservoir

Acid cleaning cycles are user programmable as shown in Figure 4-9. 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 4-9: Sampling and Flushing Parameters

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

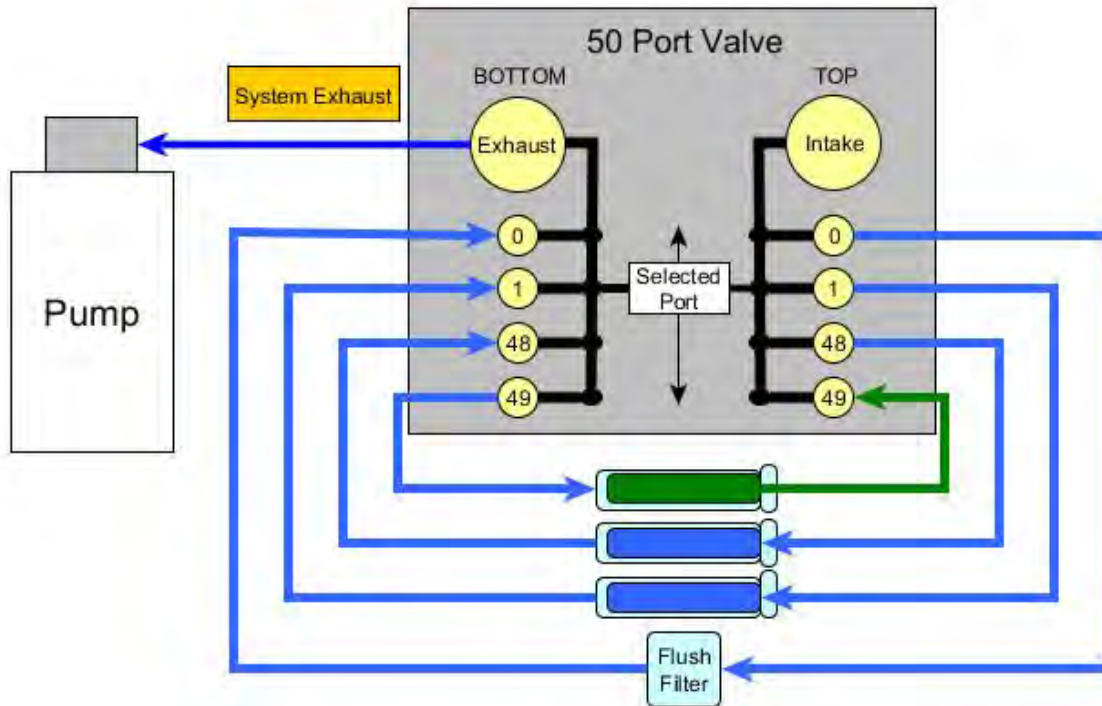


Figure 4-10: Pumping Operation

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.

**Water Flush
25mm
Filter Holder
(Port 00)**

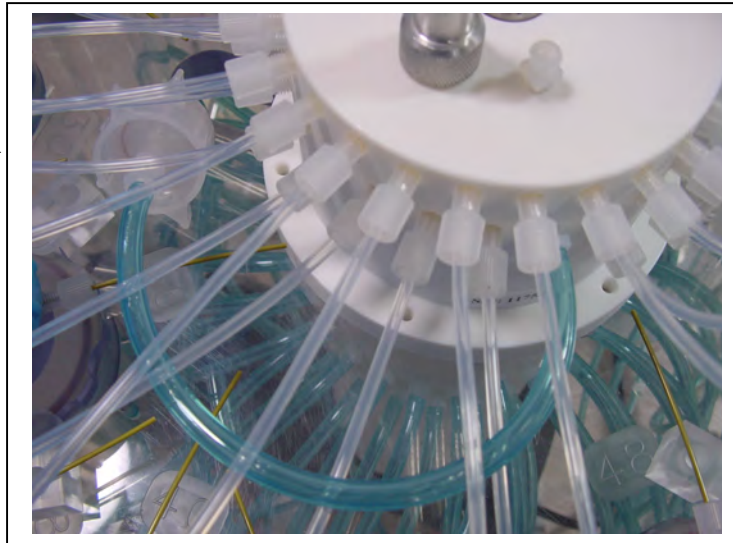
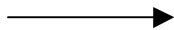


Figure 4-11: Water Flush Filter Holder

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.

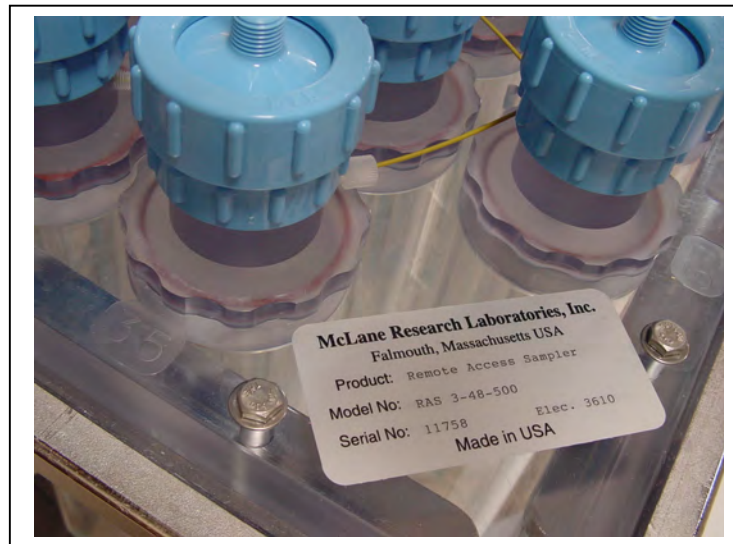


Figure 4-12: RAS-500 Serial Number Label

Notes

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, Flow rate adjusts to prevent sample or mesh damage and lower battery drain. If rapid intake clogging occurs, pumping stops to protect the sample.

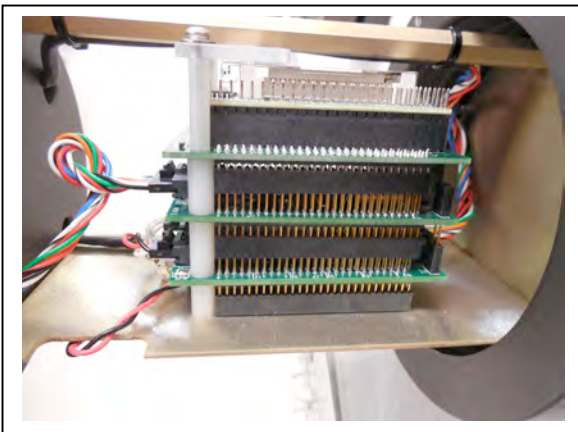


Figure 5-1: CF2 Four Board Stack



Figure 5-2: Microcontroller & Interface Board



Figure 5-3: Three Phase Board

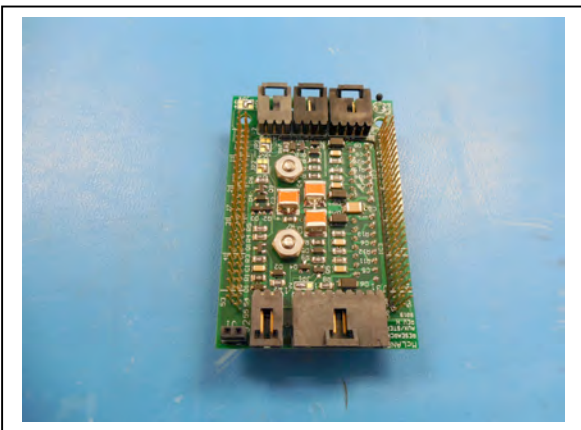


Figure 5-4: AUX Stepper Board



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

Main Battery

Depending on the RAS manufacture date, the battery style could have a battery holder for user replaceable 'D' cell alkaline batteries (Figure 5-5) or a battery pack (Figure 5-6).

If using the battery holder with user replaceable drop-in 'D' cell batteries, install the batteries with the correct orientation in the holder terminals. An instructional video showing drop in battery replacement is shown on the RAS video pages at www.mclanelabs.com.



Figure 5-5: Drop-in Battery Holder for 'D' Cell Batteries



Figure 5-6: A21-1000 Battery Pack

Pump and valve operations operate while the voltage is above 18 VDC. When the voltage falls below 18 VDC, low power sleep mode begins. When awake, only limited Main Menu functions are available.

Backup Battery

After the spring of 2015, new McLane CF2-based instruments no longer require a backup battery. Prior to this change, the backup batteries served as a voltage source for the electronics while in low power sleep mode. Electronics hardware changes made the backup battery unnecessary, and it was eliminated.

Check your system for backup batteries, if they are installed be sure to replace them before each deployment. On the TT8 microcontroller based devices, the backup battery is a 9 volt battery mounted beside the electronics. On the Persistor CF2 microcontroller based devices, the backup battery is a plastic case with two AAA batteries mounted near the electronics.

