

ACQUITY UPLC Systems Course

H-Class / I-Class Course Workbook-Week 1



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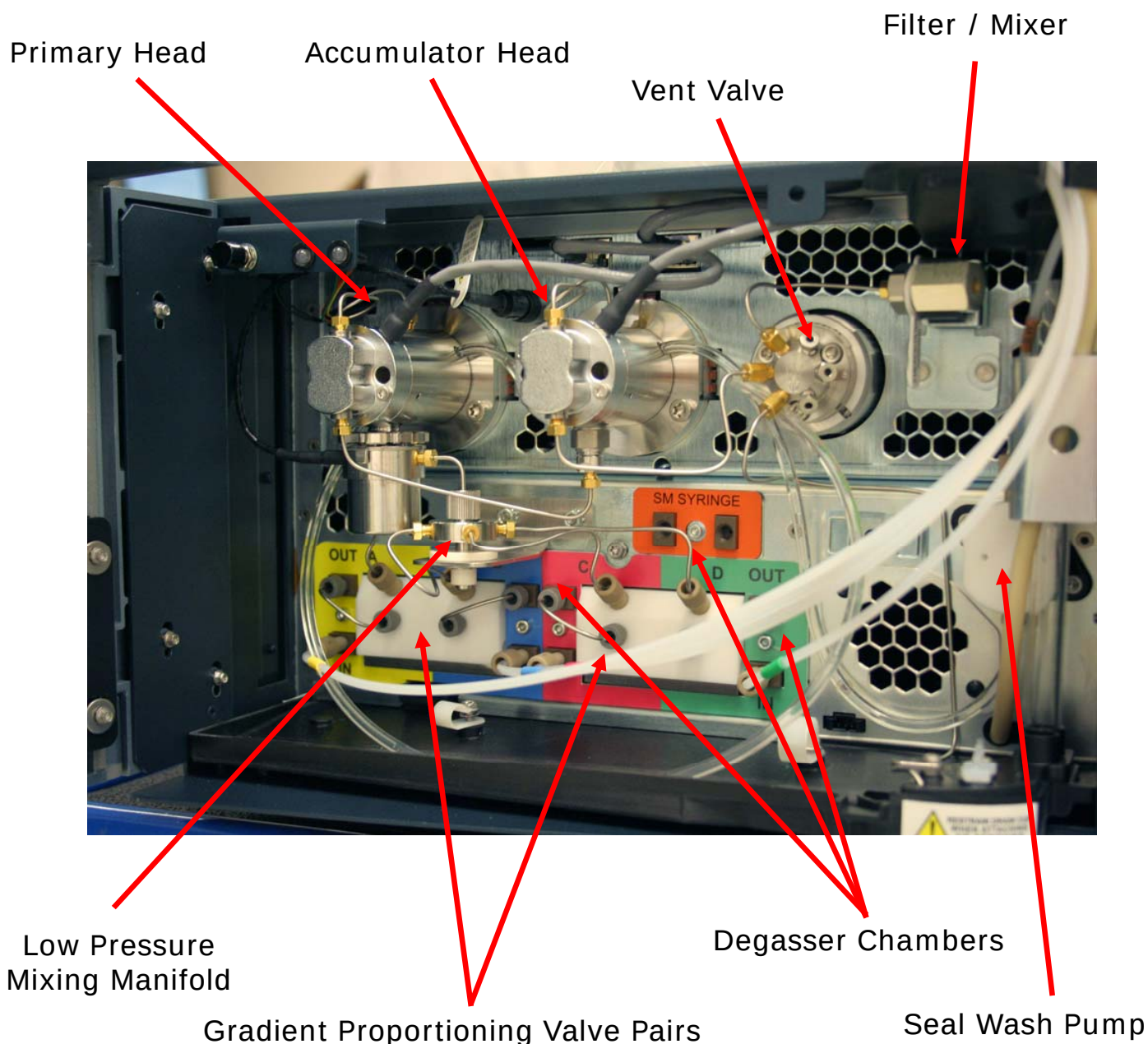


Section 1 H-Class System Overview



QSM External Components

- Open the front panel of the QSM and observe the major components as detailed in the diagram below.

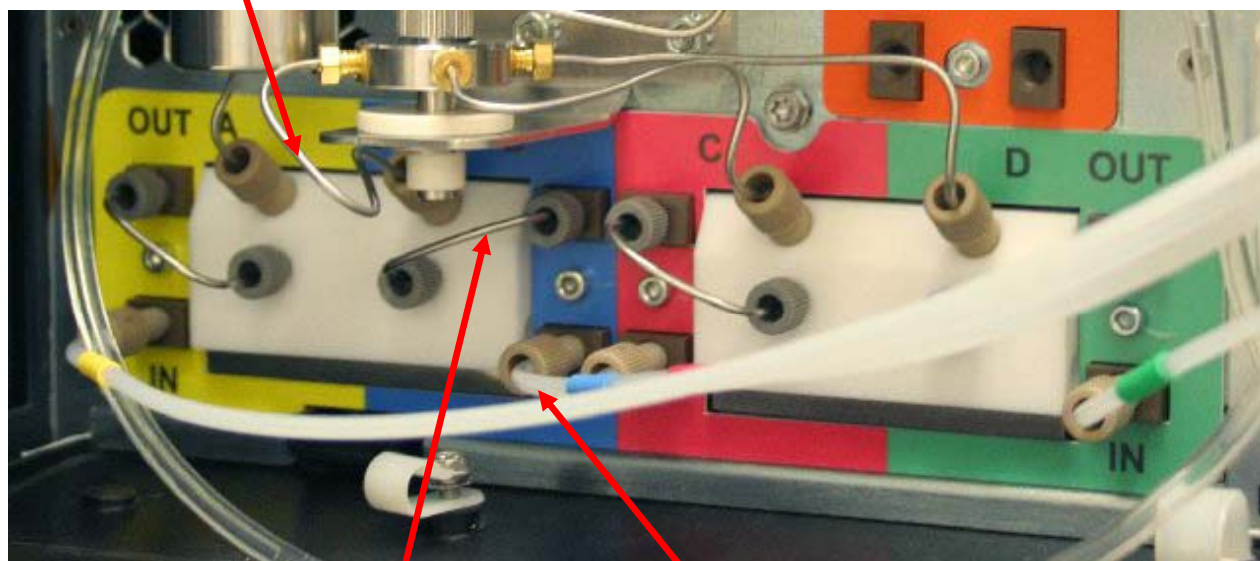


QSM Degasser H-Class Flow Path

- Follow the flow path from the Solvent Degasser through the Gradient Proportioning Valve to the LP Manifold as detailed in the diagram below.

3- GPV Outlet to LP
Manifold inlet

Sample Manager Purge Solvent
Degasser Chamber



2- Degasser Chamber
outlet to GPV inlet

1- Solvent Bottle to
Degasser Chamber inlet

QSM Pump Head Flow Path

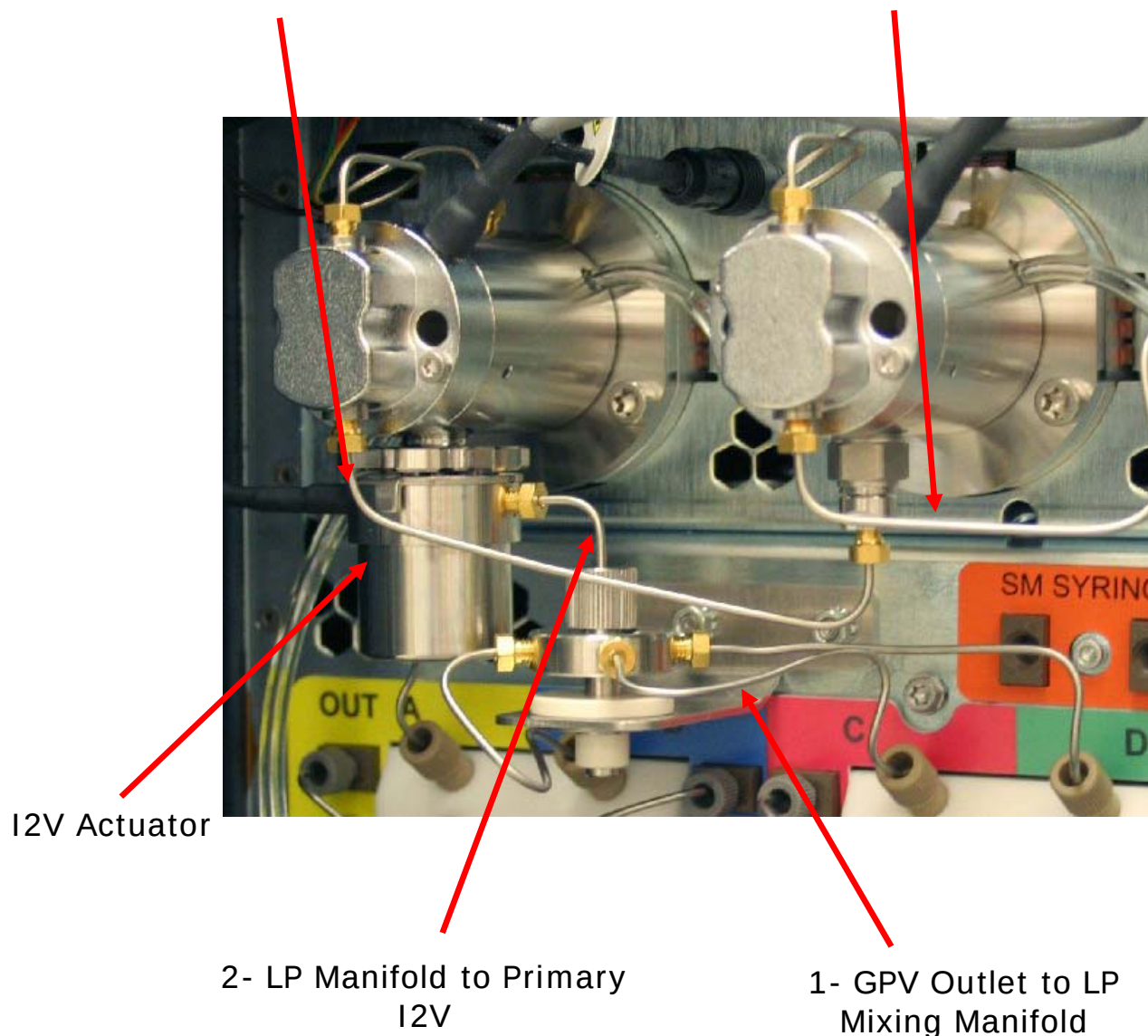
- Follow the flow path from the LP Manifold through the pump heads as detailed in the diagram below.

