

AQ400 Discrete Multi- Chemistry Analyzer

Operation Manual

Publication No.: SA-AQ400-0003
Revision: 3
Date: January 2019

Read the instructions in this manual carefully before installing or starting the system. SEAL Analytical can accept no liability for damages due to non-observance of this manual.

Read the software license agreement in the Appendix of the software manual before you open the software package.

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1 Introduction

1.1 Overview

This manual provides information and instructions about using the SEAL Analytical AQ400 Discrete Multi-Chemistry Analyzer. We assume the reader to have a basic knowledge of chemistry and laboratory procedures.



**Read this manual carefully before installing or starting the system.
Always keep the manual near the system.**

The manual is divided into the following sections:

Section 1	Introduction
Section 2	Replacement Procedures
Section 3	Troubleshooting
Section 4	Parts Listing
Section 5	SEAL Contact

SEAL Analytical is committed to providing our customers with a high degree of after-sale support to ensure your complete satisfaction with our products and services.

SEAL has an international network of support centers and authorized service partners. Please visit our website www.seal-analytical.com to find the one nearest to you if you have any problems or questions. See Section 5 – SEAL Contact for location information.

1.2 Conventions used in this Manual

The following conventions are used:

Bold type	Field labels, e.g. Statistics
<i>Bold + italic type</i>	Buttons and menu options you can select e.g. <i>Maintenance and Setup</i> . Terms like <i>Maintenance and Setup – Tests</i> means that you should select <i>Maintenance and Setup</i> from the Main Menu and then select <i>Tests</i> from the options.
Typewriter text	File or directory names and text to be entered via the keyboard, e.g. c:\AQ

The following symbols are used:



Caution:

Is used in cases where damage to personel or equipment, including data may occure.



Note:

Indicates notes and additional information useful for the operation of the software and/or the analyzer.

For closing a window or leaving a program you have the following options:

OK	To save the entered data or to carry out a command and close the window / screen
Cancel	To close the window / dialog box <u>without</u> saving or <u>without</u> carrying out a command

1.3 General Description

The AQ400 is a computer-controlled, multi-chemistry discrete analyzer.

The system is composed of a compact benchtop chemistry unit and an external PC.

All functions of the AQ400 are controlled from the PC and data handling type functions such as scheduling, reporting, and quality control are permitted without halting the instrument.

Features of the instrument include reagent cooling and reagent level detection.

Main components of the AQ400:

REAGENT COMPARTMENTS:

- Total of 26 position for reagent containers (43 mL).
 - o 20 positions cooled
 - o 6 positions at room temperature

SAMPLING STATION

- 1000 µL syringe
- Sample probe
- Flow-through probe wash assembly
- Reagent level detector (inductive-capacitive) with software adjustment and warning.

SAMPLING STATION

- Two possible configurations:
 - o 80 position tray with 60 – 2 mL sample cups and 20 – 5 mL high volume sample / standard locations
 - o 120 position tray with 100 – 1.2 mL sample cups and 20 – 2 mL high volume sample / standard locations
- All sample trays are removable for remote sample loading while the analyzer is running.

REACTION CAROUSEL

- A heated temperature controlled ring around the sample tray.
- 216 reaction wells positioned in two concentric rings of 108 wells each.
- Grouped in 12 disposable segments of 18 positions each.
- Controlled incubation at 37°C.

ASPIRATOR

- A robotic arm with probe to aspirate reaction mixture, driven by a peristaltic pump.
- Separate washing well with peristaltic pump filling system.
- Separate waste removal via peristaltic pump to pull particulates from bath.

PHOTOMETER

- Quartz-tungsten-halogen lamp light source – driven at 5.5 VDC.
- 10 position filter wheel with 9 user selectable (405 nm – 880 nm) filters
 - o 9 interference filters
 - o 1 blank position
- Flow-through high optical quality cuvette (10 mm path X 50 µL volume)
- Separate Photodiode PC Board for maximum signal to noise ratio.

1.3.1 AQ400 – Main System Components

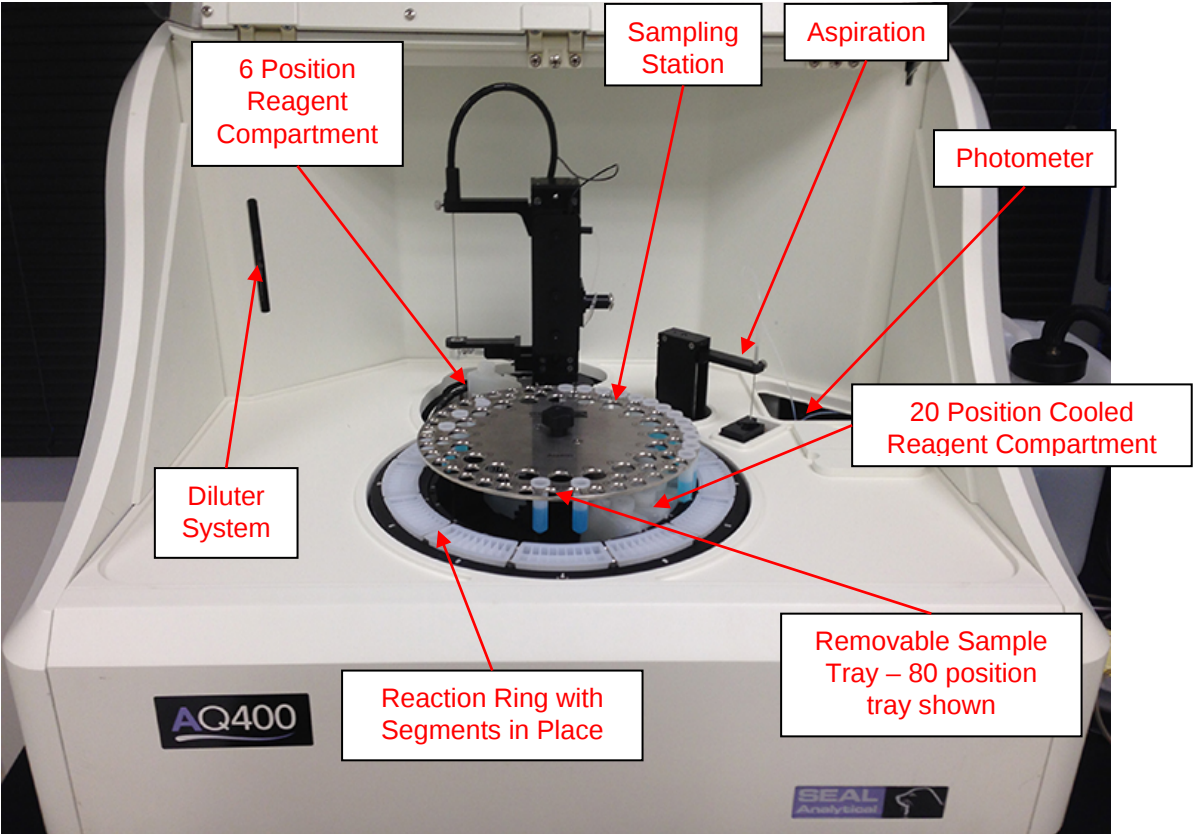


Fig. 1.1: AQ400 Main System Components

1.4 Principle of Operation

The system is a discrete automated wet chemistry analyzer.

Sample and reagent pickup and dispense is by means of a diluter system comprising a 1000 µL displacement-type syringe, 3-way valve, stainless steel sampling probe and associated tubing. The entire system is fluid-filled with the analyzer's deionized water. It is designed so that sample and/or reagent are never drawn into contact with the syringe and valve.

During the sampling cycle, the sample probe first draws reagent into Teflon™ tubing located on the top of the Sampling Arm, after which the probe descends into the sample cup, collecting the sample. When activated, the level detection system operates to check reagent volumes at the beginning of a run.

There are air gaps between system water and reagent, reagent and sample, and after the sample to avoid any contamination from previous aspirations. The sampler probe also has its own cleaning device which operates during the sampling cycle to eliminate any possible cross-contamination. Reagent and sample are then dispensed, with mixing, into a reaction well which is heated at 37°C to ensure stable reaction conditions irrespective of fluctuating ambient conditions.

A maximum of four reagents may be added to a sample at times programmed by the user. The sample and reagent(s) are mixed in the reaction well by repeated solution pick-up and dispense, also programmed by test.

Once the reaction time is complete, the reaction mixture is aspirated into the cuvette by means of a peristaltic pump, where the appropriate filter is selected and absorbance readings are taken. The cuvette is comprehensively washed between aspirations to minimize carryover. The absorbance data is then used to calculate the final result based on the calibration data.

Results may be printed using a customized report format in HTML format and/or transmitted to a host computer in tabular format as Comma-Separated Values (.csv) files.

1.5 Technical Specification

Power requirements	100 - 240 VAC 50/60 Hz Self-Selecting
Power consumption	2.5 Amps
Dimensions	W 27 in (69.5 cm) x H 22 in (54 cm) x D 20.25 in (61.5 cm)
Weight	95 lbs (43 kg)
Regulatory	CE Marked Conforms to UL and CSA C22.2 – 61010-1
Technology	Discrete colorimetric
Tests per hour	up to 150 tests per hour
Reagents	26 Total: 20 x 43 mL Cooled and 6 x 43 mL room temperature
Reagent volume	10 – 600 uL
Reagents per test	Up to 4 per test
Typical reagent volume/test	300 – 400 uL
Sample volumes	3 – 500 uL
Sample capacity	Removable tray of 80 60 - 2 mL and 20 - 5 mL (standard tray) Removable tray of 120 100 - 1.2 mL and 20 - 2 mL is also available
Reagent level Detection	Capacitance level detection
Lamp Control	Software control with End of Run feature
Reaction Heating	Software controlled with 4 levels of heating – Operator notification
Sample pre-dilution	Yes –programmable
Auto post-run dilution	Yes -for off-scale samples
Mixing	Software programmable – Aspirate / Dispense
Nitrate Reduction Coil (optional)	Automated conditioning - in-line – Nitrate reduction coil
Software	
Assay methods	Endpoint, Sample Blank, Turbidimetric
Calibration	Linear & up to 6 order polynomials using multi-standards (max = 20)
Raw data	Stored for calibration, QC, Sample data
Math Package	Calculated Test, Spike recovery calculation, Percent recovery calculation, Percent RPD calculation
Quality Control	Programmable or Manual Scheduling - Editable
OPTICS	
Cuvette	10 mm path, 50 uL volume Optional 20mm path
Direct Read	15 mm, 24 mm and 28 mm read path
Optical system	Multi-filter – 10 selectable Filter Locations
	Standard: Dark, 405, 450, 480, 505, 520, 546, 578, 660, 880 nm, other options available
Bandwidth	8 – 10 nm bandwidth at 1/2 maximum transmittance
Light source	Quartz tungsten-halogen 10 Watt – approx. 2000 hours lamp life
Detector	Silicon photodiode
Absorbance range	0-2.5 OD
Resolution	0.0001 Abs
COMPUTER	
	Intel Core I5 or above, 4 MB RAM, 40 GB Hard disk, 2 open USB Ports, Keyboard, Mouse
Operating System	Windows 7, Windows 8, and Windows 10
Interface	Bi-Directional to LIMS / Windows-NT connectivity

1.6 Warranty

SEAL warrants that analyzers sold shall be free of any defect in material or workmanship, provided that this warranty shall apply only to defects which become apparent within one year from the date of delivery of the new analyzer to the purchaser.

SEAL shall replace or repair any such defective item at no charge, except for transportation expenses to the point of repair.

In the event of any design fault occurring with the product, the Company will rectify the problem either by on-site repair or by product recall.

This warranty excludes SEAL from liability to replace any item considered as expendable in the normal course of usage, e.g. lamps, valves, syringes, fuses, diskettes, tubing, etc.

SEAL shall be relieved of any liability under this warranty if the product is not used in accordance with the manufacturer's instructions, not regularly maintained or used with equipment not approved by SEAL or used for purposes for which it was not designed.

SEAL shall be relieved of any obligation under this warranty, unless:

- A completed installation/warranty registration form is received by SEAL within 15 days of installation of this product.
- The Buyer, within the applicable period of time, returns the defective product or part thereof, freight pre-paid at Buyers expense, to SEAL.

This warranty does not apply to damages incurred in shipment of goods. Any damage so incurred shall be reported to the freight carrier for settlement or claim.

Damage from electrical surges or other outside electrical issues are not covered under the warranty. SEAL highly recommends that the analyzer be plugged into a surge protector or uninterrupted power supply.