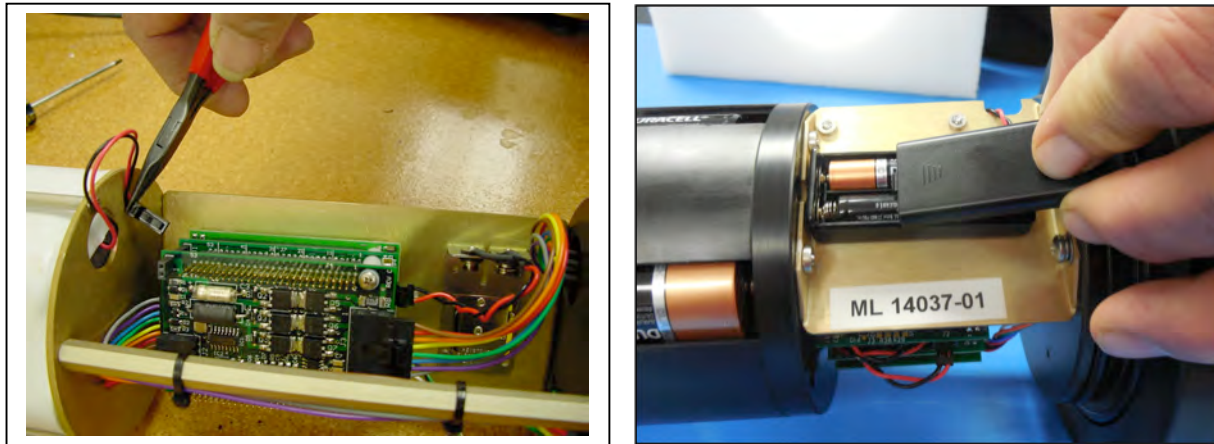


Figure 5-7: Backup Battery 9V and AAA Styles (Older Model RAS systems)

Notes

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 operational 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 McLaneTerm.



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.

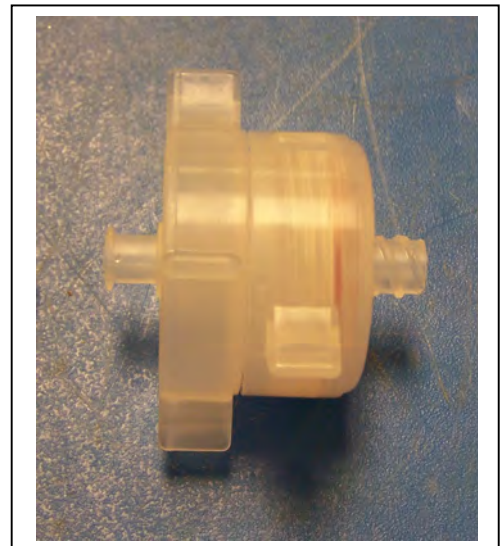
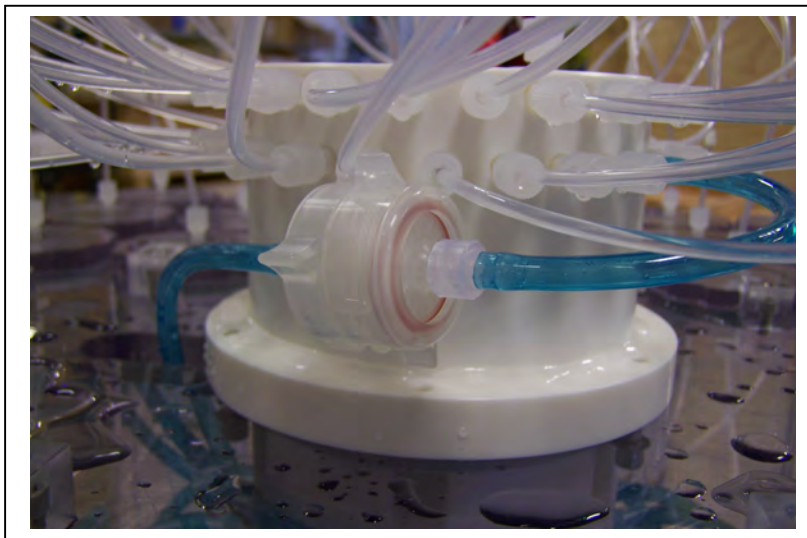


Figure 6-1: Water Flush Filter Holder

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.

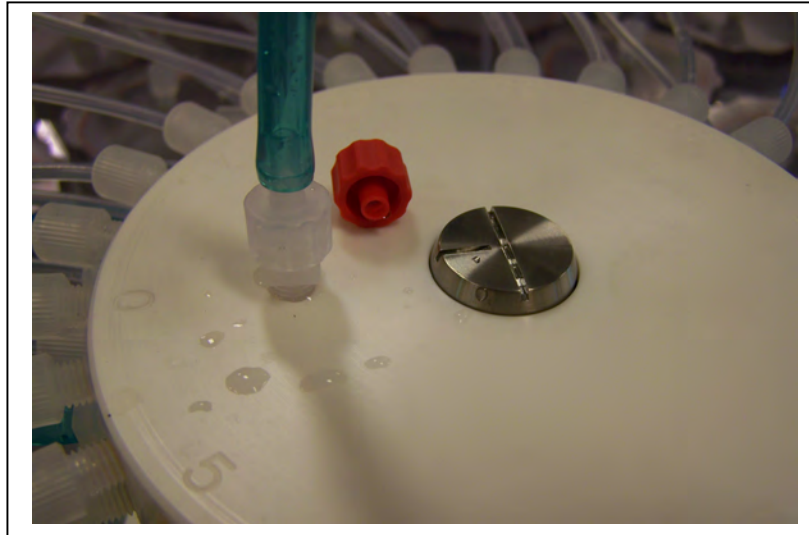


Figure 6-2: Water Flush Filter Holder Disconnected

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.

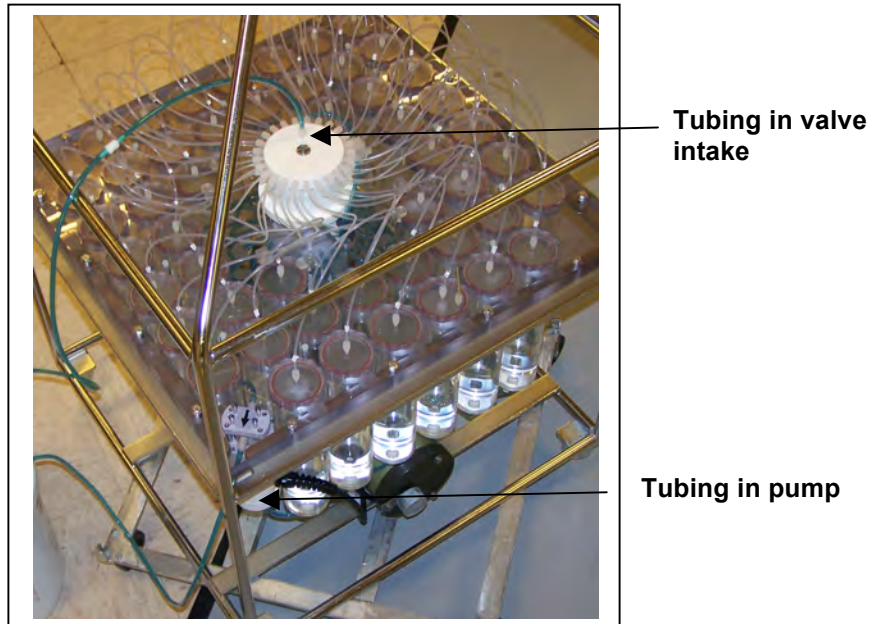


Figure 6-3: Tubing Connections for Priming

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 6-5 and 6-6. 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

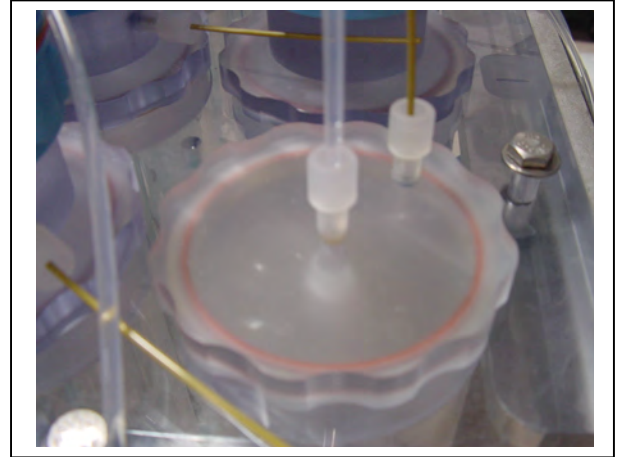


Figure 6-6: Sample Tube without Filter Holder

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.

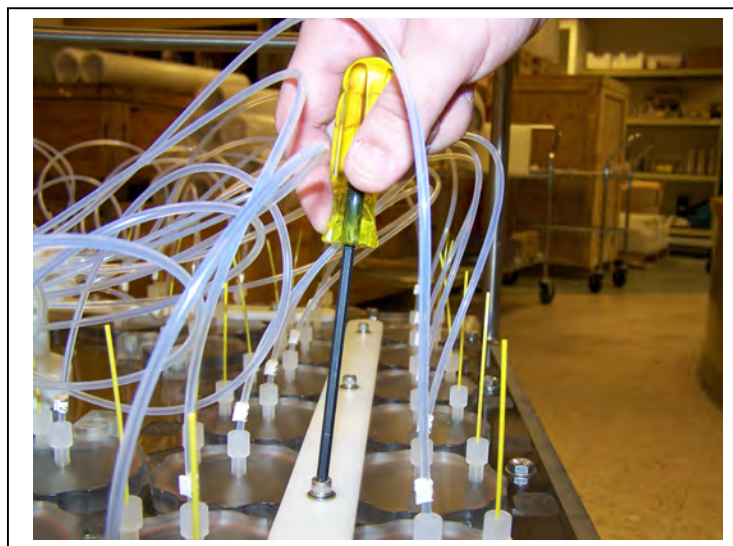


Figure 6-7: Removing Hold Down Brackets

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).