The solvent is in the low pressure state until it passes the I2V and is compressed by the Primary head.

The point at which the 4 solvents meet in the LP Manifold is considered the starting point of a gradient. It is also where the gradient delay volume is measured from. The end point of the gradient delay volume is considered the head of the column.

3- Primary Head Transducer to Accumulator Check Valve

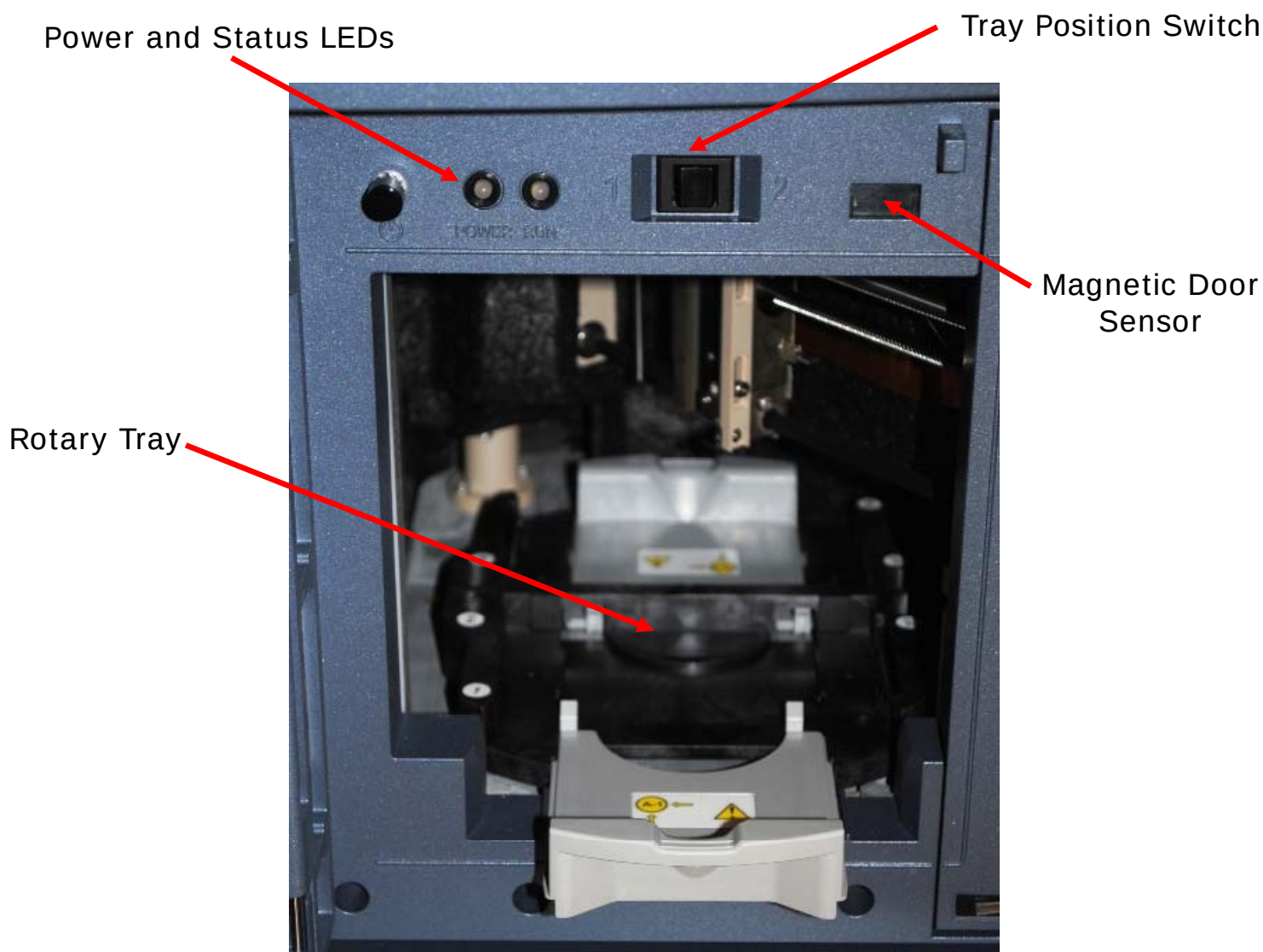
4- Accumulator Head Transducer to Vent Valve



SM-FTN External Components

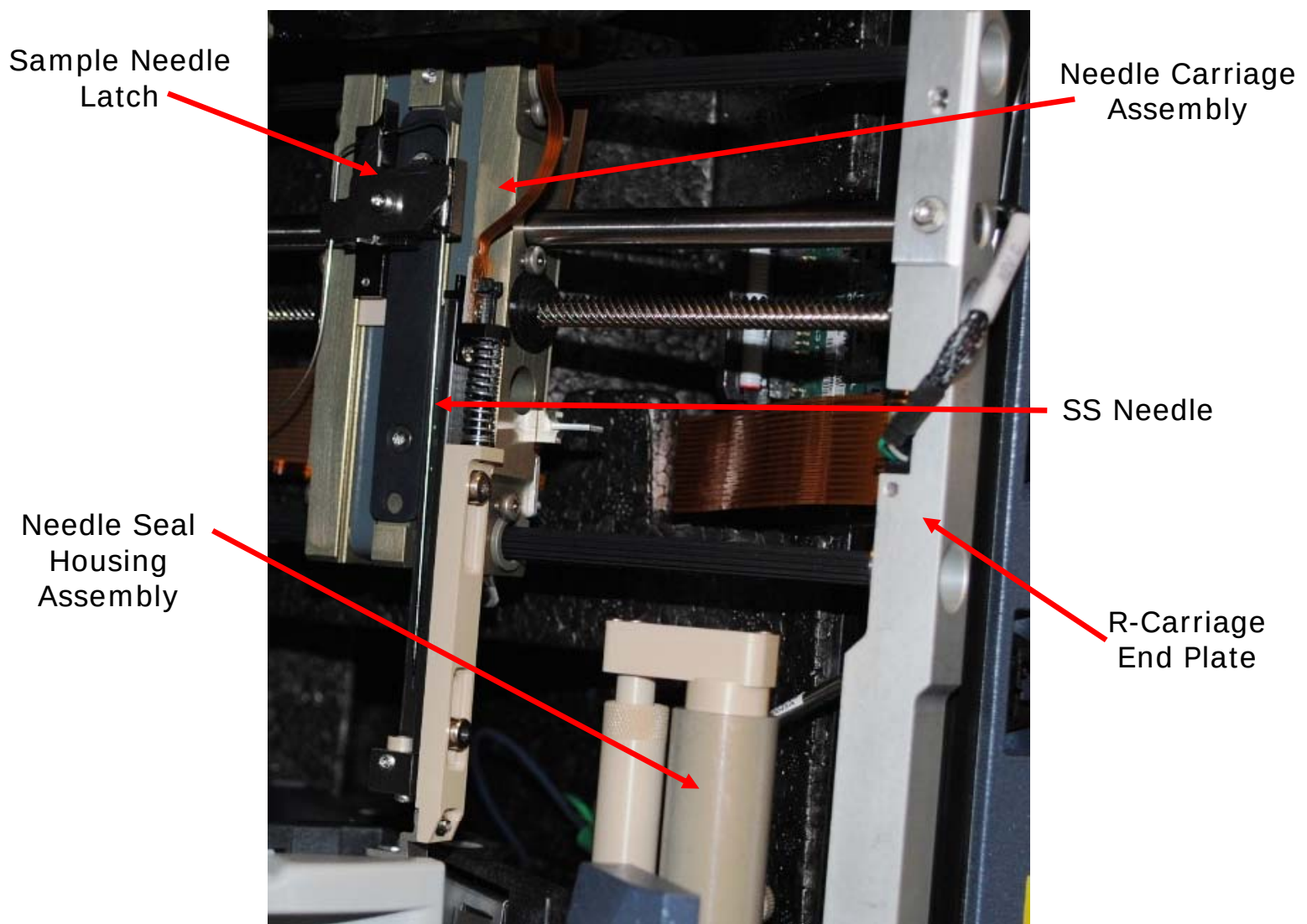
- ❑ Open the door to the SM Sample Compartment.
- ❑ Observe the main components of the Sample Compartment.
- ❑ Click on the Tray Position Switch to change bring the plate holder to position 1 and 2.
- ❑ Practice removing and inserting the plates.

What is the mechanism holding the plate in place _____?