The afore-going notwithstanding, in no case shall SEAL be liable for incidental or consequential damages arising from the sale of the AQ400 analyzer, software or consumables.

1.7 Operating hazards and precaution



Read the Operator's Handbook before setting up or operating the AQ400 analyzer. Observe all Warnings and Notes in this manual.

Lire le manuel de l'utilisateur avant d'installer ou d'utiliser l'analyseur de AQ400. Respectez tous les avertissements et les notes dans ce manuel.



Caution: Do NOT block access to AQ400 Power On / Off Switch

Attention: Ne pas bloquer l'accès à AQ400 Power On / Off



All covers must be in place before operation of the AQ400

Tous les couvercles doivent être en place avant l'opération de l'AQ400



Caution: The AQ400 weighs 95 lbs (43 kg) two people required for lifting

Attention: Le AQ400 pèse 95 lbs (43 kg) deux personnes requises pour soulever



Caution: Moving Parts - Close Front Shield Before Operation

Attention: Pices Mobiles Fermez Bouclier avant l'operation



Instrument power must be OFF before replacing electronic parts or cables.

Puissance de l'instrument doit être OFF avant de remplacer les composants électroniques ou des câbles



Do NOT use any chemical not specifically called for in the SEAL Analytical Methods

Ne utilisez aucun produit chimique ne sont pas spécifiquement demandé dans les méthodes d'analyse SEAL



Waste collected MUST be disposed of in accordance with local regulations

Déchets collectés doivent être éliminés conformément à la réglementation locale



Warning: For continued protection against Shock Hazard plug directly into a properly grounded 3 prong receptical

Avertissement: Pour continue protection contre Risque de choc brancher directement dans une prise correctement mise receptical 3 broches.



Warning: Replace fuses with 1.6A SB / 250VAC rated Fuse only

Attenzione: sostituire i fusibili con fusibili 1.6A SB / 250VAC nominale



Caution: Moving Parts when entering the Maintenance Mode

Attention : Moving Parts en entrant dans le mode Maintenance

1.8 Unpacking / Installation

Shipping and packing materials have been selected to provide maximum protection during transportation, under normal handling conditions.

Examine the shipping cartons for indications of damage, e.g. crushed or indented walls, holes or gouges, water damage, etc. Have the carrier note any such damage on the delivery receipt; this will simplify formulating a claim if any part of the analyzer is damaged.

It is recommended **that two people help with the removal of the instrument from its crate.**

Installation Requirements

The AQ400 analyzer will be installed by qualified SEAL personnel. Several items must be considered prior to the delivery and installation of your system. These include the location of the equipment, environmental conditions, power, and water. SEAL requests that you familiarize yourself with the following requirements in an effort to ensure many years of reliable instrument performance.

Weight & Dimensional Specification

The analyzer and its accessories are designed to be placed on a standard laboratory bench.

The dimensions are as follows:

AQ400 – Chemistry Unit	W 27 in (69.5 cm) x H 22 in (54 cm) x D 20.25 in (61.5 cm)
	Weight 95 lbs (43 kg)
PC with Monitor	Standard Desktop PC with Windows® 7 / 8 or higher
Laser Printer	Standard Laser Printer



Caution: The AQ400 weighs 95 lbs (43 kg) two people required for lifting

Attention: Le AQ400 pèse 95 lbs (43 kg) deux personnes requises pour soulever

Operating Environment

The AQ400 is designed to operate in a laboratory at room temperature in the range 15-32 °C (59-90 °F). Relative humidity: 5-70% (non-condensing)

Water/Waste Requirements

The analyzer is supplied with two 5-liter containers; one is used for DI Water, the other for the collection of waste. The RED waste line (from the Cuvette) can be segregated to minimize generation of hazardous waste. The BLACK waste lines (Rinse water from Aspiration and Probe Wash) could be directed to the nearby sink if local regulations permit. Typical water usage is 4 litres of Reagent Grade Deionized Water, DO NOT USE TAP WATER.



Waste collected **MUST** be disposed of in accordance with local regulations

Déchets collectés doivent être éliminés conformément à la réglementation locale

Electrical Power Requirements

The AQ400 operates on 100 – 240 VAC 50/60 Hz. Self selecting.



Warning: For continued protection against Shock Hazard plug directly into a properly grounded 3 prong receptical

Avertissement: Pour continue protection contre Risque de choc brancher directement dans une prise correctement mise receptical 3 broches



Caution: Do NOT block access to AQ400 Power On / Off Switch

Attention: Ne pas bloquer l'accès à AQ400 Power On / Off

1.9 Periodic operator maintenance

****SEE THE CUSTOMER SUPPORT MANUAL FOR ADDITIONAL INFORMATION**

1.9.1 Daily

1. Ensure fresh water is filled in the Wash Water Container
2. Check Syringe Operation. **Prime** the syringe 5 times and ensure that it moves smoothly with no bubbles in the barrel.
3. Check **Cuvette Aspiration** and adjust as necessary – see section 2.5 of this handbook for more information.
4. Check function of aspiration wash bath. Do 1-5 **Auto Washes** and confirm that the wash bath is filling and draining.
5. Check the operation of the probe wash assembly. Confirm proper flow and check for contamination and/or leaking/dripping. Clean or replace as necessary – see section 2.8 of this handbook for further details.
6. Run **Daily Start-Up** and compare **Water Baselines**.
7. Clean the cuvette with SEAL Cuvette Cleaning Solution using the **Extra Wash** function from the Maintenance screen – see Software Manual for further details.
8. If running nitrate via cadmium reduction, regenerate as necessary. See section 2.12 for more details.
9. Ensure at the end of the day the waste container is emptied.

1.9.2 Weekly

1. If phosphates, silicates or sulfates are being analyzed on the AQ400, clean the cuvette with alkaline EDTA solution (2% NaOH and 1% EDTA (w/v)) using the **Extra Wash** function in the Maintenance screen – see Software Manual for further details.
2. Check the peristaltic pump tubing for damage. Replace as necessary – see section 2.5 of this handbook for further details.
3. Check cuvette aspiration tubing and waste tubing for kinks, damage, or blockages. Replace as necessary.
4. Check that the waste pump functions correctly (i.e. operates to empty sampler wash well and to pull water through the probe wash assembly).
5. Using a swab, clean the walls of the inner and outer sections of the sampler wash bath and aspiration wash bath.
6. Inspect the sample probe and aspiration probe for cleanliness, leaking, dripping, or damage. Clean, adjust, or replace as necessary – see section 2.6 and 2.11 of this handbook for further details.
7. Optional: Regenerate and reactivate the cadmium coil, if in use. Dependant on usage, this may be required more or less frequently than weekly – see section of this handbook for further details. You can also request additional information from SEAL Technical Support.

1.9.3 Monthly

1. Replace pump tubes and check **Cuvette Aspiration** – see section 2.5, of this handbook for further details.
2. Back-up software files – from the AQ400 directory on the PC's hard drive, copy the Data folder. SEAL also recommends that customers zip the entire AQ400 directory every three months and save the files. When creating the WinZip® archive, please tick the following boxes under Folders: Include subfolders and Save full path info.
3. Inspect the cadmium coil connector sleeving and replace as necessary – see section 2.12 of this handbook for further details.
4. Remove and wash the air fan filter near the cuvette – see section 2.14 of this handbook for further details.
5. To avoid bacterial growth, SEAL recommends cleaning the DI water reservoir with a 2% bleach solution. Be sure to fully rinse the container after the bleach and prior to using on the instrument.
6. SEAL also recommends running and recording the results of an MD test. See Customer Support Manual for more details or request additional information from SEAL Technical Support.

1.9.4 6 Month

1. Replace the probe wash assembly and check the sample probe – see sections 2.6, 2.8, and 2.9 of this handbook for further details.
2. Replace the syringe barrel, piston and 'O' ring. Clean and lubricate the syringe screw drive – see section 2.10 of this handbook for more information.
3. Replace the lamp – see section 2.2 of this handbook for further details.
4. Inspect aspiration inlet/outlet tubing and waste tubing for kinks, damage, or blockages. Replace as necessary.
5. Inspect aspiration probe and sample probe for bends, damage, or blockages. Replace as necessary.
6. Inspect and replace reagent containers and caps as needed.

2 Replacement Procedures

2.1 Removal of Main Cosmetic Covers

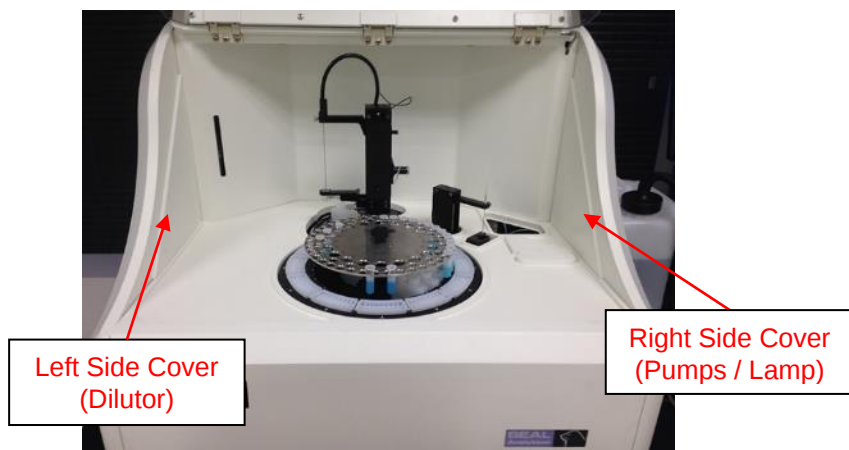


Fig. 2.1: AQ400 Covers

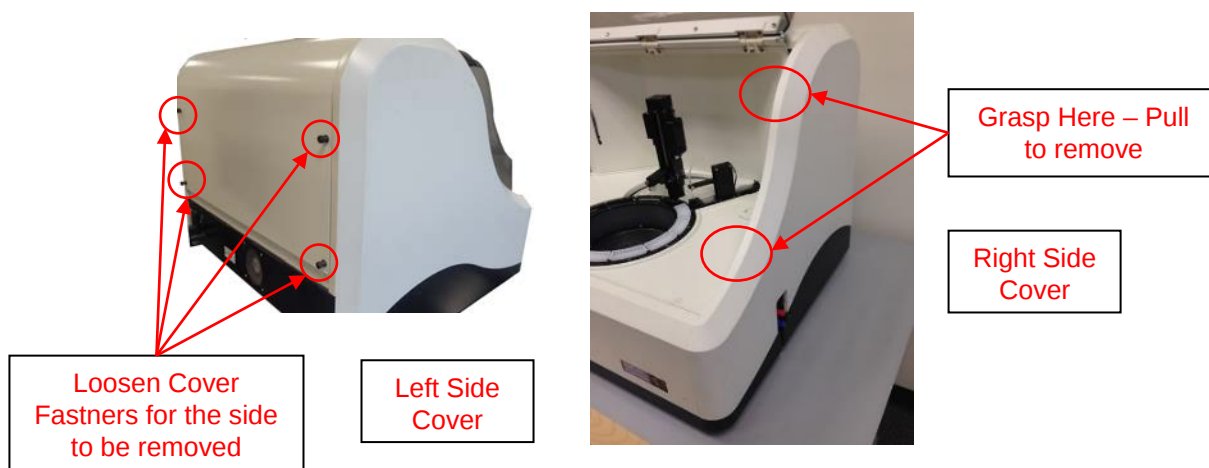


Fig. 2.2: Side Cover Removal



NOTE: Side and front covers are held in place with "Ball - Studs" for easy removal and replacement.



All covers must be in place before operating the AQ400
Tous les couvercles doivent être en place avant l'opération de l'AQ400



Caution: Moving Parts when entering the Maintenance Mode
Attention : Moving Parts en entrant dans le mode Maintenance

2.2 Lamp Replacement



Instrument power must be OFF before replacing the lamp.

Puissance de l'instrument doit être OFF avant de remplacer la lampe.