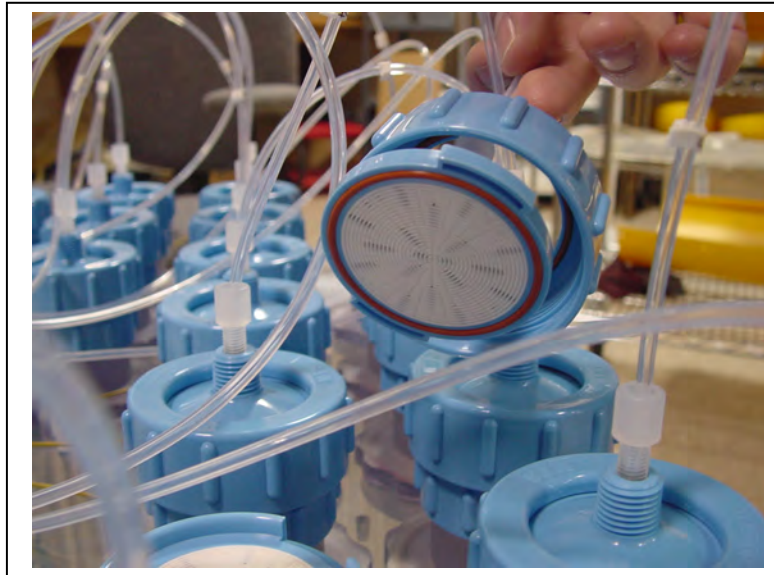


Figure 6-8: Removing Filter Holder Tops

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

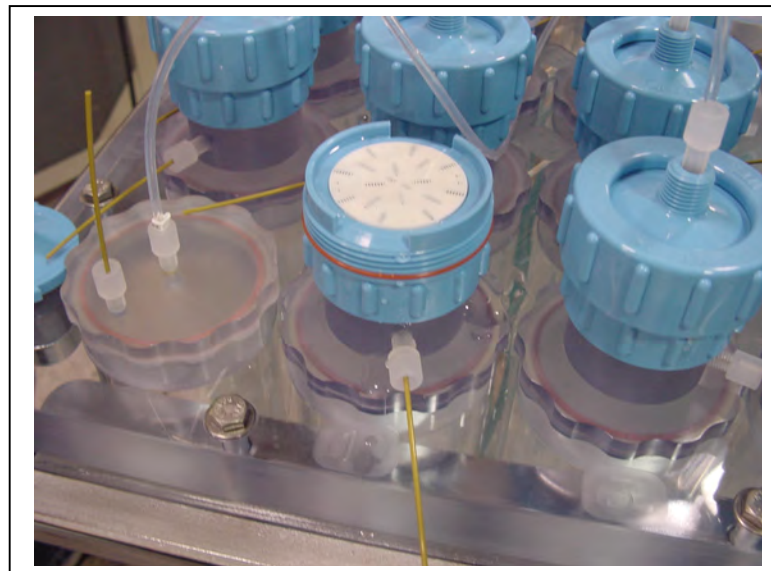


Figure 6-9: Pressure Compensation Tube

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.

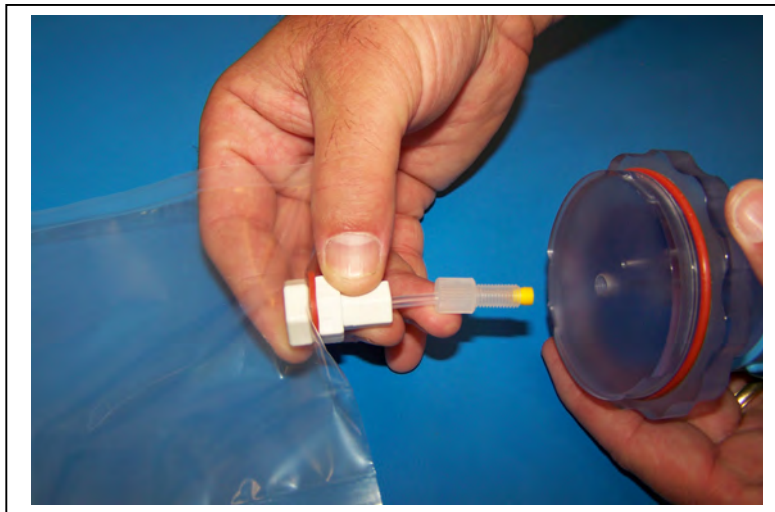


Figure 6-10: JACO Bag with Ferrule

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, confirm the chemical compatibility with bag material.

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

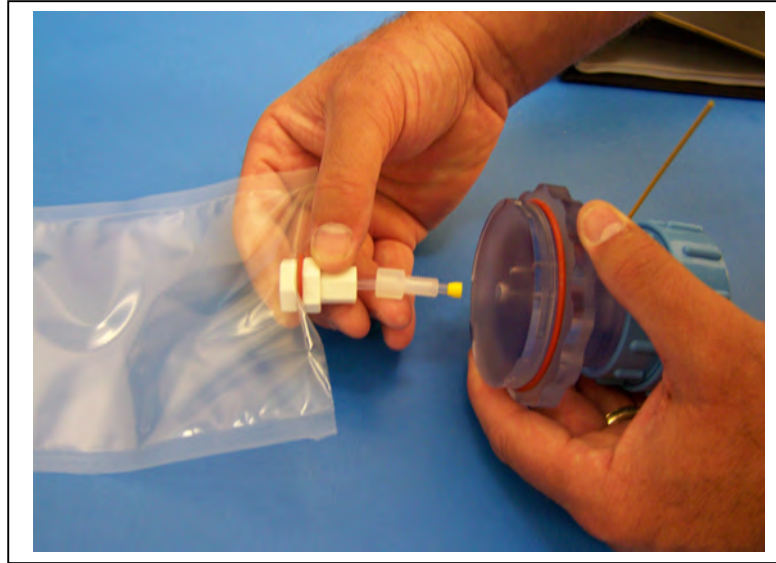


Figure 6-11: Attaching a Sample Bag

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 6-12). 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.

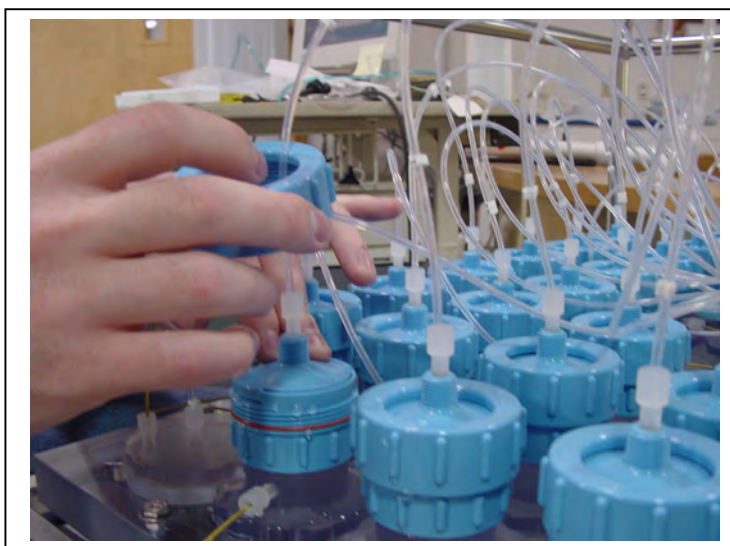


Figure 6-13: Closing the Filter Holder Cap

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 RAS has a +36VDC, drop-in D-cell battery pack with a total capacity of 10,000 mAh. Battery capacity for a planned deployment can be estimated using the Instrument Current Consumption tables in this section. In addition to these typical current consumption numbers, battery drain is affected by flow rate, pump speed and types of filters used in the filter holders. Higher pump speeds and filters that have collected more material will draw additional battery capacity and can make battery endurance estimation more difficult.

Instrument Current Consumption	
Controller electronics ON	9.0 mA
Controller electronics LOW POWER SLEEP	0.22 mA
Moving Valve	340 mA
Forward/Reverse Pumping	135 mA

Instrument ON Consumption	
Moving Valve (48 port deployment)	1.0081 h = 3629 s
Moving Valve (single port advance)	0.0017 h = 6 s
Pump Acid Flush (10 mL @ 75 mL / min)	0.0023 h = 8 s
Pump Water Flush (100 mL @ 75 mL / min)	0.0223 h = 80 s
Pump Sample (500 mL @ 75 mL / min)	0.1112 h = 400 s
Acid Exposure Time Delay	0.0167 h = 60 s
Sample Pause to Reduce Pressure Differential	0.0334 h = 120 s

System Deployment /Event Parameters for this example	
Number of Events	48
Length of Deployment	1-Year
Acid: Pre-sample Acid Flush	Enabled
Flushing Volume	10 mL
Exposure Time Delay	1 min
Water: Flushing Volume	100 mL
Sample: Sample Volume	500 mL
Sample Time Limit	25 min
Timing: Pump Data Period	15 s