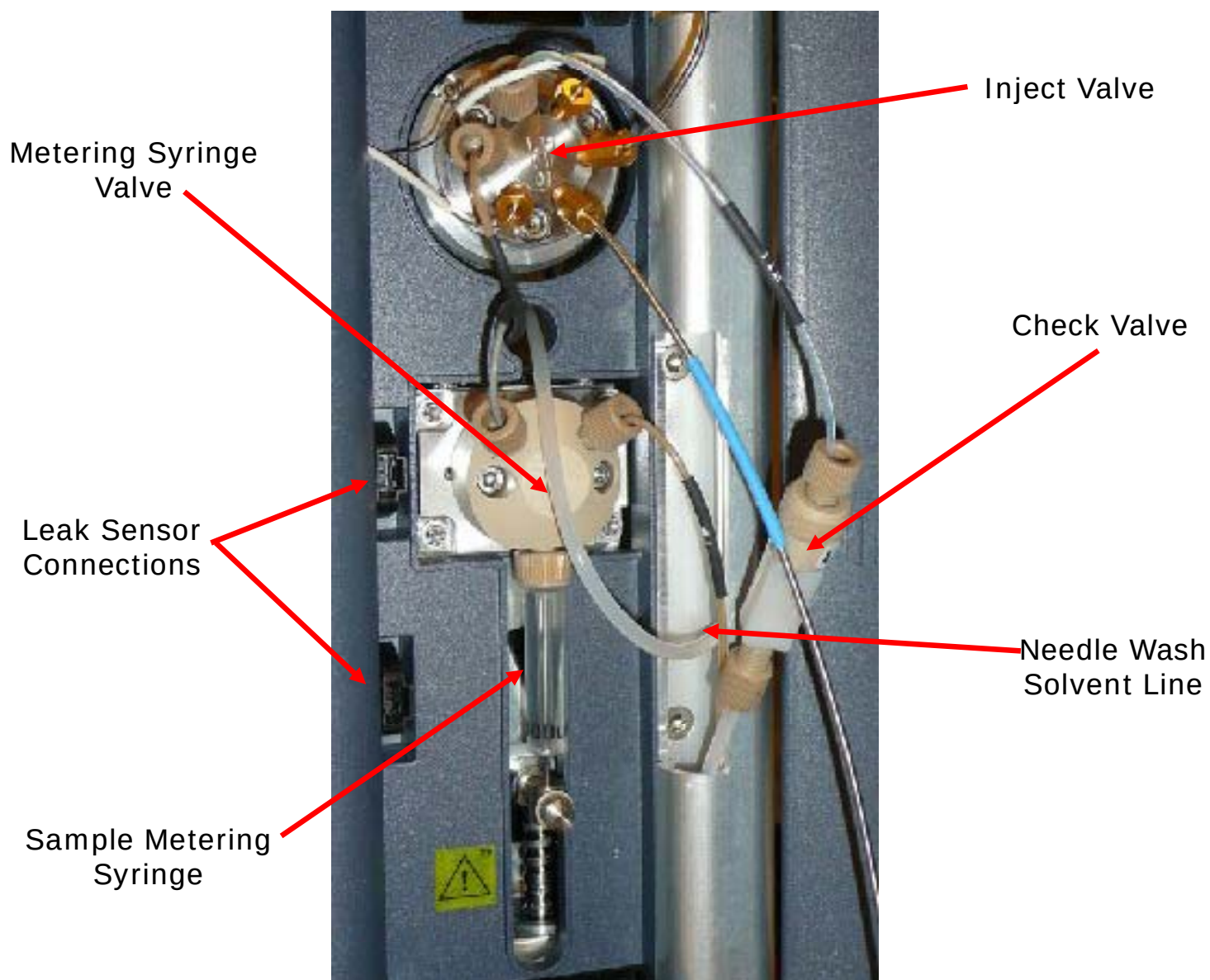
SM-FTN Components

- ❑ Remove the 2 T20 screws securing the access panel in front of the Inject Block and remove the panel.
- ❑ Observe the main components of the Needle Carriage Assembly and the Needle Seal Housing Assembly as seen below.
- ❑ Where possible, trace the solvent lines and SS tubing line back to their origins.
- ❑ You will find it quite useful to compare the actual fluidics layout to the fluidics diagrams listed on the coming pages.



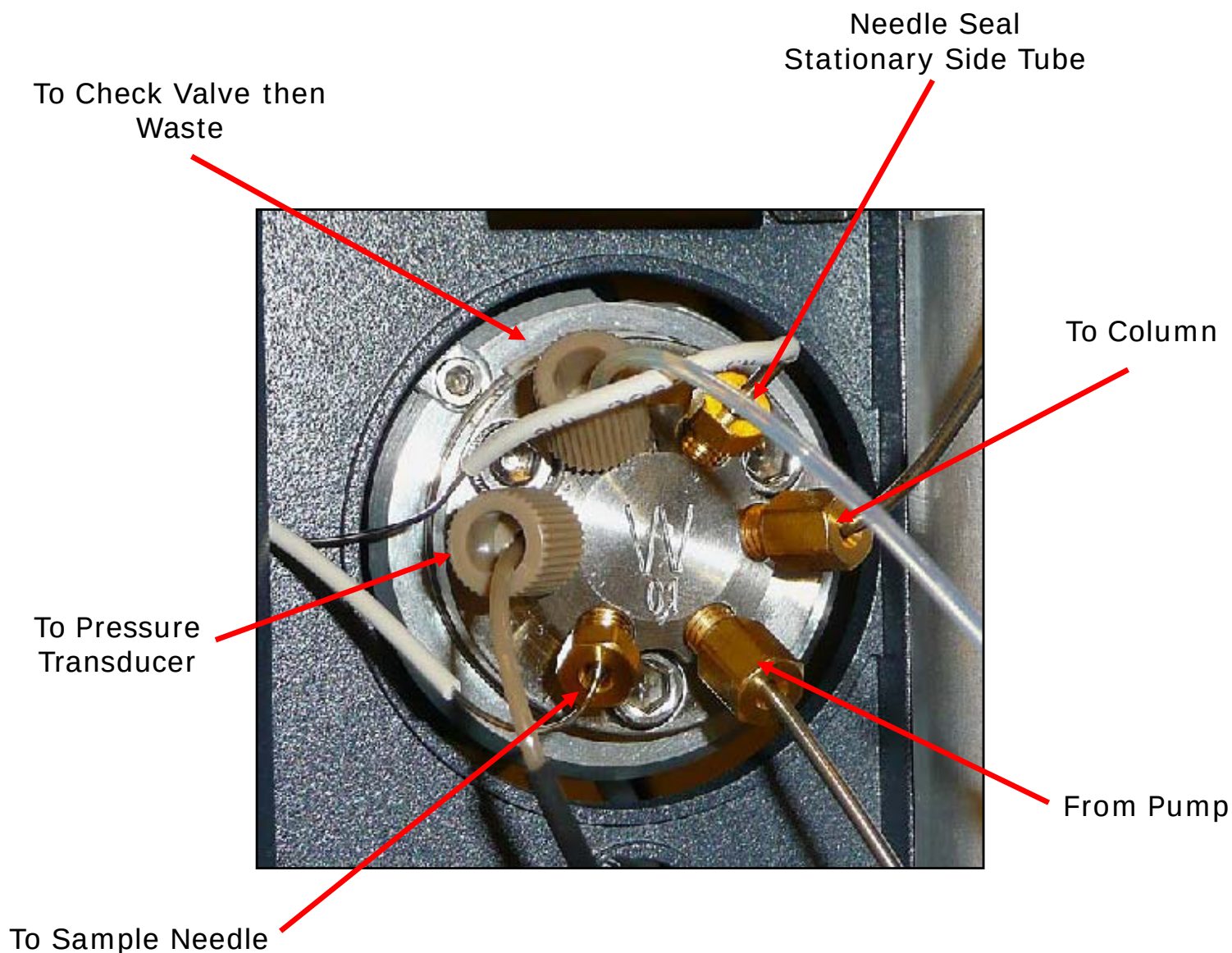
SM Syringe and Inject Valve

- Observe the main components of the Inject Valve and Sample Metering Syringe as seen below.



SM Inject Valve Connections

- Observe the main connections to the Inject Valve and as seen below and trace each line to its end point. You will need to open the right side panel of the SM to see some of the connection terminations. The internal fluidic components are detailed on the next page.



Internal Fluidic Connections

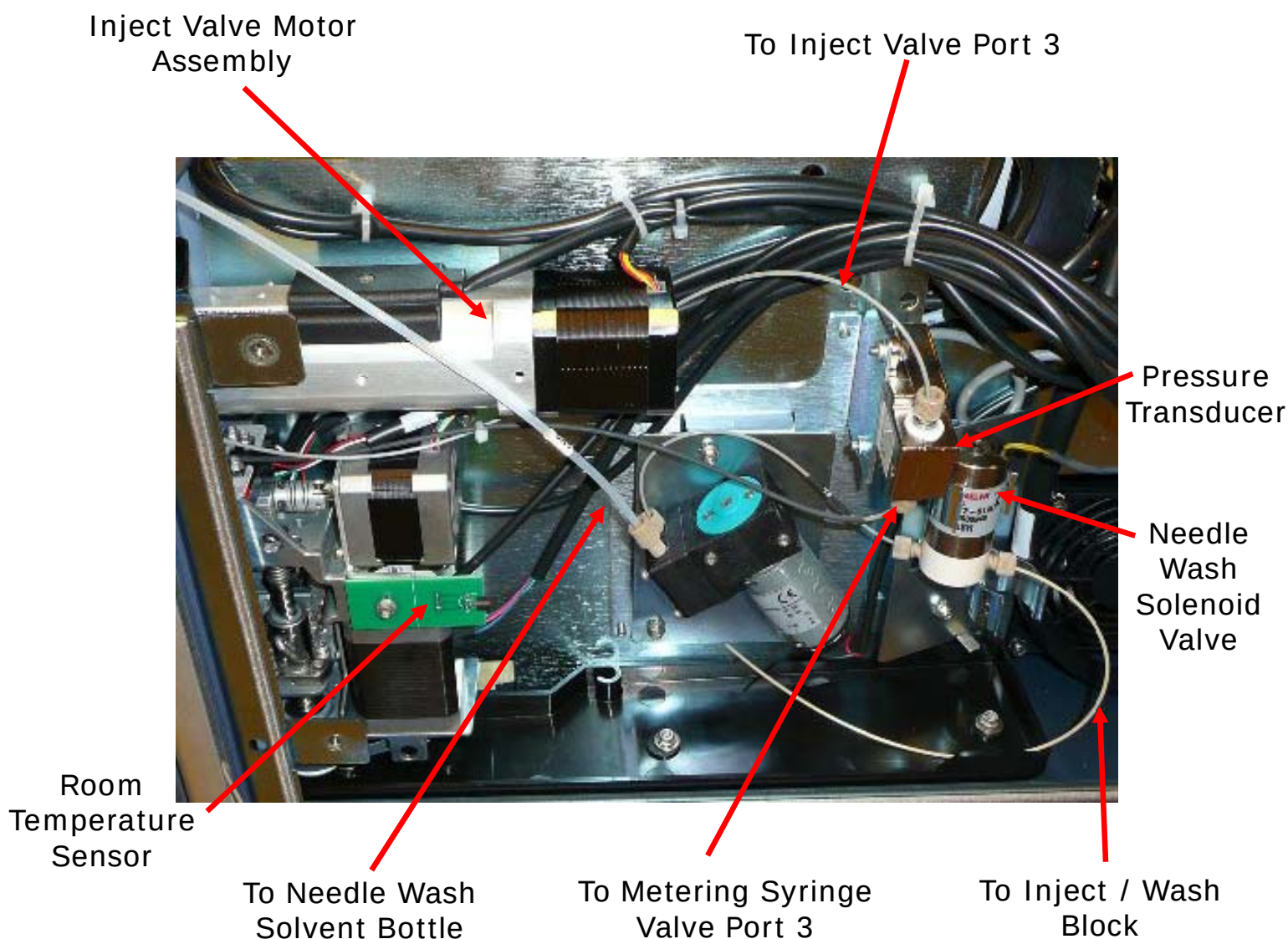
- Remove the 2 T20 screws securing the right side panel of the SM-FTN and remove the panel.