1. Power off the instrument at the main power switch on the rear of the analyzer.



Fig. 2.3: Main Power On/Off Switch

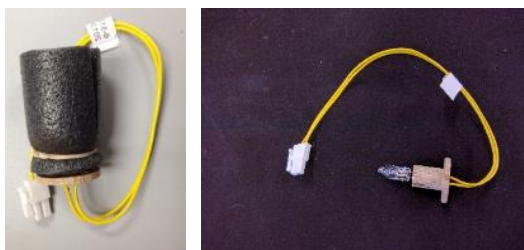


Fig. 2.4: Lamp

2. Remove the Right Side Cover
3. Disconnect the lamp cable from the socket located near the cooling fan.

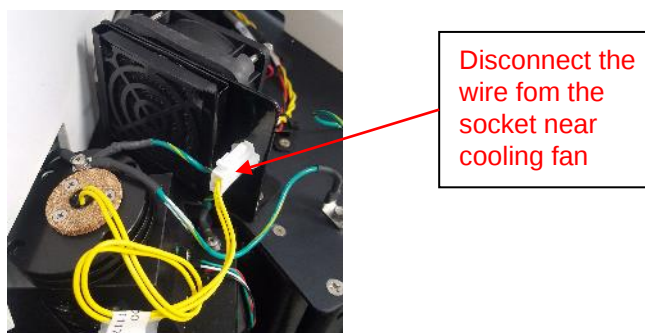


Fig. 2.5: Lamp Cable

4. Remove the 3 screws (M3X6 FHMS) holding the lamp in place.

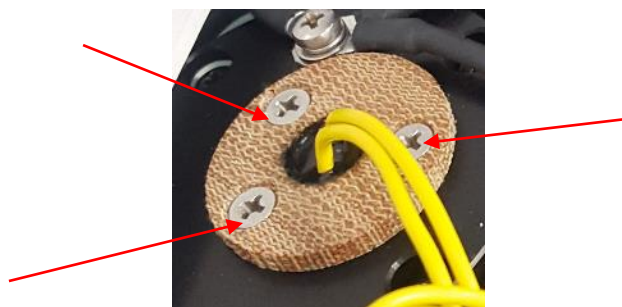


Fig. 2.6: Installed Lamp

5. Remove the old lamp.
6. Inspect the new lamp filament, which should be intact and tightly wound.

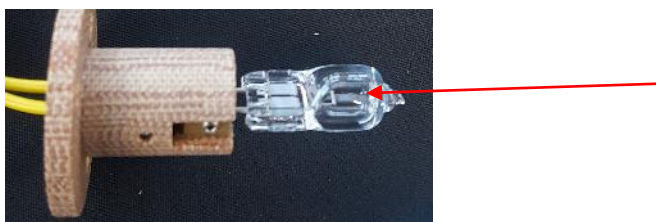


Fig. 2.7: Lamp Filament



Caution:

Avoid touching the quartz envelope around the filament as skin excretions will burn into the quartz and change the characteristics of the emitted light.

7. Install in reverse order.
Because of the positioning of the 3 screws the lamp can only be installed in the correct rotation and there is no physical alignment needed.
8. Having installed a new lamp the **Water Baselines** must now be performed.

2.3 Spectro (Water Baselines – On AQ400s with Serial Numbers >241xxx)

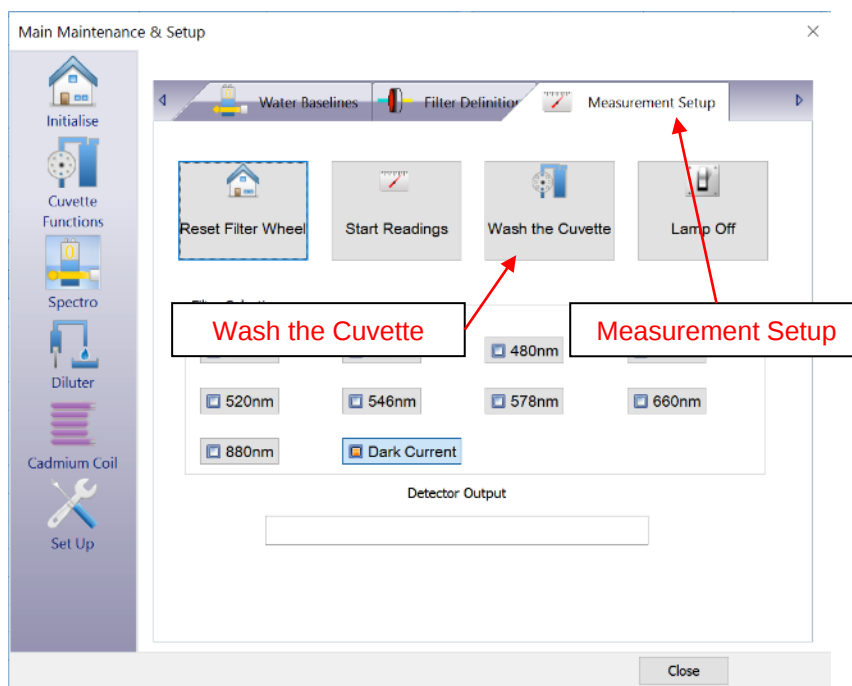
The **Water Baseline** procedure must be performed after replacing the lamp, after replacing any other measurement system component, and if indicated by Water Baselines being out of limit. If running an AQ400 with an adjustable gain – please see section 2.4.

1. From the **Maintenance** menu select the **Spectro** icon

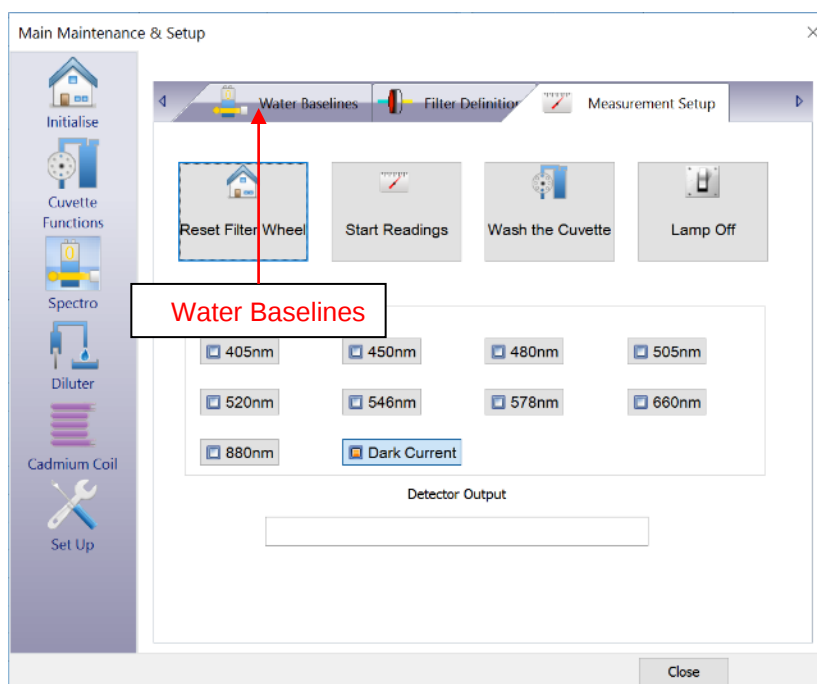


Spectro Icon

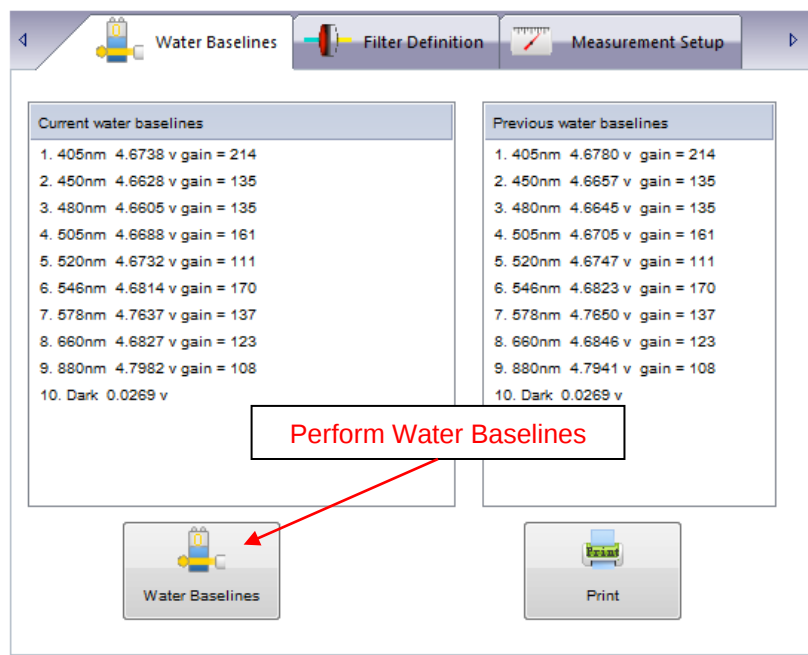
2. Select the **Measurement Setup** tab and then hit the **Wash the Cuvette** icon. This will flush the cuvette and fill it with fresh water. This should be performed three times before taking readings.



3. Navigate to the **Water Baselines** tab.



4. Perform Water Baselines by selecting the **Water Baselines** icon and from the **Current Water Baselines**.

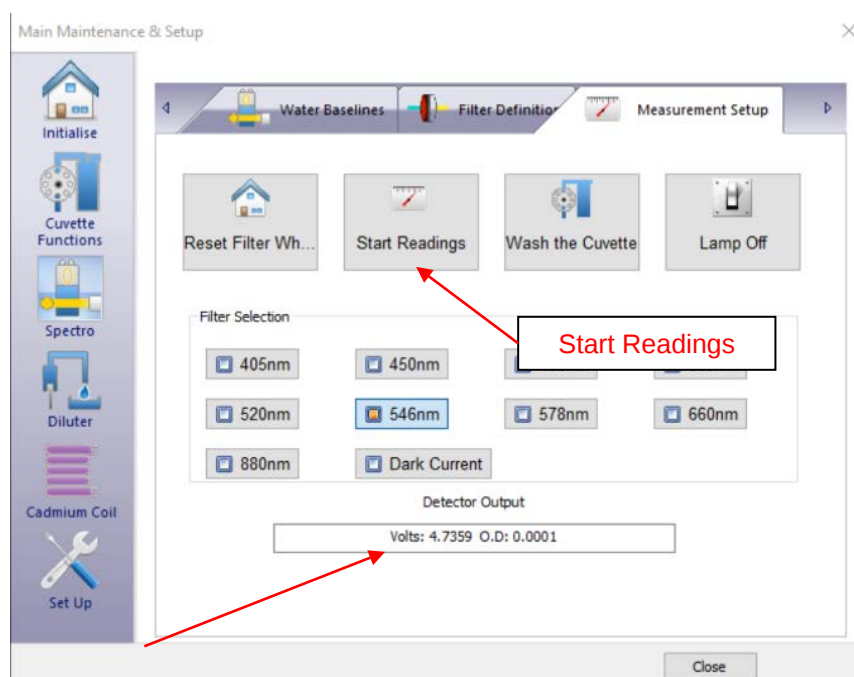


5. The water baselines should be as follows:

- i. Filters 1 – 9: 3.5 – 4.85 V
- ii. Filter 10: ~0.027 V

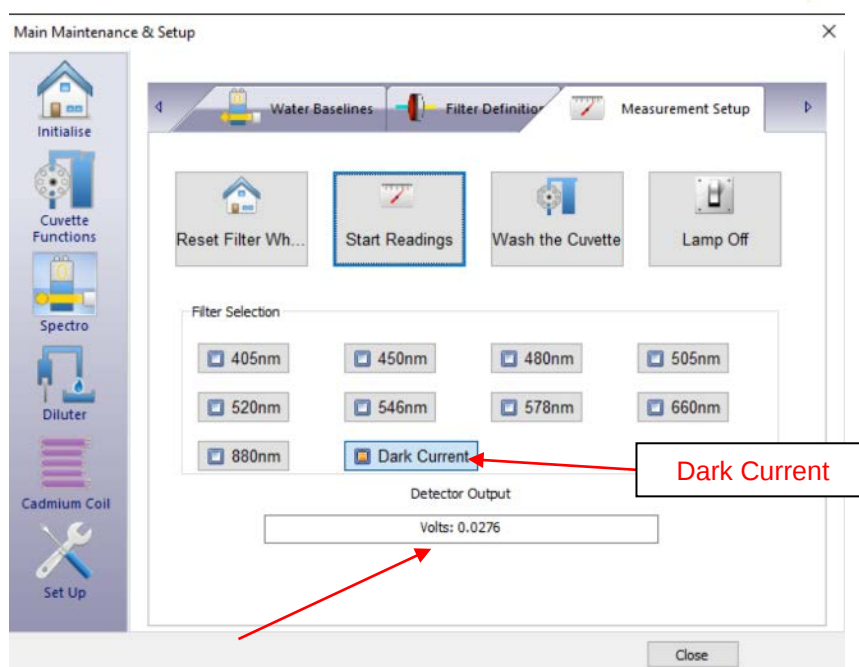
NOTE: If the Gain changes by 5 over the course of a week, the lamp may need to be changed.