Example of Estimating Battery Life for One Year Deployment

Pre-deployment (system prep)	
Controller Electronics (ON) – 3 hours	$3 \text{ h} \times 9.0 \text{ mA} = 27.0 \text{ mAh}$
Moving Valve (100 ports, single port advance, twice around)	$100 \text{ ports} \times 0.0017 \text{ h} \times 340 \text{ mA} = 57.8 \text{ mAh}$
Pumping – 1.0 hour	$1.0 \text{ h} \times 135 \text{ mA} = 135.0 \text{ mAh}$
	Subtotal = 219.8 mAh
Deployment	
Controller Electronics (Low Power Sleep) – 1 year	$8760 \text{ h} \times 0.22 \text{ mA} = 1927.2 \text{ mAh}$
Moving Valve (48 port deployment)	$1.0081 \text{ h} \times 340 \text{ mA} = 342.8 \text{ mAh}$
Pump Acid Flush (48 ports)	$48 \text{ ports} \times 0.0023 \text{ h} \times 135 \text{ mA} = 14.9 \text{ mAh}$
Acid Exposure Delay (48 ports)	$48 \text{ ports} \times 0.0167 \text{ h} \times 0.22 \text{ mA} = 0.2 \text{ mAh}$
Pump Water Flush (48 ports)	$48 \text{ ports} \times 0.0223 \text{ h} \times 135 \text{ mA} = 144.5 \text{ mAh}$
Pump Sample (48 ports)	$48 \text{ ports} \times 0.1112 \text{ h} \times 135 \text{ mA} = 720.6 \text{ mAh}$
Pause to Reduce Pressure Differential (48 ports)	$48 \text{ ports} \times 0.0334 \text{ h} \times 0.22 \text{ mA} = 0.4 \text{ mAh}$
Pause to Reduce Pressure Differential (48 ports)	$48 \text{ ports} \times 0.0084 \text{ h} \times 150 \text{ mA} = 60.5 \text{ mAh}$
	Subtotal = 3211.1 mAh
Recovery (offload data, remove samples)	
Controller Electronics (ON) – 2 hours	$2 \text{ h} \times 9.0 \text{ mA} = 18.0 \text{ mAh}$
Moving Valve (50 ports, single port advance, once around)	$50 \text{ ports} \times 0.0017 \text{ h} \times 340 \text{ mA} = 28.9 \text{ mAh}$
	Subtotal = 46.9 mAh
Total Battery Consumption	
	$219.8 + 3211.1 + 46.9 = 3477.8 \text{ mAh}$

In this example, the total energy consumed is less than the 10,000 mAh capacity of the battery and the proposed deployment plan will have sufficient battery life.

Chapter 7

Deployment and Recovery

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.

Final steps before Deployment

Deploying the RAS requires the following (in order):

- Connect the battery and close the end cap (see chapter 2 for details about the end cap and connectors).
- Connect the communications cable and confirm firmware deployment settings (see chapter 3 for details about programming the deployment).
- Disconnect the communications cable and attach the dummy plug.
- 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.
- Attach the RAS to the mooring.

Recovery Procedure

Post-recovery steps include the following:

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

Removing the Sample Bags

To remove the sample bags, follow these steps 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 Deployment Data

Deployment event data and pumping data is stored to volatile memory and non-volatile EEPROM during a deployment. After a system is recovered this data can be offloaded and captured to a text file for future 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.

```
Configuration: RAS-125M100                CF2 V3_08 of Jan 23 2017
-----
                        Offload Menu
-----

      Mon May 14 15:41:14 2018
      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 7-1: Offload/Display Data File Menu



The computer should be on and McLaneTerm running before connecting to the RAS electronics. Do not disconnect the battery (which erases the data) until checking the capture files to confirm that the data offload was successful.

Offload menu options

<1> Display ALL data: Displays all event summary and pumping data stored in volatile RAM memory. If power is removed, this data is lost.

<2> Display event summary data: Displays only event summary data.

<3> Display pump data: Displays only the pumping data recorded and the pump data interval programmed while setting up the deployment.

<4> EEPROM data backup cache: Displays EEPROM event data summary. While the data is limited, it will remain in memory after power is cycled.

See post-deployment steps in Chapter 6 “Operations”, then follow these steps to offload deployment data:

1. Establish communication with the RAS and start a capture file named "RAS_OFFLOAD_[DATE & TIME].txt".
2. Select Main Menu option <7> to offload data.
3. Select Offload menu option <1> to display all data. After all the data has been printed to the screen press any key to return to the offload menu.
4. Select Offload menu option <4> to display the backup deployment data summary to the screen. Press any key to return to the offload menu.
5. Stop logging to file.
6. Select Offload menu option <M> to return to the main menu, and put the device to sleep.

The screens that follow show an exempling of selecting Option <1> ‘Display ALL Data’.

```
Configuration: RAS-125M100                CF2 V3_08 of Jan 23 2017

-----
                        Offload Menu
-----
      Mon May 14 15:41:14 2018
      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_08.c
Compiled:          Jan 23 2017 14:26:11
Electronics S/N:  ML12345-01
Temperature probe: Internal

Data recording start time = 05/14/18 10:22:18
Data recording stop time  = 05/14/18 15:35:33
```

Figure 7-2: Offload/Display Data File – Display All (1 of 2)

HEADER

Bench Test, 05-14-2018
s/n 12345-01
CGP

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] = 50
Water flush time limit [minutes] = 3

Sample:

Sample volume [ml] = 50
Sample time limit [minutes] = 3

Post-sample acid:

Acid flush volume [ml] = 0
Acid flush time limit [minutes] = 0

SCHEDULE

Event 1 of 48 @ 05/14/18 10:30:01
Event 2 of 48 @ 05/14/18 10:36:24
Event 3 of 48 @ 05/14/18 10:42:47
Event 4 of 48 @ 05/14/18 10:49:10
.
.
.
Event 47 of 48 @ 05/14/18 15:23:39
Event 48 of 48 @ 05/14/18 15:30:02

DEPLOYMENT DATA

1 05/14/18 10:30:03 35.9 Vbat 23.0 řC PORT = 00
Pre-sample acid flush 12 ml 10 sec LB 35.8 V Volume reached
Flush port = 49
Intake flush 52 ml 42 sec LB 35.8 V Average I 49.0 mA Highest I 55.0 mA
Volume reached
Flush port = 00
Sample 52 ml 42 sec LB 35.8 V Average I 45.0 mA Highest I 52.0 mA
Volume reached
Sample port = 01
05/14/18 10:33:08 35.9 Vbat 24.5 řC PORT = 01
Post-sample acid flush 0 ml 0 sec LB 0.0 V . . .
Flush port = 49

2 05/14/18 10:36:26 35.9 Vbat 24.8 řC PORT = 00
Pre-sample acid flush 12 ml 10 sec LB 35.8 V Volume reached
Flush port = 49
Intake flush 52 ml 42 sec LB 35.8 V Average I 54.0 mA Highest I 60.0 mA
Volume reached
Flush port = 00
Sample 52 ml 42 sec LB 35.8 V Average I 47.0 mA Highest I 57.0 mA
Volume reached
Sample port = 02
05/14/18 10:39:33 35.9 Vbat 25.8 řC PORT = 02
Post-sample acid flush 0 ml 0 sec LB 0.0 V . . .
Flush port = 49
.
.
.

← Display shortened to save space

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

PUMPING DATA

Sample interval = 15 [seconds]

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

PUMPING DATA

Sample interval = 15 [seconds]

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

1	75	19	35.8	46.0	50.0
1	75	37	35.8	45.0	52.0
2	75	19	35.8	48.0	49.0
2	76	37	35.8	47.0	53.0
3	75	19	35.8	48.0	49.0
3	75	37	35.8	47.0	55.0
4	75	19	35.8	51.0	56.0
4	75	37	35.8	51.0	57.0
5	75	19	35.8	51.0	53.0
5	75	37	35.8	50.0	57.0
6	75	19	35.8	48.0	52.0
6	75	37	35.8	47.0	51.0

. . . ← **Display shortened to save space**

48	75	19	35.8	52.0	54.0
48	75	37	35.8	51.0	58.0

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

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

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.

Inspecting O-Rings

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.

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:

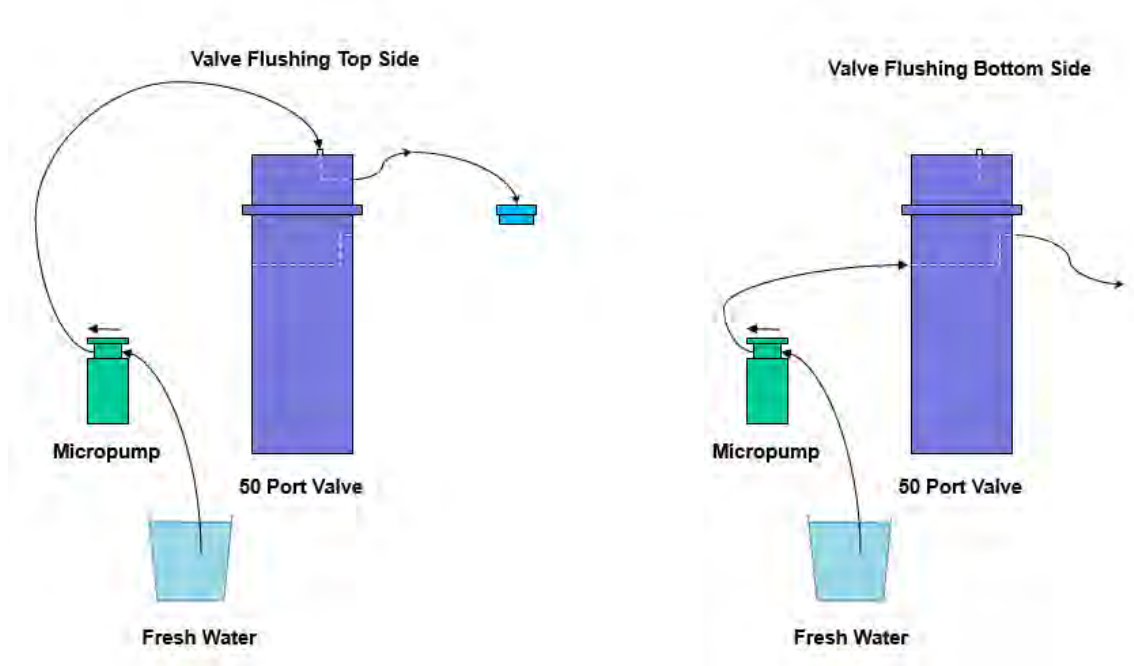
- Offload all data from memory.
- Rinse all instrument components with fresh water.
- Use the System Flush firmware option (explained in the section that follows) to flush the valve with fresh water.
- Remove main and backup batteries. If the main battery is still usable, first cover the connector with 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.

Appendix A

Adaptive RAS Command Reference

RAS Firmware version 3.11 added a command-line interface to standard menu driven RAS firmware. Users can switch between menu-driven and command-line interface (adaptive sampling) modes.

Adaptive firmware gives users access to system functionality through a command-line interface.

Some basics before we get started:



Regardless of menu or command-driven mode, You must be in menu mode to use the Configuration menu.

- The Command-line interface can be accessed from the Main menu by entering the menu option “>” and the password “ADA”.