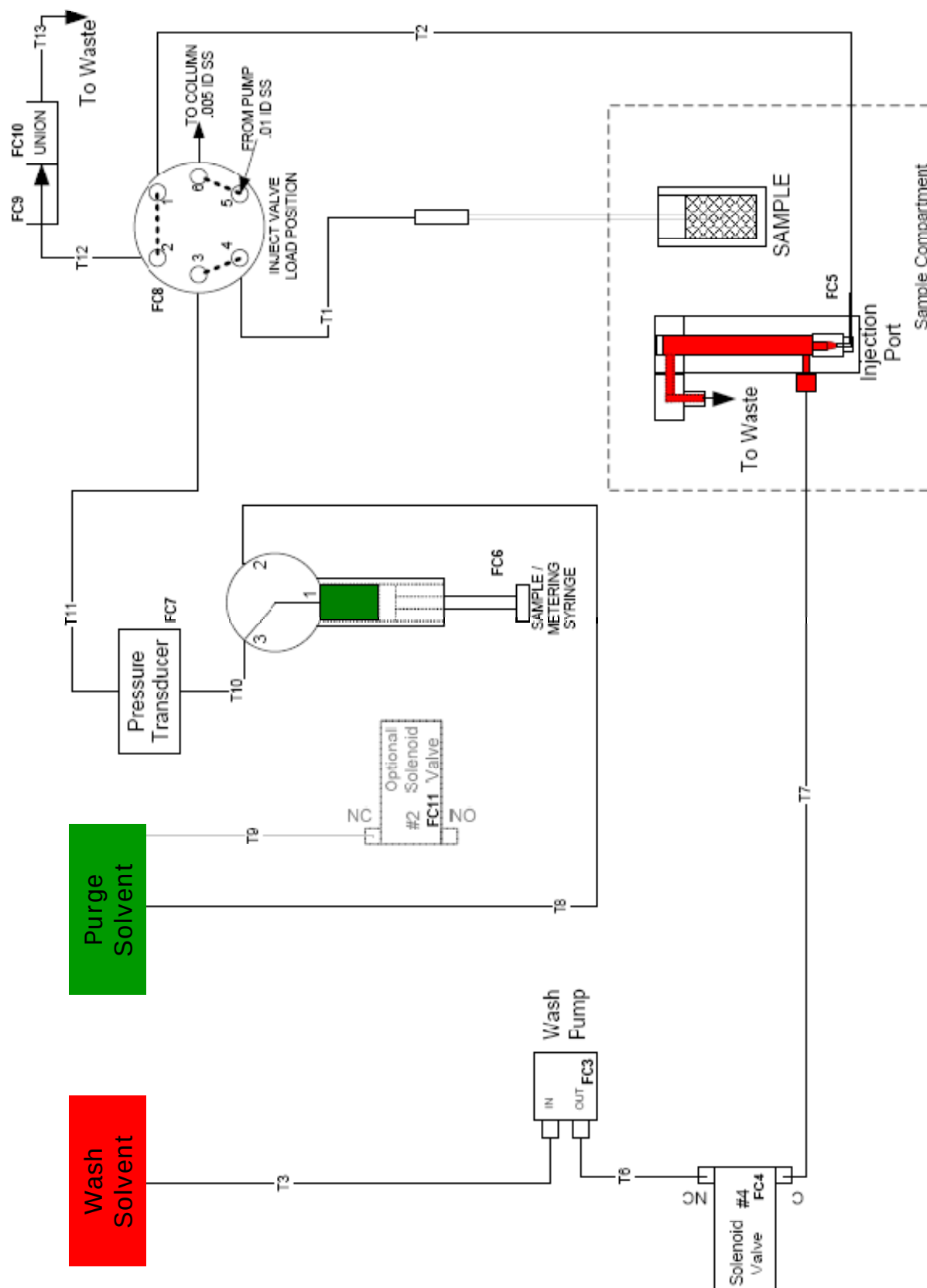
Warning- Beware of live AC and DC voltages when troubleshooting and servicing with side panels removed.

Observe the internal fluidic components as detailed in the picture below.

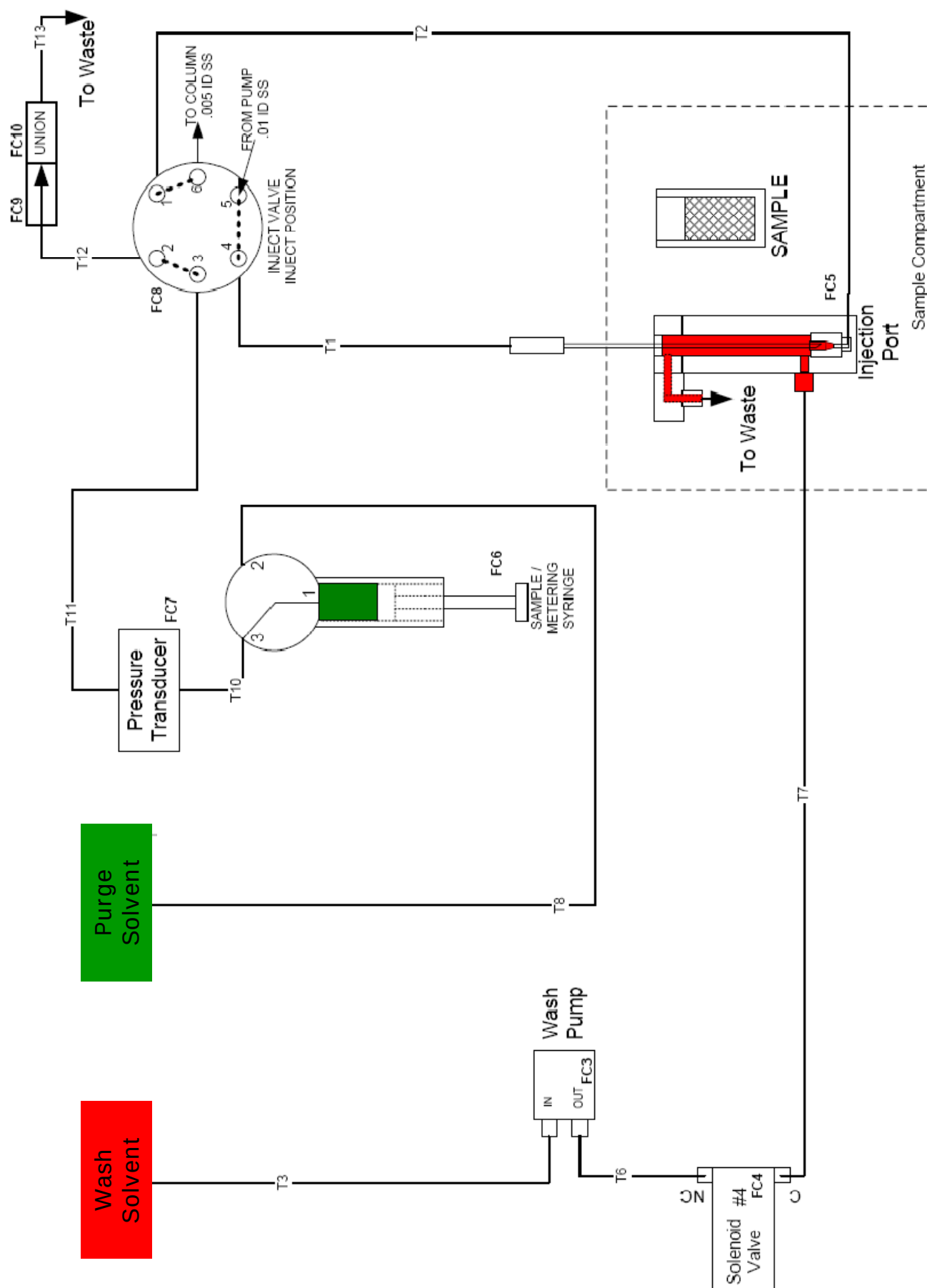
- As mentioned on the previous page, trace each line to its end point.
- When you have finished tracing the lines, reinstall the front and side panels.



Sample Withdrawal Diagram



Sample Injection Diagram





Section 2 ACQUITY Console Overview



ACQUITY Console Overview

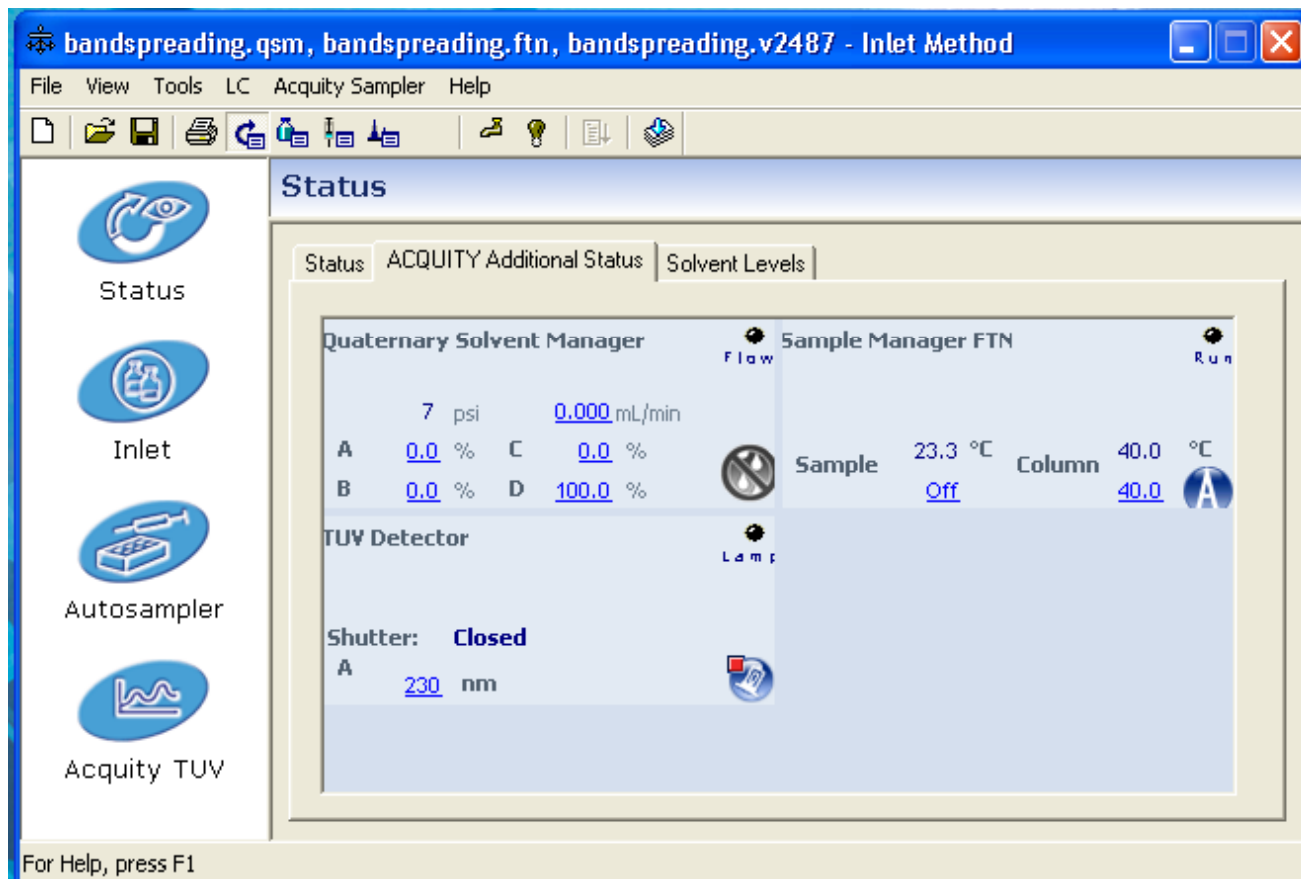
This workbook assumes that you have basic familiarity with either Empower or MassLynx software. The focus of the course is as well as the workbook is on ACQUITY H-Class and I-Class system control, verification, troubleshooting and service procedures. If you are unfamiliar with the software, please group-up with a partner that has knowledge of the software or ask the instructor for assistance.