6. To get a live reading from the lamp for Troubleshooting purposes, go to the **Measurement Setup** tab, then select a wavelength (clicking on any wavelength or the Dark Current will move the filter wheel to put the selected filter in the light path).
7. Click on the **Start Readings** icon.



The **Detector Output** will display a real-time readout of the filter selected.

8. Select the **Dark Current** icon from the **Filter Selection** box. The filter wheel will now rotate to enable a “Dark Current” or “Offset” reading to be displayed. Clicking on the **Start Readings** icon will display a real-time readout.



It should be noted that all filters are automatically adjusted and if the value is significantly different than noted above, then please contact SEAL Analytical.

Clicking on the **Close** icon will stop the readings and exit the maintenance window.

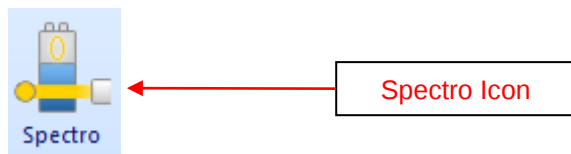
2.4 Measurement Setup (For Adjustable Gain/Offset Instruments On AQ400s with Serial Numbers <241xxx)

The Measurement Setup procedure must be performed after replacing the lamp or any other measurement system component and also if indicated by Water Baselines being out of limit. This procedure is for those instruments that have an adjustable gain.

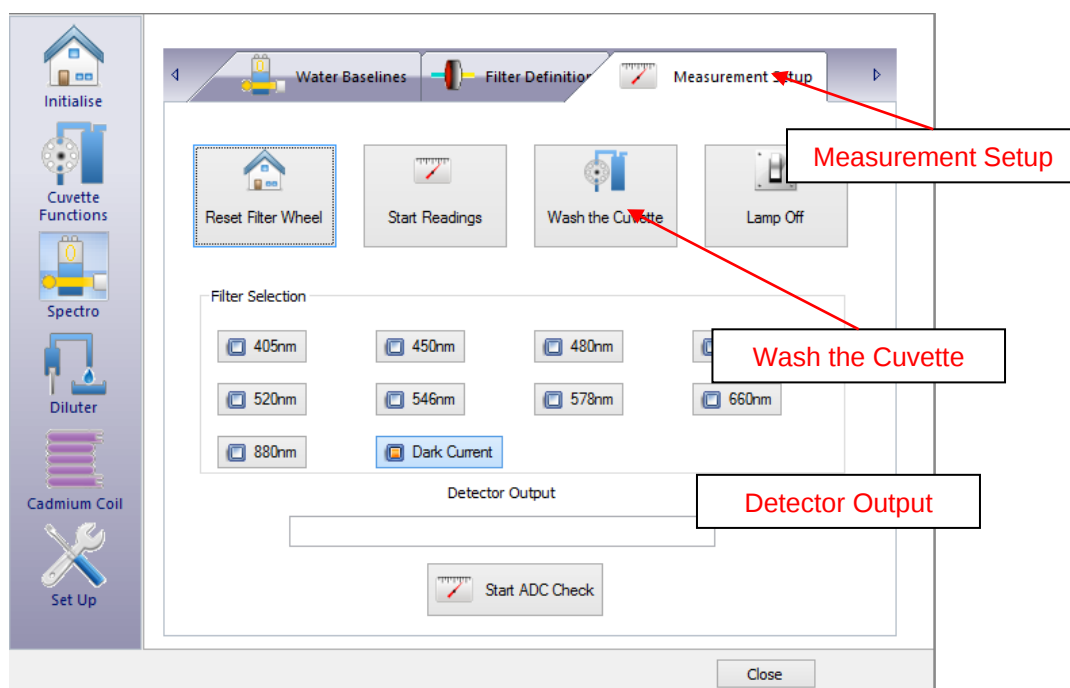
1. Select **Maintenance and Setup** from the menubar



From the **Maintenance** menu select the **Spectro** icon



2. Select the **Measurement Setup** tab and then select the **Wash the Cuvette** icon. This will flush the cuvette and fill it with fresh water. This should be performed three times before taking readings.



3. Step through each of the 9 filters, noting the filter with the highest reading displayed in the Detector Output.

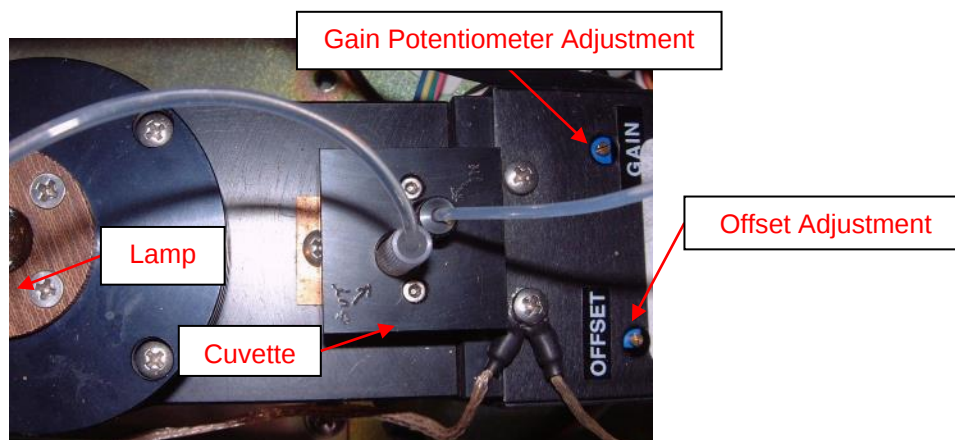
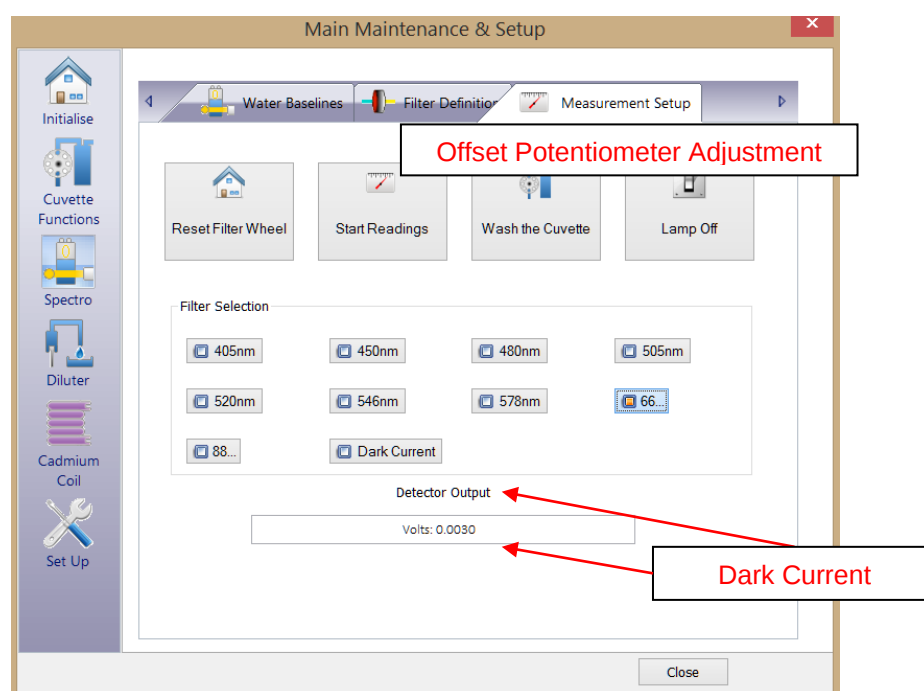


Fig. 2.8: Gain and Offset Potentiometer Adjustment

9. Select the filter with the Highest Reading (determined by the Water Baselines). Click the **Start Readings** button.
 - i. For instruments with an adjustable offset, adjust the voltage reading with the potentiometer labelled **GAIN**, to show **3.95 ± 0.1 Volts** (situated under the photometer cover plate).
 - ii. For instruments with a fixed offset, adjust the voltage reading with the potentiometer labelled **GAIN**, to show **4.85 ± 0.1 Volts** (situated under the photometer cover plate).
 - iii. For instrument with Auto-gain, this step is no longer required.
10. Select the **Dark Current** icon from the **Filter Selection** box (for those instruments with adjustable offset). The filter wheel will now rotate to enable a “Dark Current” or “Offset” reading to be displayed. Clicking on the **Start Readings** icon will display a real-time readout.



Adjust the Offset (if applicable) with the Offset adjustment potentiometer (Fig. 2.8) to 0.00030 +/- 0.0005 Volts. (0.0025 to 0.0035)

11. If the Offset has to be adjusted, recheck the Gain adjustment (step 9) before proceeding to perform Water Baselines.

Clicking on the **Close** icon will stop the readings and exit the maintenance screen.

2.5 Peristaltic Pump Replacements

2.5.1 Replacing Peristaltic Pump Tubing (Black Pumps – On AQ400s with Serial Numbers 040xxx, 141xxx, 241xxx)

There are two peristaltic pumps on the system, one for aspiration into the cuvette and the other for filling and maintaining the water level in the aspiration wash well.

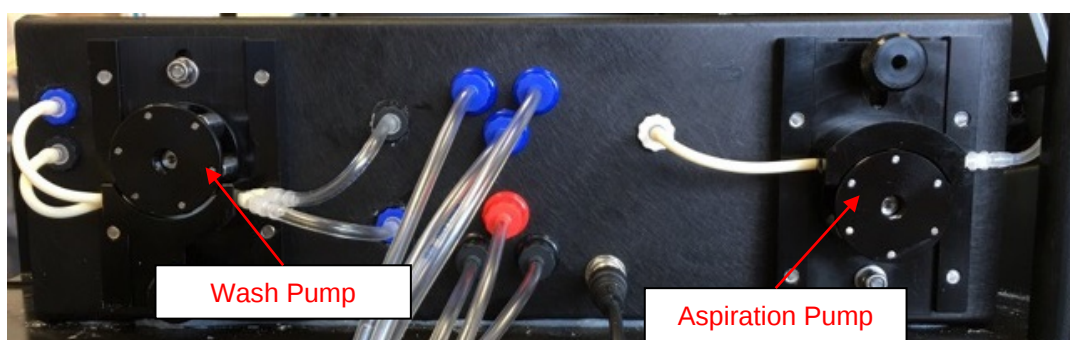


Fig. 2.9: Peristaltic Pumps (Black Pumps – s/n 041xxx, 141xxx, 241xxx)

The tubing in the peristaltic pump is pressed by a semi-circular platen against the rotor of the pump. This bar is mounted on a plate, kept in position by a large thumbscrew.

1. Remove the AQ400 Right Side Cover
2. Loosen the thumbscrew on the Pump – Slide the Platen away from the rollers
3. Remove the old tubing
4. Clean the six rollers of the rotor and platen with IPA / Methanol on a paper towel / foam swab.
5. Lubricate each roller using a SEAL lubrication pen [Part Number AQLP]. Apply at the points shown, on the side of each of the rollers (between the rollers and the end plate). Move the roller side to side and rotate to allow the oil to penetrate inside the rollers. Wipe off excess lubricant. Check that all rollers rotate freely.

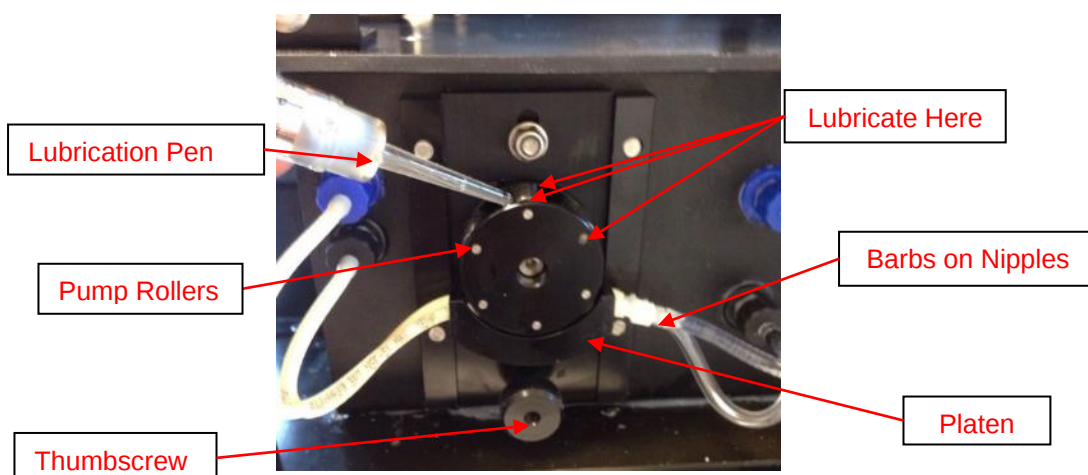


Fig. 2.10: Pump Roller Oil Points

6. Install new pump tubes making sure that the tube is pushed beyond the first barbs on the nipple. Trim the pump tubes before installation to 10 cm.
7. Hold the platen and tubing firmly against the rollers whilst tightening the thumbscrew.