```
Configuration: RAS-125M500-RBR_T          CF2 V3_11 of Sep 15 2020
                McLane Research Laboratories, Inc.
                Remote Access Sampler
                ML12345-01

-----
                Main Menu
-----
                Fri Oct  2 09:12:28 2020
                Port 00

<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 [ ] ? > Password: ***
```

Type >
and then
Password
ADA

- The system enters a low-power sleep mode after standing idle for 20 minutes.
- In order to wake from low-power sleep mode enter three [CTRL-C] characters with about a second between each. Alternatively, you can just hold down [CTRL-C] for a few seconds.

- [CTRL-C] is also used as a "cancel" or "back" button. If you are in the middle of something that you need to cancel or escape from, just enter [CTRL-C].
- Command arguments are separated by spaces.
- If you ever need help with a command and you don't have this document, just enter "[the command name] ?" to access the command documentation.

Help:

Description: Displays the command set. Enter a command name at the prompt for a command description. Alternatively, the user can get command help by entering the command name followed by a space and a question mark.

Syntax: HELP or [COMMAND] ?

Example:

```
>help
-----
COMMANDS:
-----
BATTERY
CLOCK
COPYRIGHT
EXIT
FORWARD
HELP
HOME
ID
MCLANE
PORT
QUIT
RESULT
REVERSE
SLEEP
VERBOSE
VERSION
?
SAMPLE_RESULT
START_DEPLOY
RESUME_DEPLOY
STOP_DEPLOY
SAMPLE
SET
OFFLOAD
OFFLOAD_EEP
PRINT_PARAMS
SYSTEM_FLUSH
REBOOT
TEMPERATURE
TEMPERATURE_INTERVAL
TEMPERATURE_SLEEP
TEMPERATURE_DATA
APPLY_FIXATIVE
FIXATIVE_VALVE
FIXATIVE_AVAILABLE
MAIN_MENU

Which command do you want help with?  [^C] to return to prompt.
```


SYSTEM COMMANDS:

MAIN_MENU:

Description: Return to menu based programming

Syntax: MAIN_MENU

Example:

```
>main_menu

-----
Configuration: RAS-125M500                CF2 V3_11 of May 28 2019

      McLane Research Laboratories, Inc.
      Remote Access Sampler
      ML12345-01
-----
                        Main Menu
-----
                        Fri Apr 24 11:26:49 2020

                        Port 00

<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 [] ?
```

BATTERY:

Description: Display the system battery voltage

Syntax: BATTERY

Example:

```
>battery

Battery: 36.0V [Alkaline, 18V minimum]
```

CLOCK:

Description: Display or set the date and time

Syntax: CLOCK

CLOCK [MONTH] [DAY] [YEAR] [HOUR] [MINUNTE] [SECOND]

CLOCK [MM/DD/YYYY] [HH:MM:SS]

Example:

```
> clock 04 20 2020 10 27 00

Clock: 04/20/20 10:27:00
```

COPYRIGHT:

Description: Display the firmware copyright notice

Syntax: COPYRIGHT

Example:

```
>copyright  
  
-----  
CF2-RAS-3.11 RAS-125M500 S/N ML12345-01 Remote Access Sampler  
  
© 1996-2019 McLane Research Laboratories. All rights reserved.  
-----
```

ID:

Description: Display the system identification information

Syntax: ID

Example:

```
>id  
  
Identity: CF2-RAS.C ML12345-01
```

MCLANE:

Description: Display McLane contact information

Syntax: MCLANE

Example:

```
>mclane  
  
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-C  
Electronics S/N: ML12345-01  
Compiled: May 28 2019 11:21  
  
Press any key to continue.
```

SLEEP:

Description: Invoke low-power sleep

Syntax: SLEEP

Example:

```
>sleep  
  
04/20/2020 11:52:54 Suspended ...
```

VERBOSE:

Description: Displays or enables and disables reporting detailed information while executing commands. Default setting is ON.

Syntax: VERBOSE [on|off]

Example:

```
>verbose  
  
Verbose: ON
```

VERSION:

Description: Display version information

Syntax: VERSION

Example:

```
>version  
  
Version:  
WTS 12345-01 v2.10
```

EXIT:

Description: Exit the program

Syntax: EXIT password

Password: MCLANE or MCL

Example:

```
>exit mcl  
  
-----  
Persistor CF21M   SN 16479   PicoDOS V4.03r1   PBM V4.03  
(C) 1998-2007 Persistor Instruments Inc. - www.persistor.com  
-----  
  
CompactFlash card missing, most features disabled  
  
CF2>
```

QUIT:**Description:** Exit the program**Syntax:** QUIT [password]**Password:** MCLANE or MCL**Example:**

```
>quit mclane

-----
Persistor CF21M  SN 16479  PicoDOS V4.03r1  PBM V4.03
(C) 1998-2007 Persistor Instruments Inc. - www.persistor.com
-----

CompactFlash card missing, most features disabled

CF2>
```

REBOOT:**Description:** Reboots the system. **WARNING:** rebooting will return to the menu driven command line. Re-enter the adaptive command line using ">" password: ada.**Syntax:** REBOOT**Example:**

```
>reboot

Resetting...

-----
CF2-RAS-3.11  RAS-125M500  S/N ML12345-01  Remote Access Sampler

© 1996-2019 McLane Research Laboratories. All rights reserved.
-----

Clock reads 04/24/2020 11:41:51.  Change [N] ?

-----
Configuration: RAS-125M500  CF2 V3_11 of May 28 2019

-----
McLane Research Laboratories, Inc.
Remote Access Sampler
ML12345-01
-----
Main Menu
-----
Fri Apr 24 11:44:53 2020

Port 99

<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 [] ?
```

PUMP COMMANDS:

FORWARD:

Description: Executes a manual pumping operation in the forward direction using the provided pumping parameter arguments.

Syntax: FORWARD [volume] [flowrate] [minflow] [timelimit]

Example:

```
>forward 50 100 50 0
```

Pump Drive	Hall Hz	Average Hall Hz	Volume Pumped	Flow Rate	Elapsed Seconds	Batt. Voltage	Pump Current
1600 h	44 I_Hz	11 A_Hz	0.3 ml	18.4 ml/min	1 sec	36.0 V	65 mA
1990 h	117 I_Hz	40 A_Hz	1.1 ml	48.9 ml/min	2 sec	36.0 V	76 mA
2235 h	159 I_Hz	80 A_Hz	2.2 ml	66.5 ml/min	3 sec	36.0 V	80 mA
. Shortened							
2862 h	229 I_Hz	229 A_Hz	46.4 ml	95.7 ml/min	31 sec	35.9 V	80 mA
2835 h	227 I_Hz	229 A_Hz	48.0 ml	94.9 ml/min	32 sec	36.0 V	81 mA
2812 h	225 I_Hz	227 A_Hz	49.6 ml	94.1 ml/min	33 sec	36.0 V	81 mA

Result: Volume reached
Elapsed Seconds: 34
Volume: 50 ml
Lowest Flow Rate: 94.1 ml
Average Current: 81.0 mA
Highest Current: 91.0 mA
Lowest Battery: 35.9 V

REVERSE:

Description: Executes a manual pumping operation in the reverse direction using the provided pumping parameter arguments.

Syntax: REVERSE [volume] [flowrate] [minflow] [timelimit]

Example:

```
>reverse 100 100 50 0
```

Pump Drive	Hall Hz	Average Hall Hz	Volume Pumped	Flow Rate	Elapsed Seconds	Batt. Voltage	Pump Current
1600 h	48 I_Hz	12 A_Hz	0.3 ml	20.1 ml/min	1 sec	36.0 V	69 mA
1982 h	118 I_Hz	41 A_Hz	1.2 ml	49.3 ml/min	2 sec	36.0 V	84 mA
2225 h	161 I_Hz	81 A_Hz	2.3 ml	67.3 ml/min	3 sec	36.0 V	85 mA
. Shortened							
2398 h	191 I_Hz	192 A_Hz	97.3 ml	79.9 ml/min	66 sec	35.9 V	77 mA
2389 h	189 I_Hz	190 A_Hz	98.6 ml	79.0 ml/min	67 sec	36.0 V	75 mA
2385 h	189 I_Hz	190 A_Hz	100.0 ml	79.0 ml/min	68 sec	36.0 V	76 mA

Result: Volume reached
Elapsed Seconds: 69
Volume: 100 ml
Lowest Flow Rate: 79.0 ml
Average Current: 82.0 mA
Highest Current: 90.0 mA
Lowest Battery: 35.9 V
Lowest Flow Rate: 79.0 ml
Average Current: 71.0 mA
Highest Current: 81.0 mA
Lowest Battery: 35.9 V

RESULT:

Description: displays the results for manual pumping operation

Syntax: RESULT

Example:

```
>result

Result:           Volume reached
Elapsed Seconds:  34
Volume:           50 ml
Lowest Flow Rate: 94.1 ml
Average Current:  81.0 mA
Highest Current:  91.0 mA

Lowest Battery:   35.9 V
```

VALVE COMMANDS:

HOME:

Description: The 50 port valve uses port 0 as the home reference port of the valve. The HOME command locates, and then sets the port position to the home port.

Syntax: HOME

Example:

```
>home

Seeking home port... Located. Aligning... Confirmed.
```

PORT:

Description: Display or set the valve position

Syntax: PORT

PORT [port]

Example:

```
>port

Port: 0

>port 1

Seeking port 01. located. Aligning... Confirmed.
```

DEPLOYMENT PREPARATIONS:

SET:

Description: The SET command defines deployment event procedure parameters. During a deployment event, each

procedure will be executed according to these parameters. The procedure parameters can be changed at any point during an adaptive deployment.

Note: allow the system to automatically calculate time limits by entering a value of zero. Disable acid, water or fixative by entering procedure name followed by a zero.

Syntax:

PRE-SAMPLE ACID FLUSH:

Syntax: SET PREACID [Volume] [Exposure Time]

Example: SET PREACID 10 1

PRE-SAMPLE WATER FLUSH:

Syntax: SET WATER [Volume]

Example: SET WATER 100

SAMPLE:

Syntax: SET SAMPLE [volume] [timelimit]

Example: SET SAMPLE 100 0

POST-SAMPLE ACID FLUSH:

Syntax: SET POSTACID [Volume]

Example: SET POSTACID 10

Example:

```
>set water 100

Water Flush:
Volume      [ml]      = 100
Flow rate   [ml/min]   = 100
Min. flow rate [ml/min] = 50
Time limit  [minutes] = 3

>set sample 500 0

Sample:
Volume      [ml]      = 500
Flow rate   [ml/min]   = 75
Min. flow rate [ml/min] = 50
Time limit  [minutes] = 11
```

PRINT_PARAMS:

Description: Displays the predefined procedure parameters from the SET command

Syntax: PRINT_PARAMS

Example:

```
>print_params

-----

Event Parameters
-----

Water Flush:
Volume           [ml]           = 100
Flow rate        [ml/min]        = 100
Min. flow rate   [ml/min]        = 50
Time limit       [minutes]       = 3

Sample:
Volume           [ml]           = 500
Flow rate        [ml/min]        = 75
Min. flow rate   [ml/min]        = 50
Time limit       [minutes]       = 11

Post-Sample Acid Flush:
Volume           [ml]           = 10
Flow rate        [ml/min]        = 75
Min. flow rate   [ml/min]        = 50
Time limit       [minutes]       = 1
```


ADAPTIVE DEPLOYMENT COMMANDS:

Adaptive firmware has the ability to execute an adaptive deployment made up of automated deployment events. This feature dramatically decreases the amount of commands required to execute a deployment using adaptive firmware. The commands in this section allow the user to:

- Predefine deployment event parameters.
- Start an adaptive deployment.
- Trigger the automated deployment events using the SAMPLE command.
- Offload deployment event data stored in data.
- Stop and resume a deployment.

An **Adaptive Deployment** is made up of 48 individual **events** which are made up of one to four **Procedures**.

Procedures in the order they would be executed in an adaptive deployment event:

- **Pre-Sample Acid Flush** - If pre-sample acid flush parameters are defined, the system pumps through port 49 in reverse to push antifouling solution through shared intake plumbing.
- **Water Flush** - Flushes standing fluid from shared intake plumbing prior to a sample.
- **Sample** - Mandatory event procedure that takes a sample through the next available valve position in the adaptive deployment.
- **Post-Sample Acid Flush** - If a post-sample acid flush is defined, the system pumps through port 49 in reverse to push antifouling solution through common plumbing.

The program keeps track of what valve position it sampled last in non-volatile memory. If power is removed for one reason or another, after the RAS is powered back on, the user can restart the deployment that it was running by entering the RESUME_DEPLOY command. It will continue where it left off before the power interruption.

Deployment event data is stored to RAM and non-volatile memory during the deployment, and can be viewed at any point during the deployment using the OFFLOAD and OFFLOADEEP commands. Certain commands are disabled or enabled during an adaptive deployment. This can be bypassed by stopping the deployment, executing the disabled command, then resuming the deployment, but that is not recommended and should only be done if absolutely necessary. The system does not keep track of where manual operations are pumping into. Pretend for a moment that port five is next in line in an adaptive deployment. If the user stops the deployment to manually pump into port five, the system does not record where manual pumping operations are pumping into. If the deployment is resumed after the manual pumping operation, the next event will also pump into port five. The commands that are disabled during a deployment were disabled because they could possibly cause problems during the deployment, so use them at your own risk.

START_DEPLOY:

Description: Start an adaptive deployment. Once an adaptive deployment is started, predefined deployment event procedures can be executed by simply entering the SAMPLE command.

Syntax: START_DEPLOY

Example:

```
>start_deploy

Performing 6 second low-power sleep mode test...

Erasing EEPROM entries .....

Command-line deployment started.
```

RESUME_DEPLOY:

Description: Resume an adaptive deployment from where it left off

Syntax: RESUME_DEPLOY

Example:

```
>resume_deploy

Performing 6 second low-power sleep mode test...

Resuming command-line deployment from event 32.
```

STOP_DEPLOY:

Description: Stop an adaptive deployment. Certain deployment commands will become unavailable, and some basic commands will become available again.

Syntax: STOP_DEPLOY

Example:

```
>stop_deploy

Command-line deployment ended.
```

SAMPLE:

Description: If the system is in an adaptive deployment, execute the next predefined deployment event in the deployment. Use the SET command to change sample parameters

Syntax: SAMPLE

Example:

```
>sample

04/20/2020 13:17:27 Event 6

Water Flush:
Volume           [ml]           = 100
Flow rate        [ml/min]        = 100
Min. flow rate   [ml/min]        = 50
Time limit       [minutes]       = 3

-----

FLUSHING INTAKE PORT

-----

Pump   | Hall   | Average | Volume | Flow   | Elapsed | Batt. | Pump   |
Drive  | Hz     | Hall Hz | Pumped  | Rate   | Seconds | Voltage | Current |
-----|-----|-----|-----|-----|-----|-----|-----|
1600 h | 51 I_Hz | 12 A_Hz | 0.4 ml  | 21.3 ml/min | 1 sec | 36.0 V | 61 mA
1976 h | 123 I_Hz | 43 A_Hz | 1.2 ml  | 51.4 ml/min | 2 sec | 36.0 V | 74 mA
2209 h | 166 I_Hz | 85 A_Hz | 2.4 ml  | 69.4 ml/min | 3 sec | 36.0 V | 74 mA
. . . . . Shortened . . . . .
2353 h | 191 I_Hz | 192 A_Hz | 96.2 ml | 79.9 ml/min | 65 sec | 36.0 V | 66 mA
2344 h | 190 I_Hz | 191 A_Hz | 97.5 ml | 79.4 ml/min | 66 sec | 36.0 V | 66 mA
2338 h | 189 I_Hz | 190 A_Hz | 98.8 ml | 79.0 ml/min | 67 sec | 36.0 V | 62 mA

Result:           Volume reached
Elapsed Seconds:  69
Volume:           100 ml
Lowest Flow Rate: 79.0 ml

Average Current:  70.0 mA
Highest Current:  83.0 mA
Lowest Battery:   35.9 V

Seeking port 06..... located. Aligning... Confirmed.

Sample:
Volume           [ml]           = 500
Flow rate        [ml/min]        = 75
Min. flow rate   [ml/min]        = 50
Time limit       [minutes]       = 11

-----

PUMPING SAMPLE

-----
```

Pump Drive	Hall Hz	Average Hall Hz	Volume Pumped	Flow Rate	Elapsed Seconds	Batt. Voltage	Pump Current
1600 h	51 I_Hz	12 A_Hz	0.4 ml	21.3 ml/min	1 sec	36.0 V	65 mA
1857 h	103 I_Hz	38 A_Hz	1.1 ml	43.1 ml/min	2 sec	36.0 V	65 mA
2010 h	135 I_Hz	72 A_Hz	2.0 ml	56.4 ml/min	3 sec	36.0 V	69 mA
. Shortened							
1918 h	125 I_Hz	124 A_Hz	94.4 ml	52.3 ml/min	89 sec	36.0 V	57 mA
1917 h	124 I_Hz	124 A_Hz	95.3 ml	51.8 ml/min	90 sec	36.0 V	57 mA
1918 h	125 I_Hz	124 A_Hz	96.2 ml	52.3 ml/min	91 sec	36.0 V	56 mA

Result: Min flow reached
Elapsed Seconds: 91
Volume: 96 ml
Lowest Flow Rate: 51.8 ml
Average Current: 62.0 mA
Highest Current: 76.0 mA
Lowest Battery: 35.9 V

Two minute pause to reduce pressure differential.
04/20/2020 13:20:33 Suspended until 04/20/2020 13:22:33 ... Awake

Seeking port 49..... located. Aligning... Confirmed.

Post-Sample Acid Flush:
Volume [ml] = 10
Flow rate [ml/min] = 75
Min. flow rate [ml/min] = 50
Time limit [minutes] = 1

PERFORMING ACID FLUSH

Pump Drive	Hall Hz	Average Hall Hz	Volume Pumped	Flow Rate	Elapsed Seconds	Batt. Voltage	Pump Current
1600 h	51 I_Hz	12 A_Hz	0.4 ml	21.3 ml/min	1 sec	36.0 V	56 mA
1857 h	103 I_Hz	38 A_Hz	1.1 ml	43.1 ml/min	2 sec	36.0 V	64 mA
. Shortened							
2208 h	172 I_Hz	163 A_Hz	6.6 ml	71.9 ml/min	7 sec	36.0 V	62 mA
2223 h	175 I_Hz	169 A_Hz	7.8 ml	73.2 ml/min	8 sec	36.0 V	63 mA
2232 h	176 I_Hz	172 A_Hz	9.0 ml	73.6 ml/min	9 sec	36.0 V	62 mA

Result: Volume reached
Elapsed Seconds: 10
Volume: 10 ml
Lowest Flow Rate: 75.0 ml
Lowest Battery: 35.9 V

Seeking port 01.. located. Aligning... Confirmed.

Seeking home port. Located. Aligning... Confirmed.

Event 6 completed.

04/20/2020 13:23:33 Suspended ...

SAMPLE_RESULT:

Description: Display the event data of the last sample completed

Syntax: SAMPLE_RESULT

Example:

```
>sample_result
```

Event #	Procedure	Start Time	Temp. On	Temp.
Off	Volume	Duration	Procedure	Result
6	Water Flush	04/20/2020		
13:17:28	22.5	35.9	100	69
6	Sample	04/20/2020		
13:19:00	22.6	35.9	96	91
6	Post-Sample Acid Flush	04/20/2020		
13:22:58	29.7	35.9	10	10

OFFLOAD AND RECOVERY:

OFFLOAD:

Description: Display all deployment data in memory

Syntax: OFFLOAD

Example:

```
>offload

Software version: RAS.C
Compiled:         May 28 2019 11:21:31
Electronics S/N: ML12345-01

Data start:      04/20/2020 12:12:51
Data stop:       04/22/2020 15:16:39

-----
HEADER
-----
...
...
...
-----
EVENT PARAMETERS
-----

                |Flush |Sample Time |Post-Acid
                |Vol  |Vol  Limit  |Vol

Event 1: 04/20/2020 12:12:59 |100  |500  11  |10
Event 2: 04/20/2020 12:42:33 |100  |500  11  |10
Event 3: 04/20/2020 12:51:15 |100  |500  11  |10
. . . . . Shortened . . . . .
Event 45: 04/22/2020 14:35:46 |100  |500  11  |10
Event 46: 04/22/2020 14:42:01 |100  |500  11  |10
Event 47: 04/22/2020 14:50:52 |100  |500  11  |10
Event 48: 04/22/2020 15:01:06 |100  |500  11  |10

Pump data period: 15 seconds

-----
DEPLOYMENT DATA
-----

Event  |           |Start |Internal |Battery
|Volume |           |Procedure           |

Number |Procedure |Time |Temp. |Voltage
|Pumped |Duration|Result           |

|           |           |           |           |           |           |
```

12:13:07	1 Water Flush	20.3	35.9	100	69	Volume reached	04/20/2020
12:14:26	1 Sample	20.8	35.9	96	91	Min flow reached	04/20/2020
12:18:11	1 Post-Sample Acid Flush	28.1	36.0	10	10	Volume reached	04/20/2020
12:42:34	2 Water Flush	18.8	35.9	101	69	Volume reached	04/20/2020
12:43:56	2 Sample	19.2	35.9	96	92	Min flow reached	04/20/2020
12:47:43	2 Post-Sample Acid Flush	25.0	35.9	10	10	Volume reached	04/20/2020
. Shortened							
14:50:52	47 Water Flush	23.5	35.9	100	68	Volume reached	04/22/2020
14:52:18	47 Sample	23.4	35.9	97	92	Min flow reached	04/22/2020
14:56:02	47 Post-Sample Acid Flush	30.5	36.0	10	10	Volume reached	04/22/2020
15:01:06	48 Water Flush	22.9	35.9	100	68	Volume reached	04/22/2020
15:02:29	48 Sample	23.0	35.9	97	92	Min flow reached	04/22/2020
15:06:11	48 Post-Sample Acid Flush	29.7	35.9	10	10	Volume reached	04/22/2020
PUMPING DATA							
Pump data period = 15 seconds							
[event#]	[ml/min]	[ml]	[Vbat]	[Av. Cur]	[High Cur]		
1	74.8	16.3	36.0	72	72		
1	71.5	34.6	36.0	72	72		
1	64.8	51.5	36.0	71	71		
1	61.0	67.2	36.0	70	70		
1	55.2	81.8	36.0	69	69		
1	51.8	95.2	36.0	67	67		
. Shortened							
48	74.8	16.6	36.0	60	60		
48	71.1	34.9	36.0	59	59		
48	64.8	51.8	36.0	58	58		
48	61.0	67.5	36.0	57	57		
48	55.2	82.0	36.0	56	56		
48	52.3	95.4	36.0	54	54		

OFFLOAD_EEP:

Description: During a deployment, a summarized version (sample procedure results only) of the deployment event data is stored to non-volatile EEPROM in case of power cycle before offload. OFFLOAD_EEP displays this data.

Syntax: OFFLOAD_EEP

Example:

```
>offload_eep

-----
Event Summary
-----

Event:                1
Result:               Min flow reached
Start time:           04/20/2020 12:13:06
Volume pumped:        96 ml
Duration:              91 sec
Lowest battery:       35.9 mA
Average current:      67.0 mA
Highest current:      79.0 mA
Duration:              91

Event:                2
Result:               Min flow reached
Start time:           04/20/2020 12:42:33
Volume pumped:        96 ml
Duration:              92 sec
Lowest battery:       35.9 mA
Average current:      62.0 mA
Highest current:      73.0 mA
Duration:              92

Event:                3
Result:               Min flow reached
Start time:           04/20/2020 12:51:15
Volume pumped:        96 ml
Duration:              91 sec
Lowest battery:       35.9 mA
Average current:      59.0 mA
Highest current:      70.0 mA
Duration:              91
. . . . . Shortened . . . . .

Event:                47
Result:               Min flow reached
Start time:           04/22/2020 14:50:52
Volume pumped:        97 ml
Duration:              92 sec
Lowest battery:       35.9 mA
Average current:      55.0 mA
Highest current:      69.0 mA
Duration:              92
```



```

Event:          48
Result:         Min flow reached
Start time:     04/22/2020 15:01:06
Volume pumped: 97 ml
Duration:       92 sec
Lowest battery: 35.9 mA
Average current: 54.0 mA
Highest current: 65.0 mA
Duration:       92

```

End of EEPROM event backup cache.

Terminate file logging operation now
and press any key to continue.

SYSTEM_FLUSH:

Description: Automatically flush lines of the RAS. Follow system flush procedure in the manual.

Syntax: SYSTEMFLUSH [Time (2 - 120 seconds)]

Example:

```
>system_flush 10
```

Seeking home port.. Located. Aligning... Confirmed.

Already aligned to home port.

Flushing port 0

Pump Drive	Hall Hz	Average Hall Hz	Volume Pumped	Flow Rate	Elapsed Seconds	Batt. Voltage	Pump Current
1600 h	46 I_Hz	11 A_Hz	0.3 ml	19.2 ml/min	1 sec	36.0 V	86 mA
2106 h	139 I_Hz	46 A_Hz	1.3 ml	58.1 ml/min	2 sec	36.0 V	92 mA
2426 h	186 I_Hz	92 A_Hz	2.6 ml	77.8 ml/min	3 sec	36.0 V	95 mA
2653 h	212 I_Hz	145 A_Hz	4.1 ml	88.6 ml/min	4 sec	36.0 V	94 mA
2827 h	226 I_Hz	190 A_Hz	5.6 ml	94.5 ml/min	5 sec	36.0 V	97 mA
2974 h	239 I_Hz	215 A_Hz	7.3 ml	99.9 ml/min	6 sec	35.9 V	90 mA
3094 h	245 I_Hz	230 A_Hz	9.0 ml	102.4 ml/min	7 sec	36.4 V	97 mA
3203 h	252 I_Hz	240 A_Hz	10.8 ml	105.4 ml/min	8 sec	35.6 V	102 mA
3297 h	267 I_Hz	250 A_Hz	12.6 ml	111.6 ml/min	9 sec	35.7 V	95 mA
3362 h	270 I_Hz	258 A_Hz	14.5 ml	112.9 ml/min	10 sec	35.2 V	98 mA

```

Result:          Time limit reached
Elapsed Seconds: 11
Volume:          15 ml
Lowest Flow Rate: 125.0 ml
Average Current: 94.0 mA
Highest Current: 98.0 mA
Lowest Battery:  35.2 V

```

Seeking port 01. located. Aligning... Confirmed.

Flushing port 1

Pump Drive	Hall Hz	Average Hall Hz	Volume Pumped	Flow Rate	Elapsed Seconds	Batt. Voltage	Pump Current
1600 h	48 I_Hz	12 A_Hz	0.3 ml	20.1 ml/min	1 sec	36.0 V	77 mA
2102 h	139 I_Hz	46 A_Hz	1.3 ml	58.1 ml/min	2 sec	36.0 V	84 mA
2422 h	188 I_Hz	93 A_Hz	2.6 ml	78.6 ml/min	3 sec	36.0 V	86 mA
2645 h	211 I_Hz	146 A_Hz	4.1 ml	88.2 ml/min	4 sec	36.0 V	88 mA
2821 h	227 I_Hz	191 A_Hz	5.7 ml	94.9 ml/min	5 sec	35.9 V	91 mA
2966 h	239 I_Hz	216 A_Hz	7.3 ml	99.9 ml/min	6 sec	36.0 V	89 mA
3086 h	245 I_Hz	230 A_Hz	9.0 ml	102.4 ml/min	7 sec	35.5 V	94 mA
3195 h	252 I_Hz	240 A_Hz	10.8 ml	105.4 ml/min	8 sec	36.5 V	94 mA
3289 h	265 I_Hz	250 A_Hz	12.6 ml	110.8 ml/min	9 sec	36.4 V	90 mA
3358 h	270 I_Hz	258 A_Hz	14.5 ml	112.9 ml/min	10 sec	36.4 V	94 mA

Result: Time limit reached
Elapsed Seconds: 11
Volume: 15 ml
Lowest Flow Rate: 125.0 ml
Average Current: 88.0 mA
Highest Current: 94.0 mA
Lowest Battery: 35.5 V

FIXATIVE COMMANDS

APPLY_FIXATIVE:

Description: Execute a fixative flush on the specified port. Use SET to specify volume.

Syntax: APPLY_FIXATIVE [port]

Example:

```
>apply_fixative 2
```

Seeking port 02. located. Aligning... Confirmed.

Fixative valve position: FIXATIVE

APPLYING FIXATIVE

Pump Drive	Hall Hz	Average Hall Hz	Volume Pumped	Flow Rate	Elapsed Seconds	Batt. Voltage	Pump Current
1600 h	54 I_Hz	13 A_Hz	0.4 ml	22.6 ml/min	1 sec	36.0 V	52 mA
1851 h	107 I_Hz	40 A_Hz	1.1 ml	44.7 ml/min	2 sec	36.0 V	58 mA
1996 h	139 I_Hz	75 A_Hz	2.1 ml	58.1 ml/min	3 sec	36.0 V	63 mA
. Shortened							
2087 h	161 I_Hz	160 A_Hz	47.5 ml	67.3 ml/min	41 sec	36.0 V	58 mA
2071 h	158 I_Hz	160 A_Hz	48.6 ml	66.1 ml/min	42 sec	36.0 V	61 mA
2062 h	156 I_Hz	159 A_Hz	49.6 ml	65.2 ml/min	43 sec	36.0 V	50 mA

Result: Volume reached
Elapsed Seconds: 44
Volume: 50 ml
Lowest Flow Rate: 65.2 ml
Average Current: 57.0 mA
Highest Current: 64.0 mA

```
Lowest Battery:      35.9 V
```

```
30 second pause to reduce pressure differential.
```

```
Fixative valve position: WATER
```

FIXATIVE_VALVE:

Description: Change fixative valve position from water [OFF] to fixative position [ON]

Syntax: FIXATIVE_VALVE [ON|OFF]

Example:

```
>fixative_valve on
```

```
Fixative valve position: FIXATIVE
```

FIXATIVE_AVAILABLE:

Description: Show or adjust the available amount of fixative.

Syntax: FIXATIVE_AVAILABLE [Volume]

Example:

```
>fixative_available
```

```
Fixative Available = 97.35
```

BACKUP SAMPLING, STATUS, TEMPERATURE INTERVAL (RBR Sensor) (Firmware Version 3_12 and Greater)

BACKUP SAMPLING COMMANDS:

Backup_Interval (with no arguments)

Description: Echo back the current state of the backup interval feature.

Syntax: BACKUP_INTERVAL

Example:

```
06/15/2021 14:40:47 RAS 12345-01>backup_interval

Status: Enabled
Backup_Interval: 15 Days 0 Hours 0 Minutes
Backup_Interval Alarm Time: 07/15/2021 14:40:18
Time Until Backup Interval Alarm: 29 Days 23 Hours 58 Minutes"
```

Notice that if the feature is disabled, the Backup_Interval Alarm Time and Time Until Backup Interval Alarm fields are set to all zeroes. The default backup interval is currently set to 15 days, but is fully configurable from the command line, from a maximum of 365 days to a minimum of 1 hour.

Backup_Interval Enable

Description: Enables the feature if currently disabled. Backup_Interval Alarm Time will be calculated as Now + The Backup_Interval. If the feature was previously enabled, this command will have no effect.

Syntax: BACKUP_INTERVAL ENABLE

Example:

```
06/15/2021 14:41:27 RAS 12345-01>backup_interval enable

Status: Enabled
Backup_Interval: 15 Days 0 Hours 0 Minutes
Backup_Interval Alarm Time: 07/15/2021 14:40:18
Time Until Backup Interval Alarm: 29 Days 23 Hours 58 Minutes"
```

Backup_Interval Disable

Description: Turns the backup_interval feature off.

Syntax: BACKUP_INTERVAL DISABLE

Example:

```
06/15/2021 14:41:55 RAS 12345-01>backup_interval disable

Status: Disabled
Backup_Interval: 15 Days 0 Hours 0 Minutes
Backup_Interval Alarm Time: 00/00/0000 00:00:00
Time Until Backup Interval Alarm: 000 Days 00 Hours 00 Minutes"
```

Set Backup Interval [Days] [Hours] [Minutes]

Description: Sets the backup interval period. It does not enable or disable the feature. It does not update the alarm time for the backup interval alarm.

Days - Whole number 0 - 365

Hours - Whole number 0 - 24

Minutes - Whole number 0 - 60

All 3 arguments are required.

Syntax: SET BACKUP_INTERVAL [DAYS] [HOURS] [MINUTES]

Example:

```
06/15/2021 14:42:28 RAS 12345-01>set backup_interval 7 0 0
Status: Disabled
Backup_Interval: 7 Days 0 Hours 0 Minutes
Backup_Interval Alarm Time: 00/00/0000 00:00:00
Time Until Backup Interval Alarm: 000 Days 00 Hours 00 Minutes"
```

Backup Interval Extend (No arguments)

Description: Calculates a new alarm time for the backup interval feature as Now + The stored backup_interval period. This command will not enable or disable the feature.

Syntax: BACKUP_INTERVAL EXTEND

Example:

```
06/15/2021 14:42:45 RAS 12345-01>backup_interval extend
Status: Disabled
Backup_Interval: 7 Days 0 Hours 0 Minutes
Backup_Interval Alarm Time: 00/00/0000 00:00:00
Time Until Backup Interval Alarm: 000 Days 00 Hours 00 Minutes"
```

Backup Interval Extend [Days] [Hours] [Minutes]

Description: Calculates a new alarm time for the backup interval feature as Now + the period passed in the command line arguments. This command will not enable or disable the feature.

The arguments passed in the command line will NOT be stored. This command enables a on off alarm time update without affecting the stored backup_interval period.

Days - Whole number 0 - 365

Hours - Whole number 0 - 24

Minutes - Whole number 0 - 60

All 3 arguments are required.

Syntax: BACKUP_INTERVAL EXTEND [DAYS] [HOURS] [MINUTES]

Example:

```
06/15/2021 14:42:45 RAS 12345-01>backup_interval extend
Status: Disabled
Backup_Interval: 7 Days 0 Hours 0 Minutes
Backup_Interval Alarm Time: 00/00/0000 00:00:00
Time Until Backup Interval Alarm: 000 Days 00 Hours 00 Minutes"
```

STATUS_DEPLOY

Indicates whether or not the system is in deployment. If the system is deployed, the last event number and the max event numbers will be displayed.

Syntax: STATUS_DEPLOY

Example:

```
06/15/2021 14:44:12 RAS 12345-01>status_deploy  
  
Deployment: ACTIVE  
Last Event: 1  
Max Events: 48
```

TEMPERATURE_INTERVAL (for RBR sensor)

Sets maximum and minimum sampling intervals for RBR temperature samples. Maximum is 365 days, minimum is 1 minute. The default RBR temperature recording interval is 6 hours.

Setting an interval of 0 0 0 turns off RBR temperature logging when the firmware is asleep.

Syntax: TEMPERATURE_INTERVAL [DAYS] [HOURS] [MINUTES]

Example:

```
06/15/2021 14:46:22 RAS 12345-01>temperature_interval 0 0 0  
  
Temperature interval:  
Days: 0  
Hours: 0  
Minutes: 0  
  
06/15/2021 14:45:39 RAS 12345-01>temperature_interval 999 999 999  
  
Temperature interval:  
Days: 365  
Hours: 0  
Minutes: 0
```

Appendix B

Training Videos

There are priming, drop-in battery replacement, and o-ring replacement training videos available for the RAS. These videos are 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.

Video	Content
Battery Replacement with Drop-in Battery Holder	Provides the steps to install customer replaceable alkaline batteries
RAS Pre-deployment and Priming	Illustrates a sample of the PPS priming step that clears lines and valve ports of trapped air. For the complete and most up to date priming procedure, refer to the RAS User Manual.
Replacing O-Rings	The instructional video "Replacing O-Rings" provides the steps to clean and install o-rings. See the instrument User Manual for details of o-ring specifications.

Notes

Appendix C

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 C- 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.

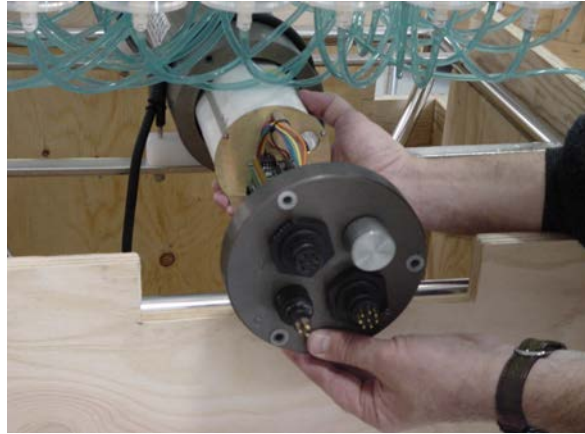


Figure C-2: Controller Housing Notch in Stand

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



Figure C-3: Remove Controller Housing through Notch in Stand