Logging in to Empower or MassLynx

- ☐ Log-in to Empower or open MassLynx depending on the software you are running.
 - ☐ If you are running Empower, open the Run Samples menu from the login menu and choose the default H-Class System and Project selected in the dialog box. The ACQUITY Control Panels should be visible and active.
 - ☐ If you are running MassLynx , open the Inlet Method Editor menu from the shortcut menu of the MassLynx main menu. Click on the ACQUITY Additional Status tab. The ACQUITY Control Panels should be visible and active.
- ☐ The ACQUITY Control Panels function exactly the same way within Empower or MassLynx so all further functions will be referred to generically.

See the screen capture at the top of the next page.

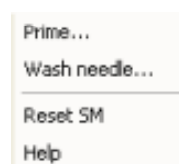
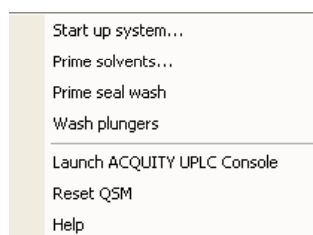
ACQUITY Control Panels



ACQUITY Control Panel Functions

The ACQUITY Control Panels were designed to provide the user access to the most frequently used functions and readouts for each module without the need to open the ACQUITY Console via hyperlinks or right-click functionality.

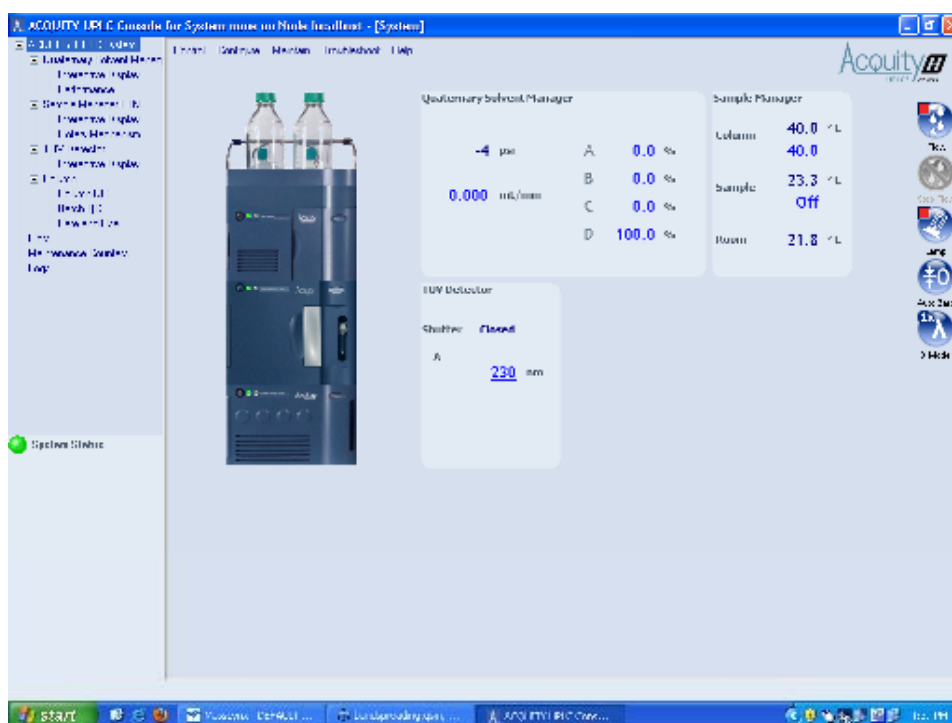
- ☐ Explore each of the key hyperlinks for each module by clicking on it then canceling out of the menu.
- ☐ Access the right-click menus for each module individually to get an overview of the menu choices.



ACQUITY Control Panels

Readying Solvents and Priming

- ☐ Obtain solvents from the prep lab area and add the ACQUITY solvent lines as follows:
 - ☐ **Line A and C-** 100% Water
 - ☐ **Line B-** 100% Acetonitrile
 - ☐ **Line D-** 100% Methanol
 - ☐ **Seal Wash, Purge Solvent and Needle Wash-** 90% Water 10% Acetonitrile
- ☐ Choose Prime solvents from the QSM right-click menu.
- ☐ Prime line D for 3 minutes to wet the pump heads with methanol. You will prime the rest of the lines from the Console menu.
- ☐ Launch the ACQUITY Console menu by clicking on the console icon  in the SM Control Panel. The top-level menu will appear (see figure below).



ACQUITY Console Menu

ACQUITY Console Top-Level Menu

The top-level menu of the console provides a common place to change settings and determine the operational status of all the modules of the ACQUITY system, as well as make system level configuration changes.

- ☐ Check the LED status lights of the ACQUITY modules on the instrument graphic. Do they match the lights on the physical modules _____?
- ☐ Hover the mouse cursor over each module graphic to obtain the S/N and firmware version. Record them in the table below.

Module	S / N	Version
QSM		
SM-FTN		
TUV/PDA		

- ☐ What is the current room temperature in the lab? _____°C
- ☐ Is the detector lamp on or off? _____
- ☐ Remove the TUV status panel from the display. Add it back in after checking that it is gone.
- ☐ What menu is used to switch pressure units between psi and bar? _____?

ACQUITY Console Menu

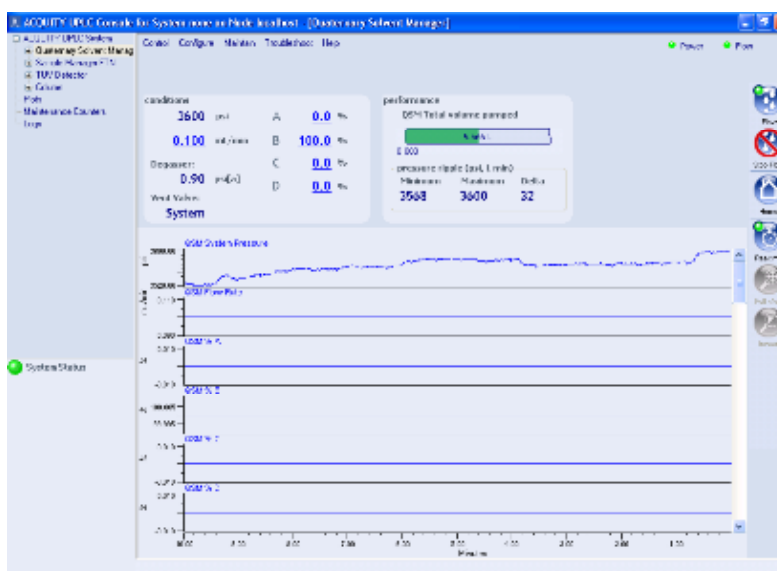
ACQUITY Console Top-Level Menu

- ☐ Run the Scan Instrument function from the Troubleshoot menu.
- ☐ Record the IP Address of each module in the table below.

Module	IP Address
QSM	
SM-FTN	
TUV/PDA	

- ☐ Make sure you have a ACQUITY column attached. Start the QSM pumping at a flow of 0.1ml/min with 100% B.
- ☐ Switch to the QSM top level menu.

The menu consists of 3 main elements: the conditions pane that allows for changing of flow conditions, the performance pane that shows key current performance data and the channel plot menu (see figure below).



Setting Plot Parameters

The ACQUITY Console plots are a key diagnostic feature of the software. All plots for all modules are automatically recorded for 96 hours even if they are not currently displayed in the menu; provided of course that the workstation and modules are powered on. This gives the user (and you of course) the ability to diagnose issues that occurred up to 4 days in the past. Information past the 96 hour mark are automatically overwritten by new data.

- ☐ Right-click on the channel plot area and choose Plot Properties from the menu.
- ☐ Change the plot time to 5 minutes.
- ☐ Switch to the QSM tab and select only the QSM Accumulator and the QSM System Pressure plots.
- ☐ Zoom in to a portion of the baseline of one of the plots. You should notice that the QSM System Pressure plot is a digitally filtered version of the plot from the same Accumulator transducer. Only one of these plots needs to be displayed.
- ☐ Right-click on the channel plot again and select only the QSM Accumulator and the QSM Primary plots. These are the 2 main plots needed for routine checks of the pump performance.
- ☐ Change the flow rate to 0.2 ml/min. Note the doubling of the frequency of the primary pump cycles.

Pressure Readings of Various Water and Acetonitrile Solvent Combinations

- ☐ Change the flow rate to 0.4 ml/min with 95% A Water and 5%B (Acetonitrile).
- ☐ Turn the Column Heater on to a temperature of 40 °C and allow the pressure to stabilize.
- ☐ Cycle through various combinations of Acetonitrile and Water, allow the change to reach the column and stabilize then record the pressure in the table below:

% A (H2O)	% B (ACN)	Pressure
95	5	
90	10	
80	20	
60	40	
50	50	
40	60	
20	80	
0	100	

- ☐ Which H2O/ACN solvent combination has the highest back pressure_____?