Caution:

On the opposite side of the pump to the platen is a locking plate which is factory set in the correct position. This prevents the bar from pressing too hard on the tubing and shortening its life. Never attempt to adjust this plate.

8. After replacing the pump tubing, verify that the Wash Pump is pumping >4.2mL with two pump cycles and that the aspiration pump is pumping between 3.6 mL and 4.0 mL with two pump cycles. Check the Aspiration Pump steps, adjust as needed. (More information on this step can be found in Section 5 of the AQ400 Customer Support Manual)

2.5.2 Replacing Peristaltic Pump Tubing (Red/Blue Pumps – On AQ400s with Serial Number 341xxx)

Located under the left side cover, are three peristaltic pumps; one for aspiration into the cuvette and the other two for filling and maintaining the water level in the aspiration wash well.

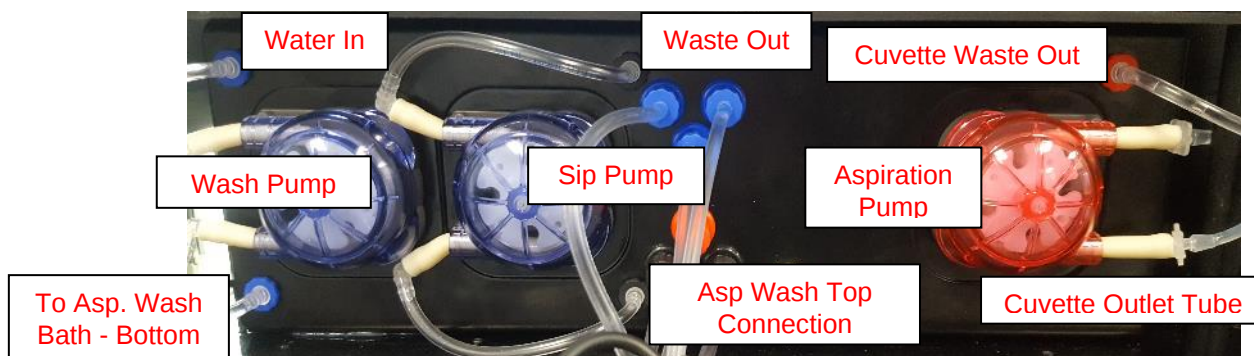


Fig. 2.11: Peristaltic Pump (Red/Blue Pumps s/n 341xxx)

To replace the tubing [Part number 5145]:

- 1) Remove the right side cover of the AQ400.
- 2) Remove the cap / cover from wash pump.
- 3) Remove the pump tube from the ring. The white rotor will come out with it.
- 4) Disconnect the Pump tube from the elbow connectors.
- 5) Install new pump tube onto the elbow connectors (p/n 5145 – Pump Tube 3.2 mm)
- 6) Apply a light coating of silicone grease on the pump tube.



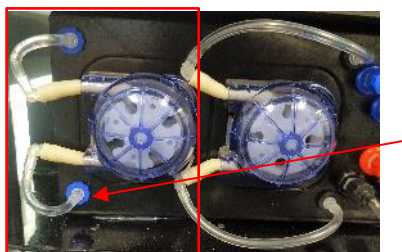
Note:

The pump tubes are coated with Silicone Grease. This is REQUIRED. Simply wipe to remove any grit / dirt and coat the new pump tube and roller with the supplied grease (p/n M309005 – Pump Tube Silicone Grease (Silicone Dielectric Compound)).

- 7) Place the white rotor back onto the pump.
- 8) Press the new pump tube into position.
- 9) Gently pull the tube as needed to make the two ends equal.
- 10) Snap the cap back into place.
- 11) Repeat for the sip pump and the aspiration pump.

To check the replacement of the Peristaltic Pump tubes

- 1) Open **Maintenance**
- 2) Select **Cuvette Functions**
- 3) Measure the Wash Pump Volume
 - a. Remove Tube at Bottom Blue Fitting

**Fig. 2.12: Aspiration Wash Bath Pumps**

- b. Place in 10 mL graduated cylinder
 - c. Do 2 cycles of **Auto Wash**
 - d. Volume should be > 4.2 mL
- 4) Measure the Aspiration Pump Volume:
 - a. Remove Tube at Top of Red Fitting
 - b. Place into 10 mL graduated cylinder

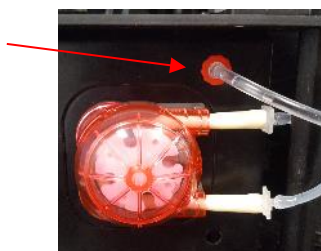


Fig. 2.13: Aspiration Pump in Graduated Cylinder

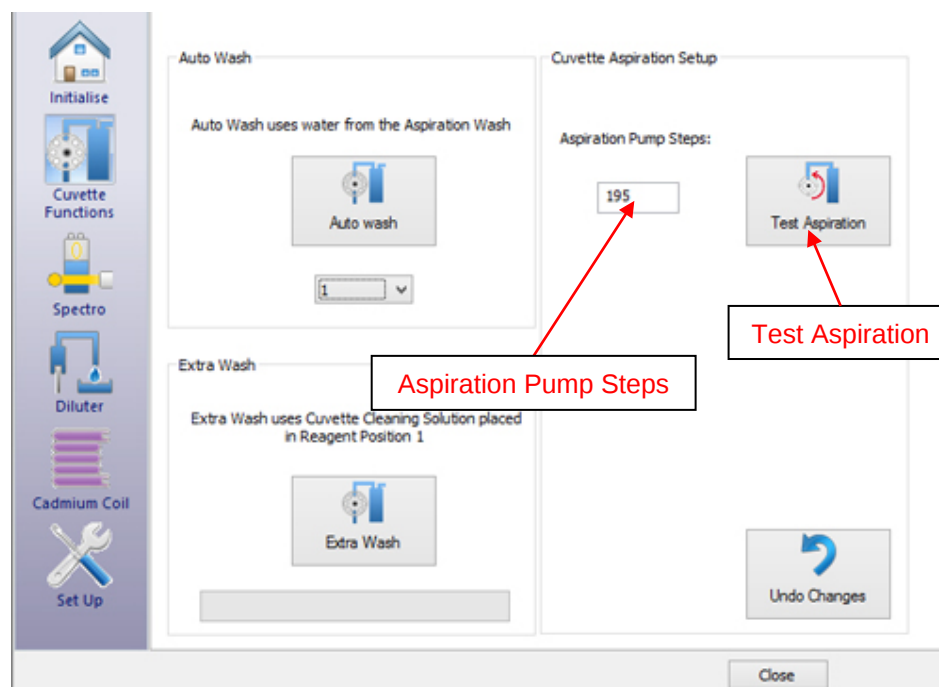
- c. Do 2 cycles of **Auto Wash**
- d. Volume should be between 3.6 and 3.8 mL

2.5.3 Setting Cuvette aspiration



Cuvette Functions Icon

1. Enter the Cuvette Functions by selecting the Cuvette Functions Icon.
2. Select the **Test Aspiration** icon, the sample arm will dispense 500 μL of deionized water into a reaction well. The tray will then rotate to the aspiration arm and the liquid will be aspirated through the cuvette as it would in runtime.



3. Adjust the number of pump steps so that 1-2 inches (3-5cm) of liquid can be seen exiting and entering the cuvette by changing the number in the "Aspiration Pump Steps" dialog box. Then select the **Test Aspirations** icon again and observe the change in liquid position. Repeat as necessary to get the required 1 – 2 inches of fluid on either side of the cuvette.

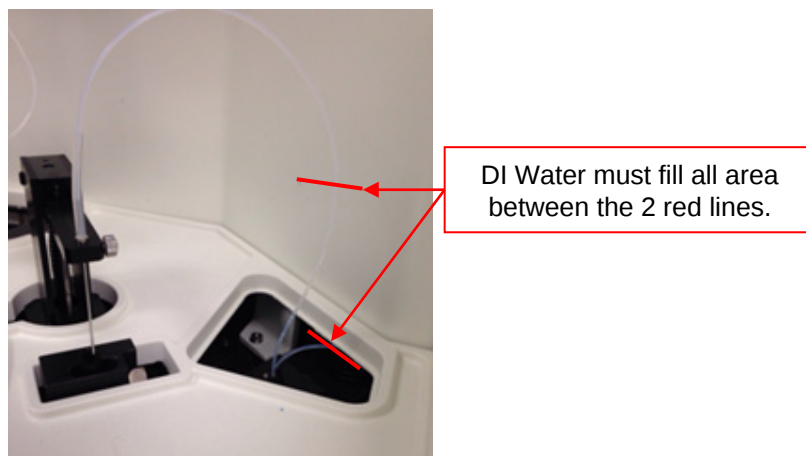


Fig. 2.14: Adjusting the Liquid Filling the Cuvette



Note: If there is a blockage in the aspiration probe, tubing, cuvette, or waste tubing, a distinct water/air interface may not be visible. In particular, check that the liquid in the aspiration tubing stops moving immediately when the aspiration pump stops.

2.6 Sample Probe Replacement

1. Turn off the main power switch at the rear of the analyzer.
2. Manually rotate the sampler so that the probe is over the sampling position.
3. Disconnect the reagent level sensor cable by pulling out the black connector.
4. Unscrew tubing fitting.
5. Loosen the thumbscrew holding the probe in place and lift the probe out of the Sample Probe Arm.
6. Install the new probe in reverse order, taking care to guide the probe through the center of the probe wash assembly.

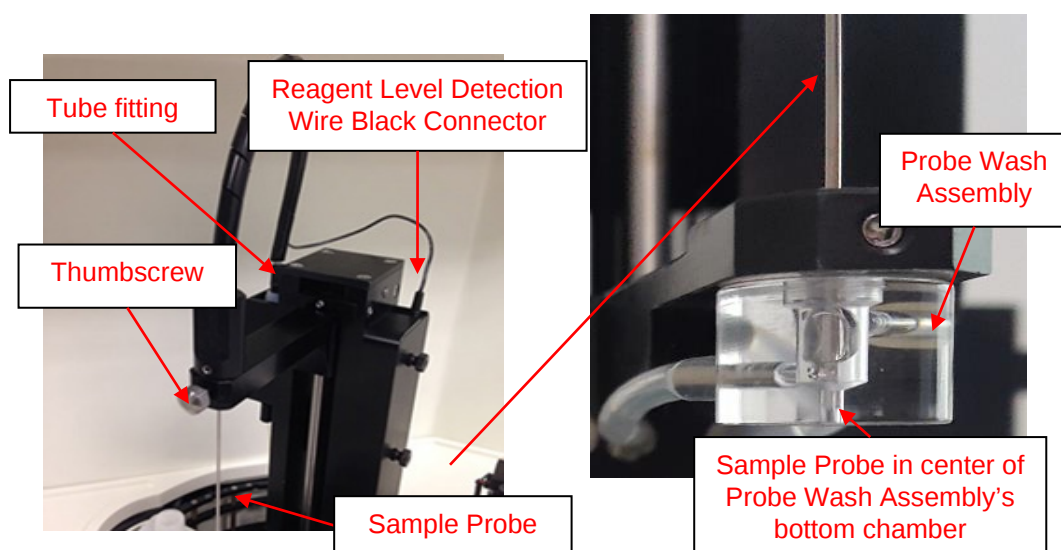


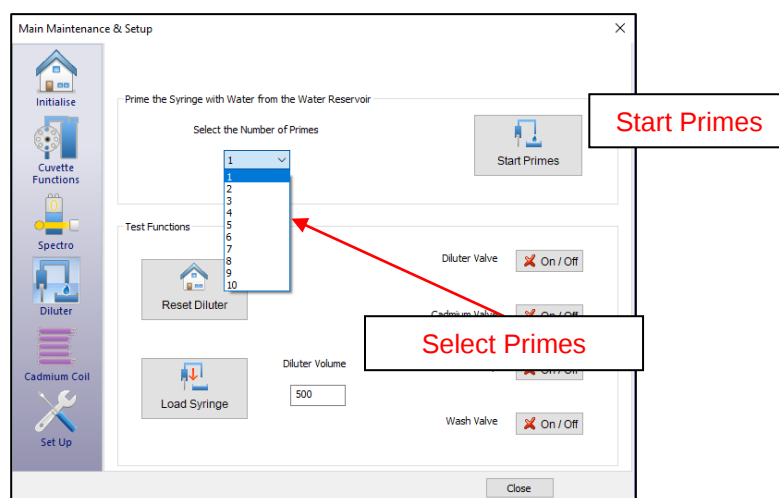
Fig. 2.15: Probe and Probe Wash Assembly

7. Check that the tip of the probe sits correctly inside the wash assembly. Poor washing may lead to cross-contamination of reagents and/or samples. Refer to Probe Up Adjustment procedure (see Software Manual) for correct adjustment.
8. Select the **Diluter** icon from the **Maintenance** menu



Diluter Icon

9. **Select 1 Prime** from the pull down menu. (You can select from 1 to 10 primes)
10. Select **Start Primes** – Inspect for any leaks or problems, correct as needed
11. Select 10 Primes / Then Select **Start Primes** - Inspect for any leaks or problems, correct as needed



- ➡ Note: If the probe is known to be damaged or bent, the probe wash assembly must be replaced at the same time. If the sample probe is damaged or if the reagent level detector is malfunctioning, the complete sample probe assembly will have to be replaced.
- ➡ Note: If the system is configured to use a cadmium coil, the selected number of primes will be repeated, with the flow directed through the coil line for the second set.

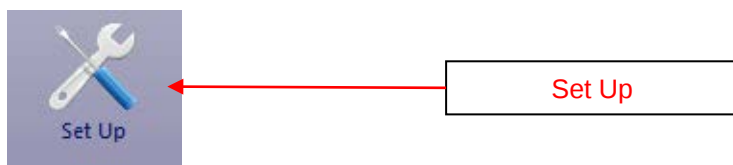
2.7 Reagent Level Detector

The calibration of the reagent level detection system should be checked

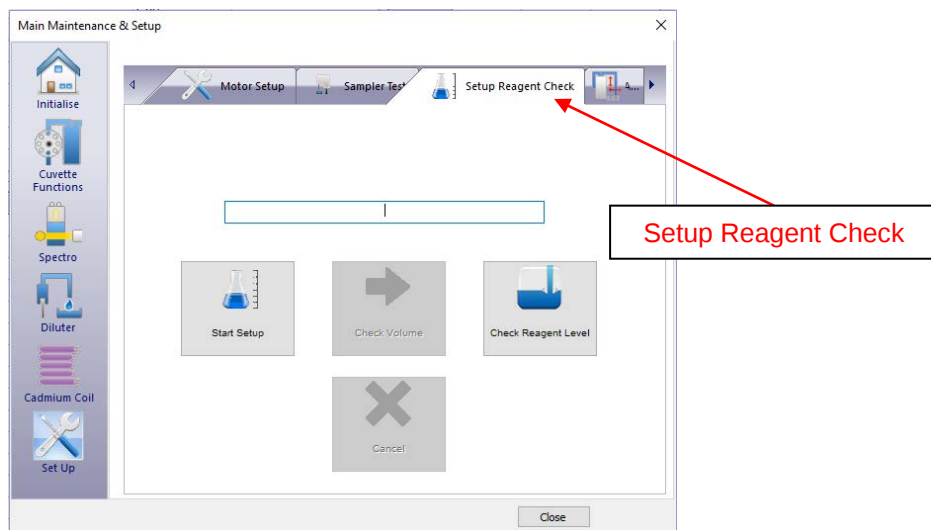
- in the event of false Insufficient Reagent warnings
- if the sample probe is replaced
- if the reagent volumes displayed during analysis are incorrect

- ➡ Note: Before continuing, the Reagent Level Detection must be set to Auto in the Maintenance menu. (Select the Initialize Icon)

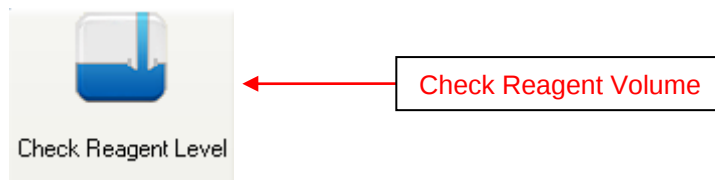
1. Select the **Set Up** icon from the **Maintenance Menu**



2. From the **Set Up** menu, select the **Setup Reagent Check** tab.



3. Place a reagent container, containing a known volume of water, at position 8 in the reagent tray.
4. Click on the **Check Reagent Volume** icon

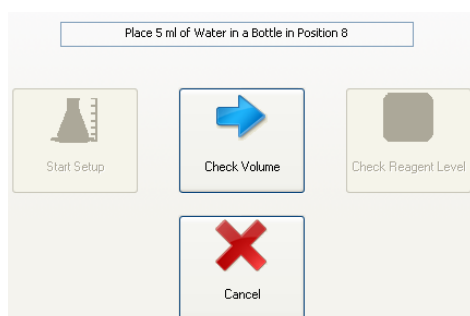


The sample probe will now rotate to container 8 and be lowered into the reagent container to detect the water. The volume detected will be displayed on the screen.

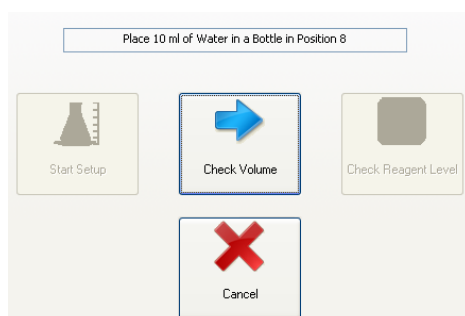
5. If the volume displayed is incorrect by more than 1 mL, the following calibration procedure must be performed.
6. Place an empty reagent container in position 8 in the reagent tray and click on the **Start Setup** icon to open the calibration routine.



7. Using a pipette or 10 mL graduated cylinder, add 5 mL water into the reagent container and click on the **Check Volume** icon.

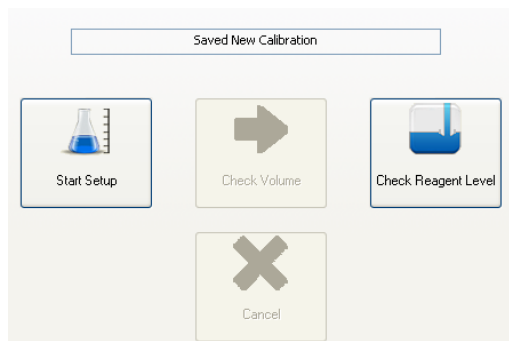


8. Add another 5 mL of water into the same container (total volume now 10 mL) and click on the **Check Volume** icon.



The sample probe will again rotate to container 8 and be lowered into the reagent container to detect the water

9. Add further 10 mL aliquots and click on the **Check Volume** icon, as prompted, until 40 mL of water has been added.



The procedure is complete when the "Saved New Calibration" appears.

10. Run the Reagent Volume Check again, as described above, to verify the calibration.

2.8 Probe Wash Assembly Replacement

1. To replace the probe wash assembly [Part Number MA000102]: Loosen the set screw holding the assembly in place on the metal arm.

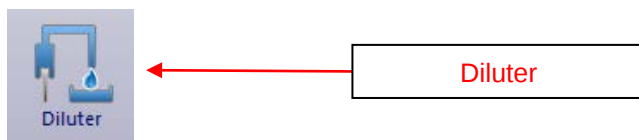


Fig. 2.16: Probe Wash Assembly

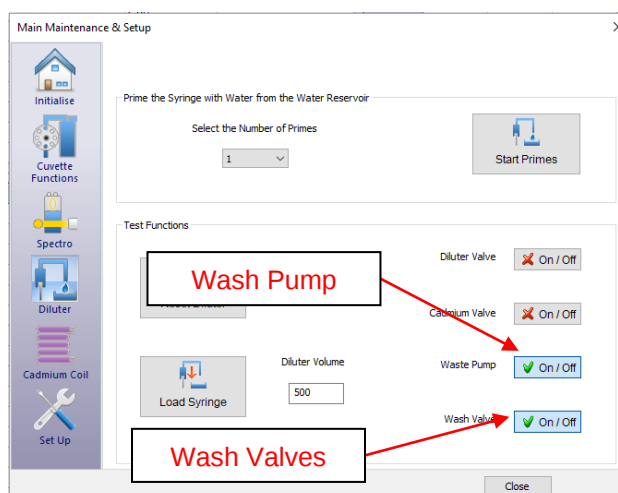
2. Move the probe wash assembly downward out of the metal arm.
3. Disconnect the silicone tubing from the two metal connectors on the probe wash assembly taking care not to damage the ends of the tubing. Note the positioning of the tubing with respect to their connectors.
4. Reattach the silicone tubing to their respective metal connectors on the new probe wash assembly, ensuring a snug fit.
5. Install the new probe wash assembly into the arm, ensuring it is pushed fully up into the sample arm.
6. Secure the probe wash assembly in place by retightening the holding screw.
7. Check the operation of the probe wash assembly, see section 2.9.

2.9 Probe Wash Assembly Test

Select the **Diluter** icon from the **Maintenance Menu**:



To test the operation of the Probe Wash Assembly, toggle **On** the **Wash Pump** and the **Wash Valves**. The user can then place their finger under the Probe Wash Assembly and test for suction and water movement through the probe wash assembly.



2.10 Syringe Replacement

The syringe piston, glass barrel, and O-ring should all be replaced at the same time. They are available in a set [Part Number 5195-1]. They may need to be replaced in the following circumstances:

- 6 or more months of normal usage (40 hr/week)
- Liquid is observed leaking down the syringe piston
- Air bubbles are consistently present in the upper part of the syringe

1. With the AQ400 turned off, remove the Left Side Panel.
2. Pull the diluter assembly stage out, and rotate to allow access to the syringe.

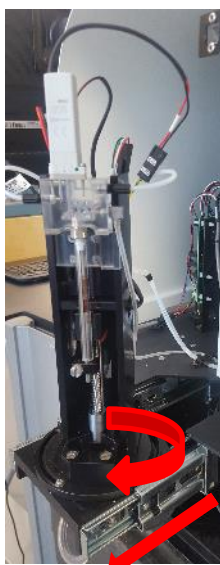


Fig. 2.17: Diluter Assembly Stage

3. Remove the three water inlet and outlet tubes. Be cautious not to tear the silicone tube connected to the metal.

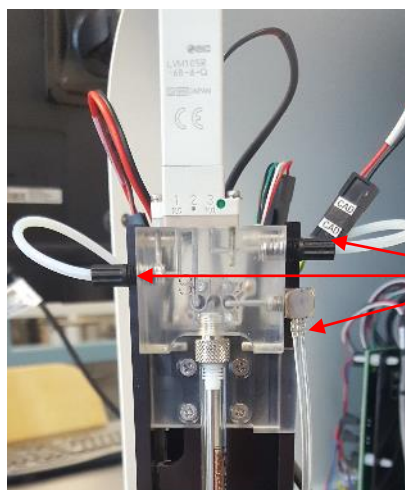


Fig. 2.18: Syringe Header Block

4. Using a screwdriver, loosen the syringe clamp screw. Manually rotate the screw drive (located behind the clamp) down with your fingers until the piston of the syringe is free of the clamp.

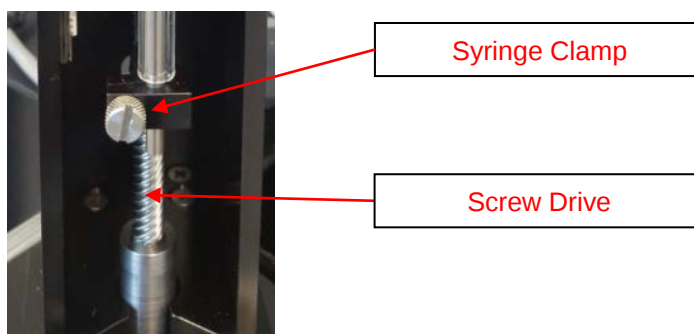
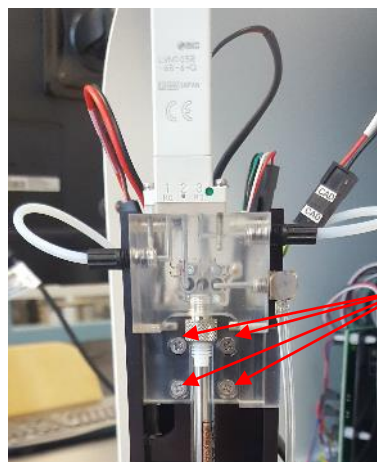


Fig. 2.19: Moving Bar Screw

5. Remove the four screws that hold the syringe header block onto the dilutor tower.



Four side screws

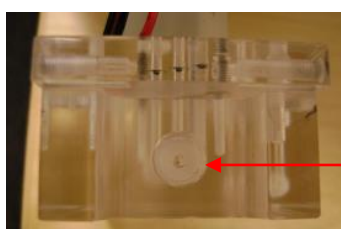
Fig. 2.20: Diluter Tower

6. Disconnect the electrovalves by carefully unplugging the CAD and DIL connections. At this point the syringe header assembly can be removed from the AQ400.