Pressure Readings of Various Water and Methanol Solvent Combinations

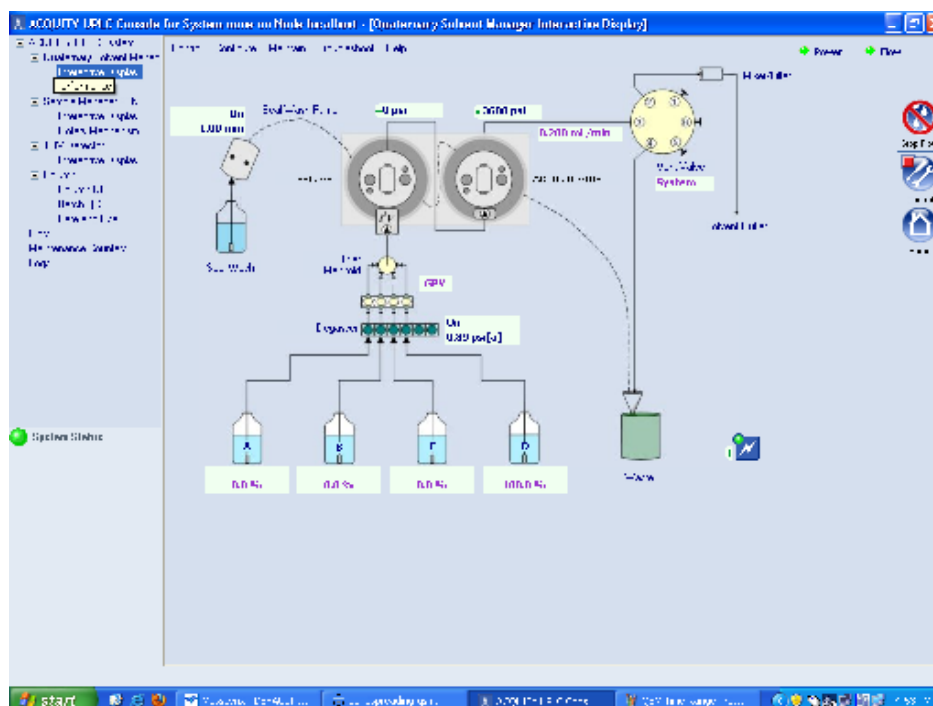
- ☐ Change the flow rate to 0.4 ml/min with 95% A Water and 5%D (Methanol).
- ☐ Allow the new solvent combination to fully reach the column and the pressure to stabilize.
- ☐ Cycle through various combinations of Methanol and Water. Allow the change to reach the column and stabilize then record the pressure in the table below:

% A (H2O)	% B (MEOH)	Pressure
95	5	
90	10	
80	20	
60	40	
50	50	
40	60	
20	80	
0	100	

- ☐ Which H2O/MEOH solvent combination has the highest back pressure_____?
- ☐ How much higher is the maximum H2O/MEOH combination over H2O/CAN?_____psi

QSM Interactive Menu

- ☐ Reduce the flow rate to 0.2 with 100% D (MEOH)
- ☐ Go to the QSM Interactive menu. Your menu should look similar to the screen below.
- ☐ Compare the flow path detailed in the Interactive menu to your actual QSM components.
Is the diagram accurate as compared to the actual front panel components_____?
- ☐ Click on the Control button to turn on interactive control.
- ☐ Does the flow remain on or does it turn off_____?
- ☐ Click on the link to the vent valve link. Switch the valve to vent.
- ☐ What happens with the flow and pressure_____?
_____?
- ☐ Switch the valve back to system and shut down the flow.



QSM Interactive Menu

- ❑ Click on the GPV link. The Set GPV menu will appear (see screen below).
- ❑ Click on each valve in order. A click should be heard as 24v is applied to actuate the normally closed valve.

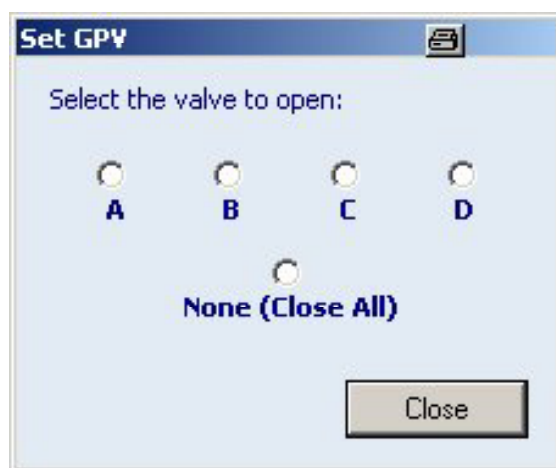
This is an excellent diagnostic tool to test the flow coming from each individual valve and solvent filter. You can troubleshoot a blocked or non-functional valve by observing the gravity fed flow from each valve from the disconnected mixer tube. This will be done in a later section. This is detailed in the Siphon Check Procedure on the portal.

- ❑ Check the voltage being read from the personality card by clicking on the  icon.

Enter the voltage readouts for your QSM in the table below.

Voltage	Reading
VCC	
VCC Ground	
+15V	
-15V	
+24V	
+24V Ground	

What is the current Degasser pressure? _____psi(a)



Checking QSM Performance

- ❑ Switch back to the QSM top level menu and set the flow rate to 0.2 again with 100% D (MEOH).
- ❑ Give the pressure at least 3 minutes to settle down and record the Pressure Ripple.

Delta Pressure Ripple MEOH- _____PSI

- ❑ Switch solvents to 50% A 50% D and repeat the above steps for Water / Methanol mix.

Delta Pressure Ripple H2O/ MEOH - _____PSI

- ❑ Switch solvents to 100% B and repeat the above steps for Acetonitrile.

Delta Pressure Ripple ACN - _____PSI

- ❑ Switch solvents to 50% A 50% B and repeat the above steps for Water / Acetonitrile mix.

Delta Pressure Ripple H2O/ ACN - _____PSI

The delta pressure ripple is an excellent diagnostic to determine the health of the pump while flow is running. In general, the delta pressure ripple should be no more than 1% of the current pressure when running at normal UPLC pressures. It needs to be examined in context with the accumulator pressure trace to look at trends over the previous few minutes. For instance, if the pressure is changing due to temperature of mobile phase changes then that has to be considered as the cause of a high pressure ripple score.

Checking QSM Performance

- ❑ Switch to the QSM Performance menu.
- ❑ Switch solvents to 100% A maintaining 0.2ml/min.
- ❑ Allow the solvent change to stabilize.
- ❑ Record the C/D Ratio and Compressibility for 100% Water.

C/D Ratio (Water)_____.

Compressibility (Water) .

- Switch solvents to 100% B and repeat the above steps for Acetonitrile.

C/D Ratio (ACN)_____

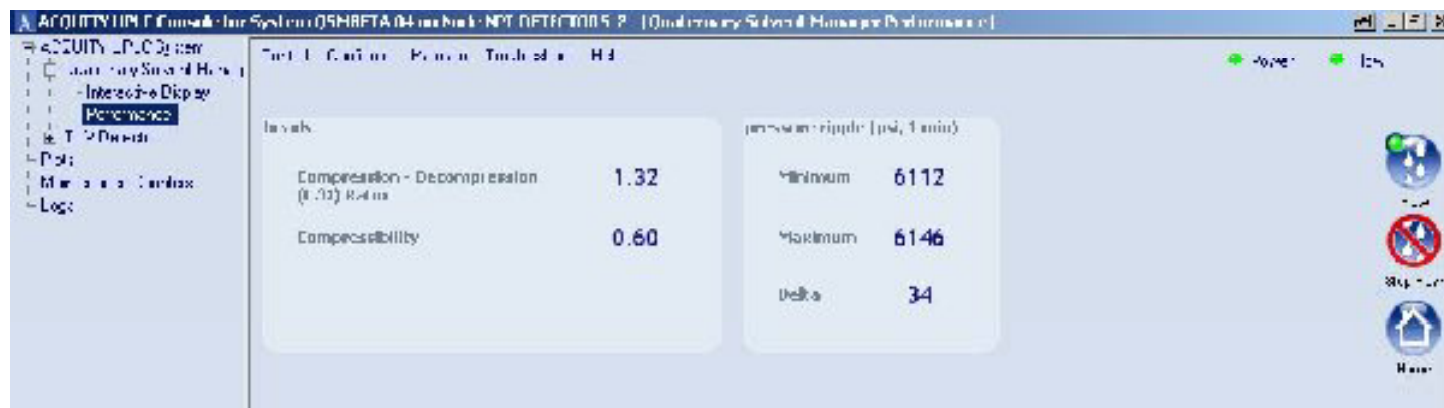
Compressibility (ACN)

- Switch solvents to 100% D and repeat the above steps for Methanol.

C/D Ratio (ACN) .

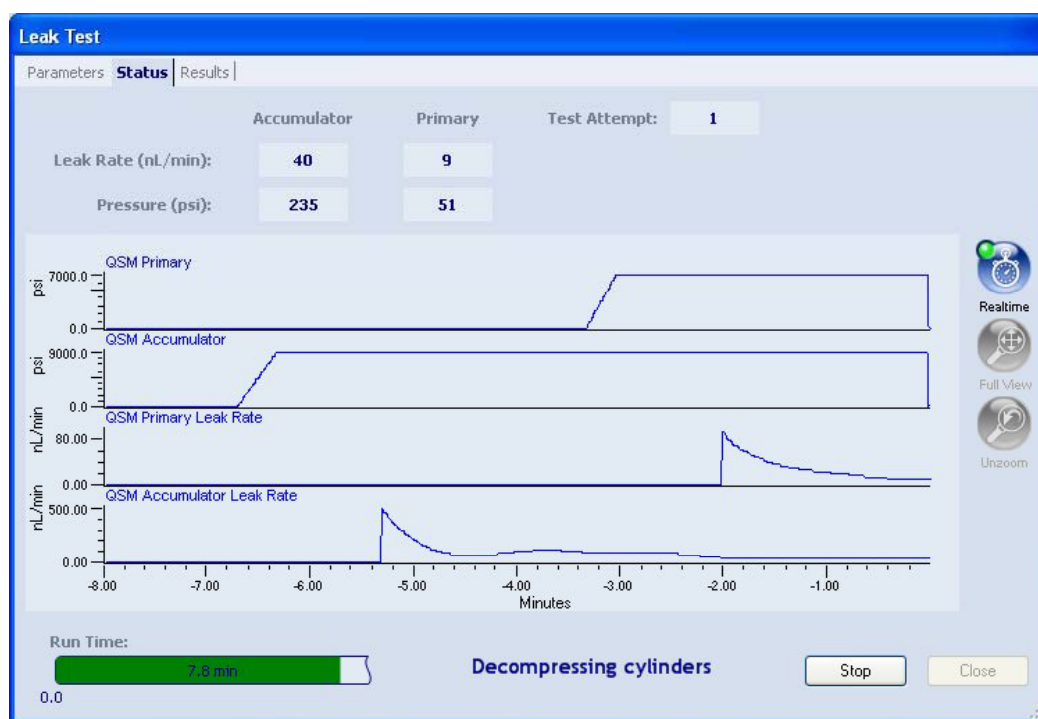
Compressibility (ACN)_____

- Switch flow back to 90% Water 10% ACN and allow the pressure to settle again.