Fig. 2.21: Disconnecting Dilutor Electrovalve

7. The glass body of the syringe can now be unscrewed and the white O-ring above the barrel threads can be removed. It should be necessary to use pliers to loosen the syringe barrel from the header block.



O-ring

Fig. 2.22: O-ring Installed in the Syringe Header Block

8. Using lint free wipes, wipe off excess water from the header holes and threads. Install a new O-ring into the syringe header, making sure the O-ring hole and header syringe hole is centered properly.
9. Using DI water, wash the white plunger of the new syringe and the inside of the new glass body. Wipe off excess water from the top of the syringe glass body using lint free wipes.

Screw in the glass body, with syringe piston already inserted, into the header assembly making sure the O-ring is centered properly. Hand tighten the syringe assembly. Then using a pliers on the metal portion of the syringe, carefully add a $\frac{1}{4}$ turn to tighten it further.

10. Reinstall the syringe header assembly with the following steps:
 - i. Plug in the connectors for the electro-valves.
 - ii. Position the header assembly so you can start the four screws into the syringe header. Do not fully tighten these screws yet, and be sure that the syringe piston is going through the syringe clamp. (See Fig 2.19)
 - iii. Reinstall the tubing and the ferrule connector of the syringe header. (See Fig. 2.18)
11. Manually rotate the screw drive (See Fig 2.19) until the syringe clamp is all the way at the top of its path. Be careful to ensure that the syringe piston is appropriately positioned in the clamp, push the syringe piston all the way up, and then back it down 3-5 mm. This can be visually judged by pulling down until you can see an additional "stripe" on the piston.

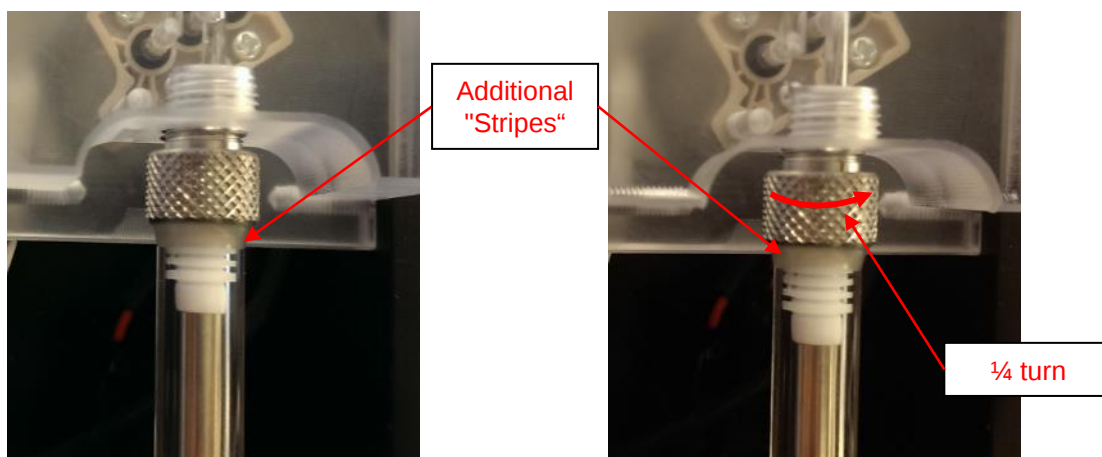


Fig. 2.23: Adjusting the Syringe Piston

This will ensure the syringe piston doesn't hit the bottom of the header when in operation. Tighten the syringe clamp using a screwdriver.

12. Prime the syringe at least ten times, checking for leaks and that the clamp has been tightened properly. Please note that a small air bubble formed over the syringe tip is normal.
13. Rotate the diluter tower counterclockwise and then carefully slide the stage in until it snaps into position (stage should be flush with frame). Replace the left side cover.

2.11 Aspiration Probe Replacement

To replace or remove the aspiration probe [Part Number 5110]:

1. Loosen the holding screw that is securing the probe in place.
2. Grasp the tubing attached to the top of the probe and pull straight up until the probe is clear of the aspiration arm, to avoid damaging the tubing and probe.

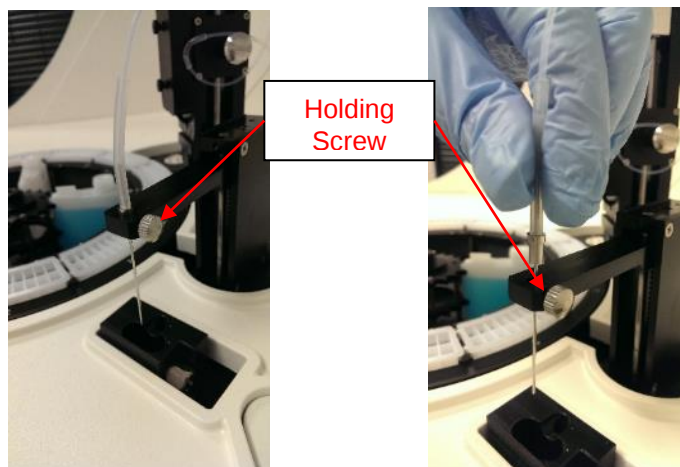


Fig. 2.24: Removal of Aspiration Probe

3. Disconnect the sleeving and tubing from the top of the probe.
4. Connect the tubing and sleeving to the new probe ensuring they are both pushed down as far as the top of the shoulder, without crimping or damaging the tubing.

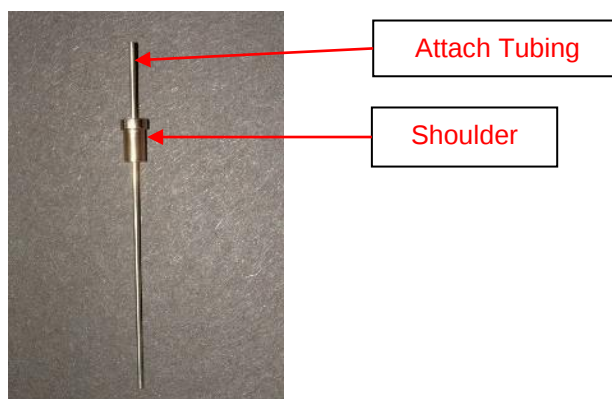


Fig. 2.25: Aspiration Probe

5. Insert the probe back into the aspiration arm, taking care to keep it vertical to avoid damaging it. Secure in place by tightening the holding screw, finger tight.

2.12 Cadmium Coil (if installed)

The cadmium coil is used to reduce nitrate to nitrite. Installation and removal of the coil is necessary for maintenance of the coil:

1. Prepare the Cadmium coil chemically for installation.
 - i. Perform an acid strip on the coil. Using a syringe, draw in a 6N HCl solution and let it sit for 2-5 minutes.
 - ii. Perform Water/Air cleaning. Using a syringe, draw water quickly through the coil and while still pulling on the plunger of the syringe, quickly pull the coil out of the water. A sucking sound should be heard. Repeat until the water in the syringe is clear and colorless.
 - iii. The cadmium coil is now ready to install on the AQ400.
2. Locate the cadmium coil fluidic loop tubing and post on the backside of the sample arm.

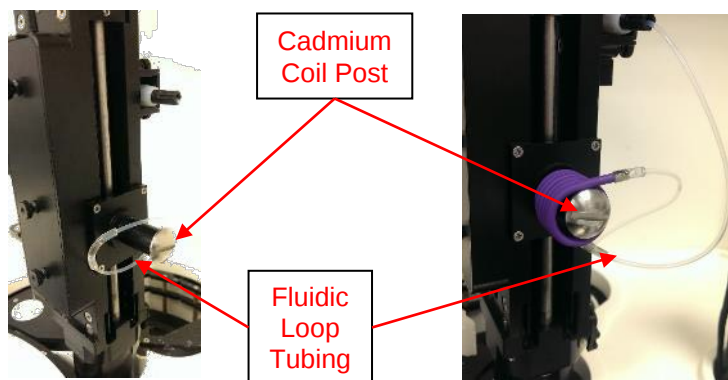


Fig. 2.26: Cadmium Coil Installation

3. Connect the regenerated Cadmium coil to the Sample Arm of the AQ400: The sleeved ends of the Cadmium coil are inserted in-line by means of the 0.04" i.d. PTFE tubing that runs from the T-connector on the AQ400 Sample Arm. This tubing has been pre-cut and the ends have been joined using tubing P/N 5719. To connect the Cd coil, remove the sleeve tubing from the 0.04" i.d. PTFE tubing. Moisten each free end and insert it into the tubing sleeves of the coil. The Sleeving should be around 1 cm long and tightly fitted to the cadmium coil. If the coil has not been used for over a month, replace the tygon tubing before installing on the instrument. Insert the PTFE tubing to within 2 mm of the cadmium metal. Hang the cadmium coil on the post being careful not to twist the tubings which may create pressure.
4. In the software maintenance menu, perform several primes of the diluter to evacuate any air in the lines.
5. To finish preparation of the cadmium coil regeneration, please refer to the Cadmium coil section in the AQ Software Manual.
6. If the Cadmium coil is uninstalled for and the instrument is to be used, a piece of sleeve tubing must be reinstalled in the Cadmium coil fluidic loop.

2.13 Fuse Replacement



Warning: Replace fuses with 2.5A FB / 250VAC rated Fuse only

Attenzione: sostituire i fusibili con fusibili 2.5A FB / 250VAC nominale



Instrument power must be OFF before replacing electronic parts or cables.

Puissance de l'instrument doit être OFF avant de remplacer les composants électroniques ou des câbles

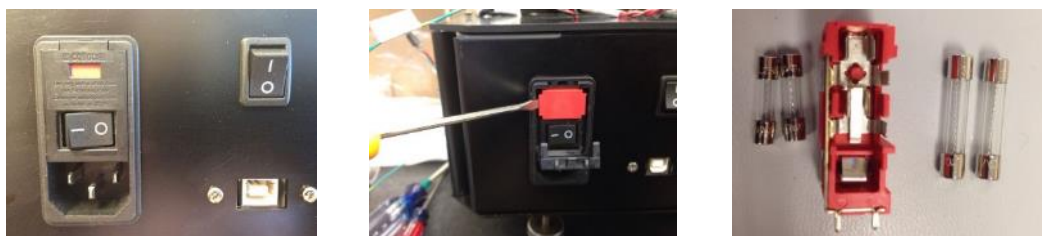


Fig. 2.27: Replacement of Fuses

If it is suspected that a fuse has blown please proceed as follows

1. Turn the Power Switch to the O – OFF position
2. Unplug the Power Cord from the Wall Socket (Input power)
3. Unplug the Power Cord from the AQ400
4. Using a small screw driver pry open the fuse compartment door (top)
5. Pry RED fuse holder out of the compartment
6. Replace BOTH Fuses with 2.5A Fast Blow (FB) / 250VAC rating.
7. Either of these two styles of fuses are acceptable.
 - a. 5x20mm Time Lag Surge Withstand Glass Body Cartridge Fuse
 - b. 3AG Fast-Acting Glass Body Fuse – (6.3x32mm) (Typical U.S. fuse size)

2.14 Cleaning the Air Filter

To avoid overheating of the lamp it is important that the lamp filter is kept clean. It is recommended that this is cleaned at least every month and should be replaced if it is damaged or blocked.

1. Switch off the analyzer and remove the right side cover. The lamp filter sits on the front of a fan just behind the lamp.