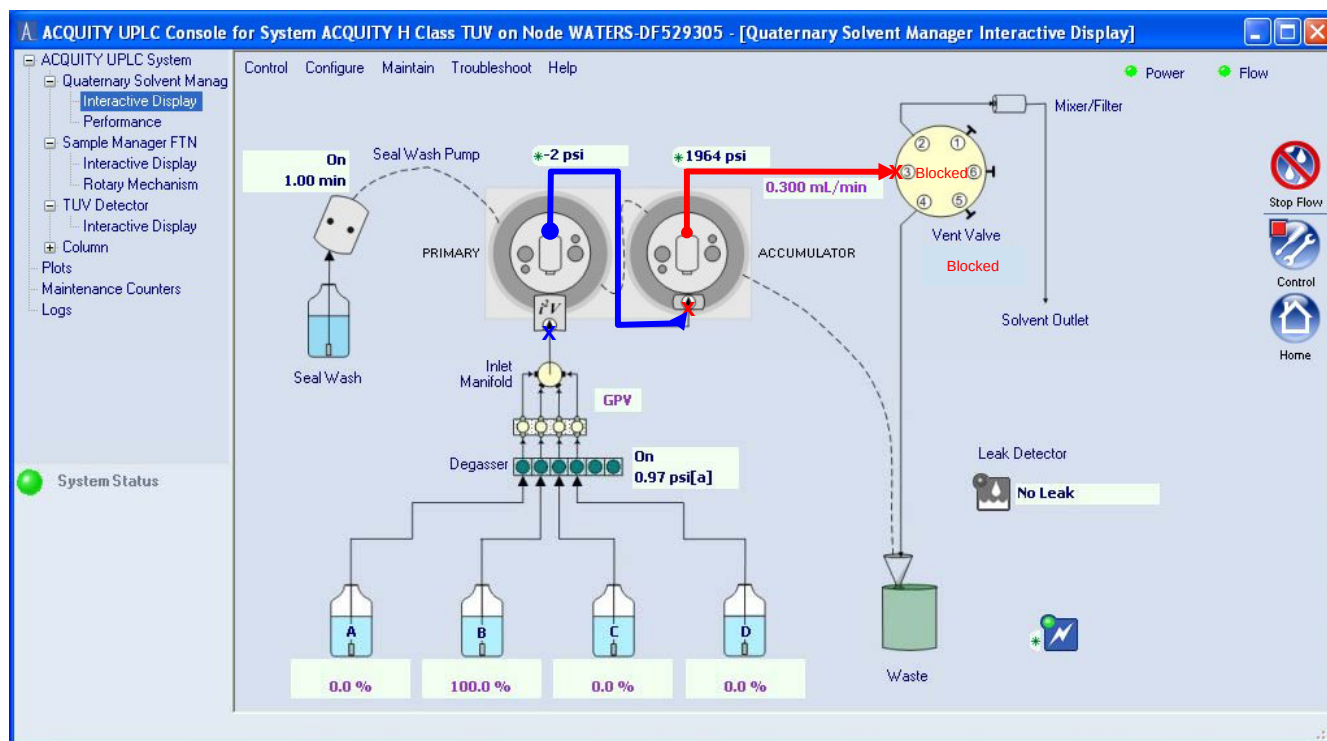


Seal Wash and Leak Test

- ❑ Shut off the flow using Set Flow from the Control menu.
- ❑ Prime the Seal Wash for about 2 minutes.
- ❑ Trace the path of the Seal Wash line and remove the line outlet line from the waste management system.
- ❑ Observe that there is a steady flow of solvent coming out indicating a good prime then stop the prime.
- ❑ Perform the Wash Plunger function from the Maintain menu. Observe the steps involved in washing the plungers.
- ❑ Switch the console menu to the top level QSM menu so you can see the pressure plots.
- ❑ Run the Leak test using solvent D at 14000 PSI with the Vent Valve as the end point.
- ❑ On the status page, you can right-click the plots and show the Accumulator and Primary pressure plots.



Leak Test Results



In the QSM interactive menu above diagram, the **red line** indicates what is tested during the Accumulator leak test and the **blue line** indicates what is tested during the Primary leak test.

The criteria for passing the leak test is a leak rate less than 150nL/min when testing to the QSM Vent Valve.

When testing to the column, the criteria for passing the leak test is a leak rate less than 300nL/min.

- ☐ Record your results in the appropriate fields:

Leak Test	
Parameters Status Results	
	Accumulator Primary
Result:	
Leak Rate:	nL/min nL/min
Maximum Pressure:	psi psi
Percent of Stroke:	% %
Compressed Volume:	uL uL
Compression Attempts:	
Test Attempts:	
Print	
Start Close	

Leak Test Results

- ❑ Repeat the leak test using 100% B (ACN) but make sure to choose to prime first.
- ❑ Record your results in the appropriate fields:

The screenshot shows a software window titled "Leak Test" with three tabs: "Parameters", "Status", and "Results". The "Results" tab is active. The window is divided into two columns: "Accumulator" and "Primary". Each column has a "Result:" label followed by a text input field. Below these are several rows of labels and input fields: "Leak Rate:" with units "nL/min", "Maximum Pressure:" with units "psi", "Percent of Stroke:" with units "%", "Compressed Volume:" with units "uL", "Compression Attempts:" (no units), and "Test Attempts:" (no units). At the bottom right, there are three buttons: "Print", "Start", and "Close".

- ❑ What are the differences in leak rates
- ❑ Repeat the leak test using 100% A (Water) and again choose to prime first.
- ❑ Record your results in the appropriate fields:

This screenshot is identical to the one above, showing the "Leak Test" window with the "Results" tab selected. It displays the same layout of input fields for "Accumulator" and "Primary" parameters, including "Result:", "Leak Rate:", "Maximum Pressure:", "Percent of Stroke:", "Compressed Volume:", "Compression Attempts:", and "Test Attempts:", along with the "Print", "Start", and "Close" buttons.

Switching QSM Solvent Lines

The ACQUITY System Verification tests are set up to use Water and Acetonitrile in either an isocratic or gradient mode. Before proceeding with the SM-FTN console menus, switch the lines and prime the system as directed below.

- ☐ Make sure that the solvent lines are inserted to the bottles as follows:

Water	Lines A,C and Seal Wash
Acetonitrile	Lines B,D
10% ACN 90% H ₂ O	SM Wash and Purge Solvent

- ☐ Prime each solvent line for 3 minutes.

What is the total time it takes to prime the QSM lines_____?

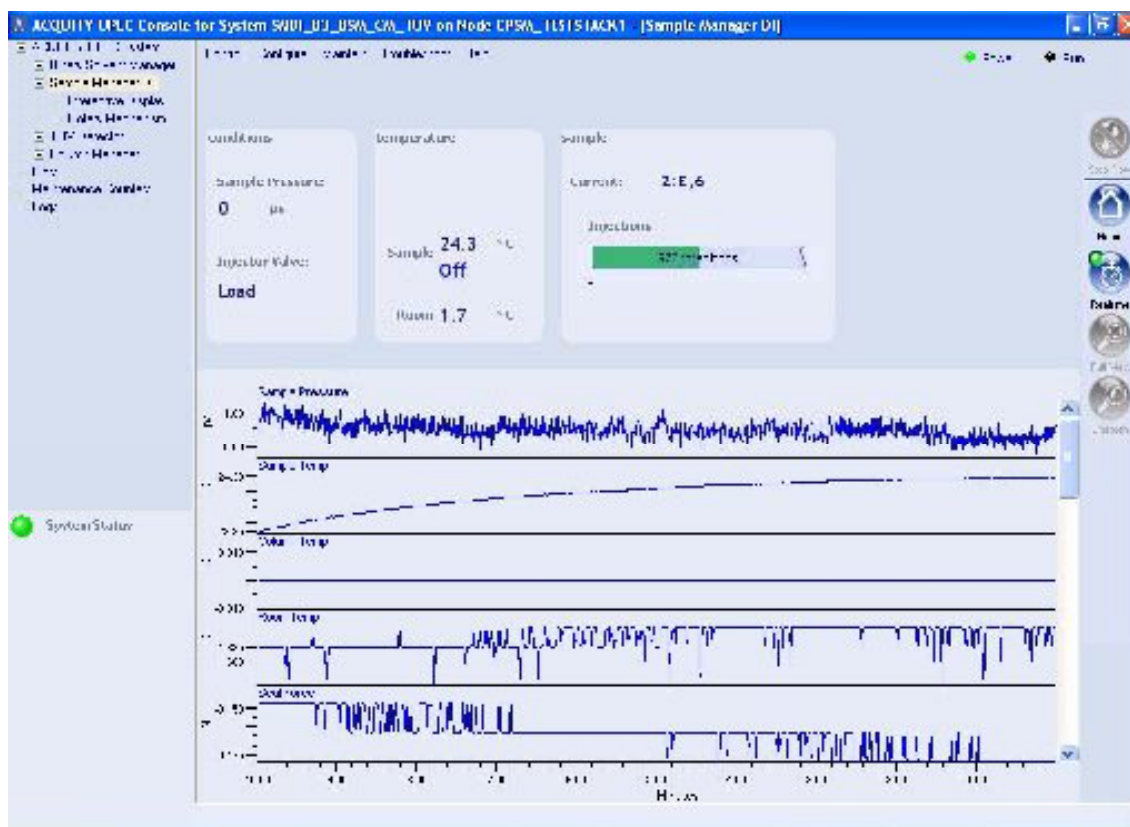
- ☐ Start the QSM pumping with 90% A (Water) and 10% B (Acetonitrile) at a flow rate of 0.1ml/min.

SM-FTN Console Menus

- Go to the SM-FTN Top Level menu. Your menu should look similar to the screen below.

Similar to the QSM, the SM-FTN top level menu is. The menu consists of 3 main elements: the conditions pane that shows current Sample pressure and inject valve status, temperature and allows for changing of flow conditions, the temperature pane that displays column sample and room temperature readouts and allows editing. The channel plot menu displays channel data specific to the SM_FTN but functions exactly the same as the QSM channel menu.