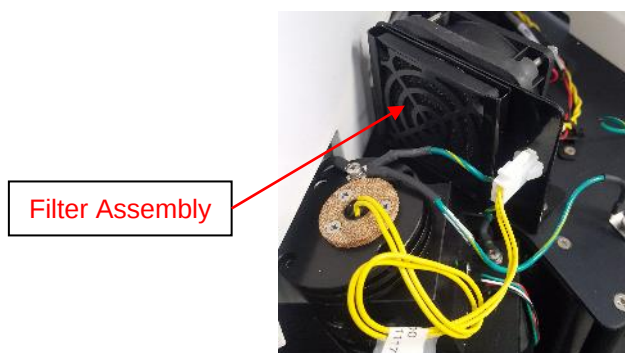


Fig. 2.28: Filter Assembly

2. Pull the lamp filter assembly up out of its housing.

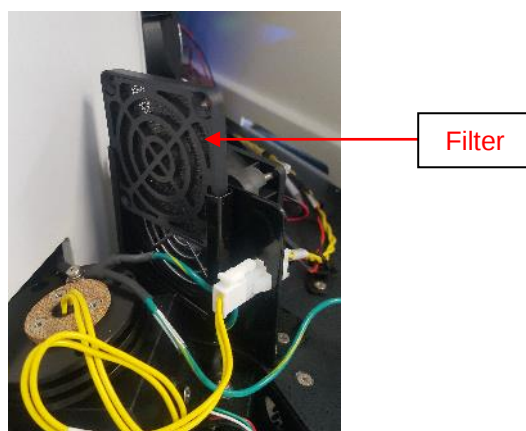


Fig. 2.29: Pulling up the Filter Assembly

3. Clean any dust from the filter using compressed air, a vacuum cleaner, or a brush. (Do not clean the filter near the analyzer). Replace the filter if necessary.
4. Replace the filter assembly in its housing and replace the right side cover.
5. Switch the analyzer back on.

3 Troubleshooting

3.1 Chemistry Troubleshooting

3.1.1 Poor Precision (Reproducibility)

1. Check that clean reaction segments have been installed.
2. Check amount and quality of deionized water in wash bottle.
3. Prepare fresh reagents.
4. Ensure there are no air bubbles trapped in sample cups.
5. Ensure instrument has been switched on and all covers have been in place for at least 30 minutes, to allow for temperature equilibration, before running chemistries.
6. Check for leaking sample probe wash assembly dripping into samples or reaction wells.
7. Check for leaking sampling system (tubing connections and syringe piston).
8. Check for blockage in sample probe.
9. Check aspiration system:
 - i. Cuvette aspiration pump steps set correctly (section 2.5).
 - ii. Aspiration probe position and height set correctly – check *Motor Setup*. (See Software Manual).
 - iii. Waste flowing freely - ensure waste container is placed at same level as analyzer and waste lines are not too long or submerged.
 - iv. Aspiration probe, tubing and cuvette not blocked. Often, a blockage can be diagnosed using *Test Aspiration*
 - v. Check aspiration pump tube. If worn, replace as described in section 2.5
10. Ensure correct Test Parameters – a minimum total volume of 500 μ L is needed in the reaction well.
11. Wash cuvette with alkaline EDTA solution (2% NaOH and 1% EDTA w/v) and then refill with fresh DI water. *Perform **Water Baselines***.
12. Replace lamp following the procedure in section 2.2, set Gain and Offset and check water baselines.
13. Run Measurement Diagnostic and print out raw data and statistics for SEAL. Call SEAL Technical Support.

3.1.2 Incorrect Absorbance Readings

1. Check reagent and standards are in the correct locations.
2. Check Cuvette Aspiration. **Maintenance and Setup > Maintenance > Cuvette Functions > Test Aspiration.**
3. Prepare fresh reagents.
4. Prepare fresh calibration standards.
5. Wash cuvette using Cuvette Cleaning Solution. If running phosphate, silica and/or sulfates, use alkaline EDTA solution in place of Cuvette Cleaning Solution. Perform *Water Baselines*.
 - i. To make alkaline EDTA solution, dissolve 1 g of Sodium hydroxide and 2 of EDTA disodium salt dihydrate in 100 mL of DI water.
6. Check for correct Test Parameters and Reagent Parameters.

3.2 Instrument Troubleshooting

3.2.1 Water Baselines

If the water baselines are incorrect:

1. Check water quality and quantity in wash bottle.
2. Wash cuvette using **Auto Wash** and check peristaltic pump and tubing to ensure no bubbles are in cuvette.
3. Wash cuvette using **Extra Wash** with alkaline EDTA solution (see Section 3.1.2 for make-up of solution). Check for leaks or blockages around cuvette.
4. Ensure that the cuvette is pushed down all the way.
5. Perform **Measurement Setup** – see section 2.4 of this handbook.
6. Replace Lamp (section 2.2) and perform **Measurement Setup**.
7. Call SEAL Technical Support.

3.2.2 Sample Probe Wash Assembly

If the probe wash assembly is leaking liquid:

1. Check if sample probe is bent and replace if necessary. The probe wash assembly should also be replaced along with a damaged probe as it is likely that it has been damaged by the bent probe.
2. Adjust sample probe height (Probe Up Adjustment) in wash assembly – see Software Manual.
3. Check that wash system valves are operating correctly.
4. Check all tubing for leaks, blockages, splits or loose connections. Repair/replace as necessary.
5. Replace probe wash assembly.
6. Call SEAL Technical Support.

3.2.3 Reaction Tray Temperature

If reaction tray is cold:

Call SEAL Technical Support

3.2.4 Sampling/Reagent Dispense

If the sample or reagent pick up and dispense is not functioning correctly:

1. Check syringe and piston for leaks. Replace piston and/or syringe barrel as necessary.
2. Check all associated tubing for blockages, damage, crimping or poor connection. Reconnect, reroute or replace as necessary.
3. Check for correct movement of piston in syringe. Tighten holding bracket if plunger is slipping. Clean and lightly oil (AQ Lube Pen) worm drive of sampling assembly, if necessary.
4. Check and adjust sample probe height in sample cups – see Software Manual.
5. Check and adjust reagent volume calibration (See Section 2.7) or parameters.
6. Call SEAL Technical Support.

3.2.5 Cuvette Aspiration

If problems are suspected with the aspiration of the reaction mixture into the cuvette:

1. Check aspiration probe for blockage or damage. Clean or replace if necessary.
2. Check aspiration tubing for damage or loose connection. Repair or replace as necessary.
3. Check peristaltic pump tubing; replace if necessary. (*Set Cuvette Aspiration volume* – section 2.5 if replaced).
4. Check waste tubing for blockages or for sitting too far below the surface of waste liquid.
5. Check that waste container is not higher than the AQ400 waste outlets.
6. Ensure there are no blockages in cuvette. Clean or replace as necessary. (Check and adjust *Cuvette Aspiration volume* – section 2.5 and *Perform Water Baselines*).
7. Check and adjust aspiration probe height using Motor Setup in Maintenance software – see Software Manual.
8. Call SEAL Technical Support.

3.2.6 Waste Well

If the waste well is not emptying or is overflowing:

1. Check for damaged or loose fitting tubing. Repair or replace as necessary.
2. Ensure waste well is clean.
3. Check waste tubing for blockages, verify waste lines are not submerged under liquid in the waste container..
4. Call SEAL Technical Support.

3.2.7 Sample Probe Entering Incorrect Sample Cup or Reaction Segment

1. Check Motor Setup in Maintenance and Set Up – in Software Manual. Please note, when checking the alignment of the Reaction Well under Sampler, this should always be centred in relation to the 5th or center well of the segment.
2. Check that the correct size of sample tray is selected
3. Call SEAL Technical Support.

4 **Parts Listing**

4.1 Parts List

<u>Part</u>	<u>Description</u>	<u>Package</u>
5000	Reaction Segments (18 reactions wells/segment)	100
5010	Reagent Containers (wedge) (43 mL)	50
6015	2 mL Sample Cups	1000
5385	1.2 mL Sample Cups (for 120 position tray)	2000
171-0354-01	5 mL Sample Cups (for 80 position tray)	1000
5050-50	Reagent Container (wedge) Caps (closed)	50
5060-50	Reagent Container (wedge) Caps (pierced)	50
AQ6M - 4	6 Month Essential Maintenance Parts Kit - for black pumps OR	1
AQ6M - 4W	6 Month Essential Maintenance Parts Kit - for red/blue pumps (s/n 341xxx or greater)	
AQ3M	3 Month Essential Maintenance Parts Kit - for black pumps OR	1
AQ3M - W	3 Month Essential Maintenance Parts Kit - for red/blue pumps (s/n 341xxx or greater)	
6100	Lamp Assembly - AQ400	1
5110	Aspiration Probe	1
6125-S	Sampler Probe - AQ400	1
MA000102	Probe Wash Assembly	1
5140	Pump Tube - pkg 6 - for black pumps OR	1
5145	Pump Tube - pkg 9 w/silicone grease - for red/blue pumps (s/n 341xxx or greater)	
M309005	Pump Tube Silicone Grease - for red/blue pumps (s/n 341xxx or greater)	1
5160	Syringe 'O' ring	1
5195-1	Syringe Piston & Syringe Glass Body w/O-Ring	1
5676	Cuvette Cleaning Solution - 250 mL	1
5210	Cadmium Reduction Coil	1
5719	Cadmium Coil Connection Tubing	1
5781	Cuvette - AQ400 Inlet Tubing	1
5778	Cuvette - AQ400 Outlet Tubing	1
001016	Wash / Waste Bottle (5L) (requires 9-0046 sensor)	1
9-0046	5 Liter Water Level Sensor	1
9-5350	80 Position Tray	1
9-5351	120 Position Tray	1
MA000160	Reagents Tray (20 reagent removable)	1
MA901290	Auxillary Reagents Tray (6 reagent removable)	1
5500	Complete Tool Kit	1
6-0005	Air Filter Element	1

4.2 Detailed Description

Part No 5000 Reaction Segments



Part No 5010 Reagent Containers



Part No 6015 Sample Cups (2 mL; 80 position tray)



Part No 5385 Sample Cups (1.2 mL; 120 position tray)



Part No 171-0354-01 Sample Cups (5 mL; 80 position tray)



Part No 5050-50 Reagent Container Caps (closed)



Part No 5060-50 Reagent Container Caps (pierced)



Part No 6100 Lamp Assembly



Part No 5110 Aspiration Probe



Part No 6125-S Sampler Probe



Part No 5700-2 Complete Tubing Set



Part No 5140 Peristaltic Tubing Set (pkg 6) – for black pumps



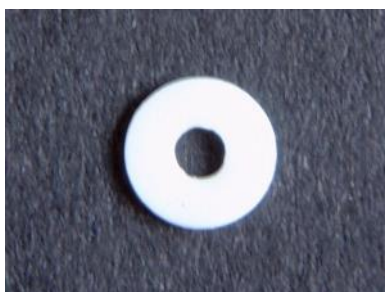
Part No 5145 Peristaltic Tubing Set (pkg 9) w/silicone grease – for red/blue pumps.



Part No 5720 Barbed Fitting



Part No 5160 Syringe 'O' ring



Part No 5195-1 Syringe Glass Body (Below), Syringe Piston (Below) and Syringe ,O-Ring (Above)



Part No MA000102 Probe Wash Assembly



Part No 5781 Cuvette Inlet Tubing



Part No 5778 Cuvette Outlet Tubing



5 SEAL Contact

5.1 SEAL Contact Details

SEAL Analytical, Inc.

Website www.seal-analytical.com

SEAL Analytical Offices:

North & South America

SEAL Analytical Inc.

Mequon Technology Center
6501 W. Donges Bay Road
Mequon, Wisconsin 53092
Tel: 262-241-7900
Fax: 262-241-7970
email: sales@seal-us.com

United Kingdom

SEAL Analytical Ltd.

Unit 3 Talisman Business Centre
Duncan road
Park Gate
Southampton, S031 7GA U.K.
tel : 44(0) 1489 864 400
fax : 44(0) 1489 880 531
email: sales@seal-analytical.com

Germany

SEAL Analytical GmbH

Werkstrasse 5
22844 Norderstedt
Germany
tel : 49(40) 609 29 29 20
fax : 49(40) 609 29 29 02
email: salesde@seal-analytical.com

SEAL Analytical Shanghai

Fortune International Plaza
Silver Building, Room 614
No. 43, Guo Quan Road
Shanghai 200433
tel: 86 21 3362 5002
fax: 86 21 3362 5002
www.seal-analytical.cn
email:sales@seal-us.com

Seal Netherlands

ROHASYS BV
Provincienbaan 4
5121 DL Rijen
The Netherlands
tel : +31 161 240152
fax : +31 161 240153
email : info@rohasys.com