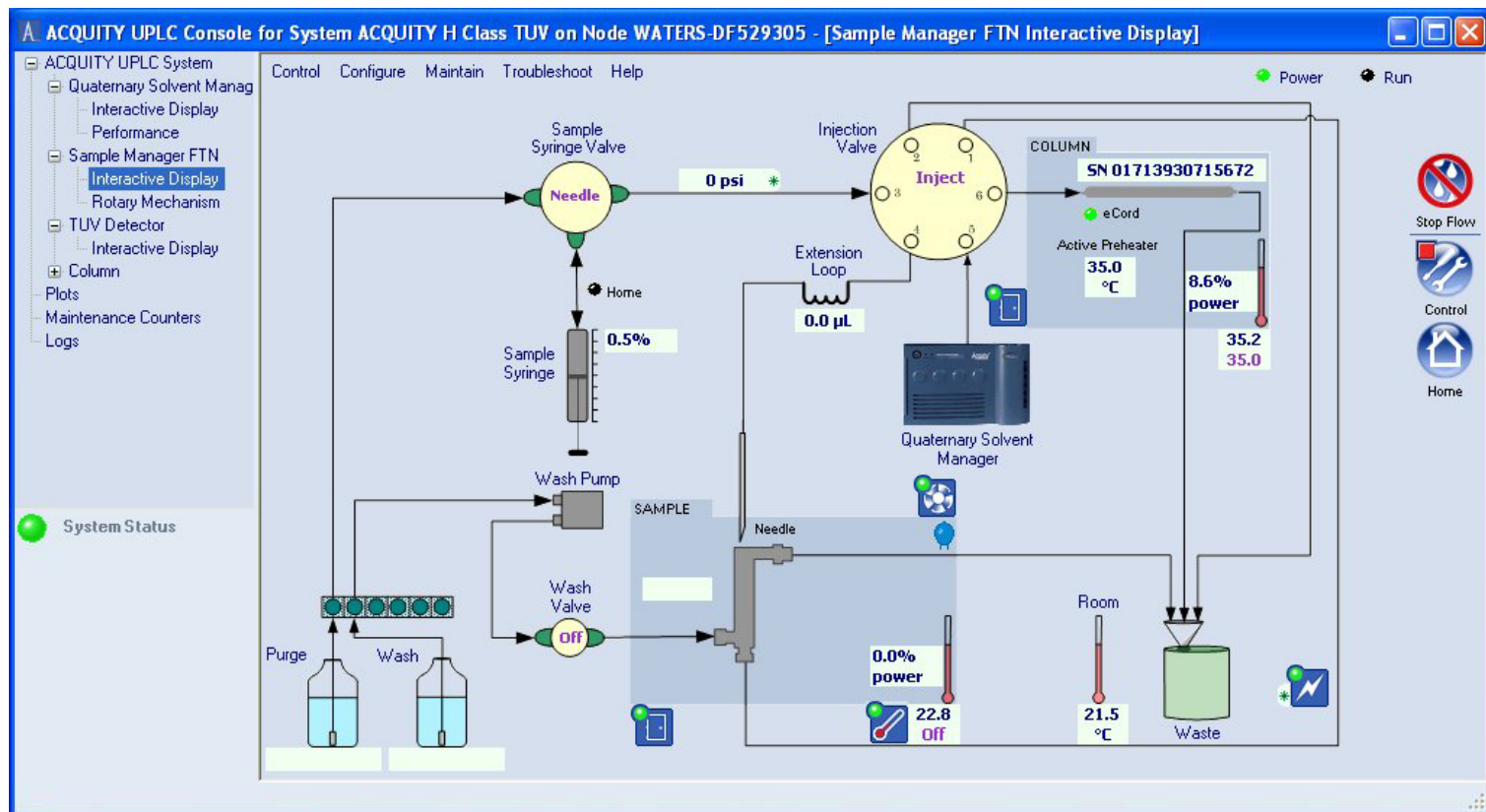
- Right-click on the SM plot display and choose properties. List the new plot channels you find compared to the SM menu.



SM-FTN Interactive Menu

- ❑ Go to the SM Interactive menu. Your menu should look similar to the screen below.
 - ❑ Compare the diagram in the Interactive menu to the SM-FTN fluidics diagram. Does the diagram accurately represent the flow path?
-
-

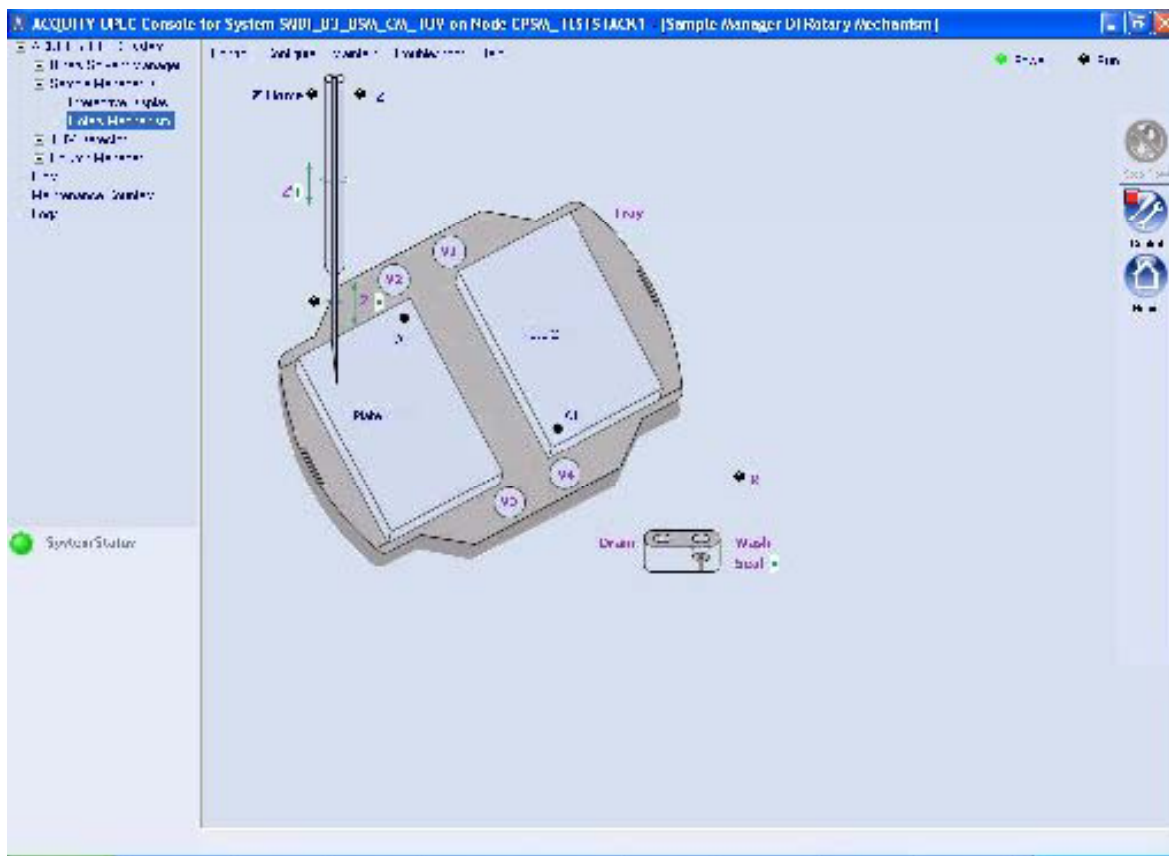
- ❑ Click on the Control button to turn on interactive control. What fields are enabled for control?
-
-



SM-FTN Rotary Menu

- ❑ Click on the Control button to turn off interactive control.
- ❑ Switch to the Rotary Mechanism menu. Your menu should look similar to the screen below.
- ❑ Click on the Control button to turn on interactive control.
- ❑ Move the needle to the V1 position while observing the movements in the Sample Compartment.
- ❑ Move the needle to the Injector Wash position then the Injector Seal position.

Caution: Keeps your hands out of the Sample Compartment when the needle is moving.



SM-FTN Configure Menu

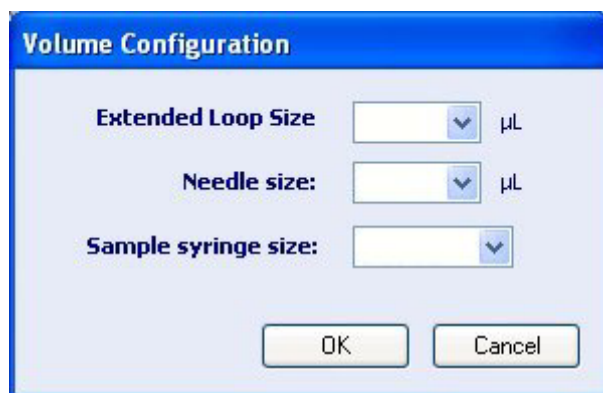
- ❑ Click on the Control button to turn off interactive control. Switch back to the SM-FTN Top Level menu.
- ❑ Click on Preferences from the Configure menu. The Configure menu will appear.



- ❑ Close the Sample Compartment door.
- ❑ Try each setting for “When the door is opened” dialog box and check for the proper result when you open the Sample Compartment door.

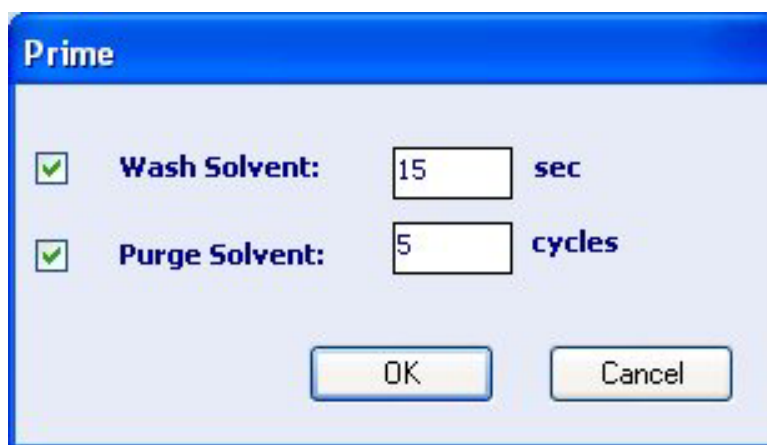
Does the light come on when it should_____?

- ❑ Click on Volumes from the Configure menu. The Volumes menu will appear.
- ❑ Fill in the values displayed in the fields below.



SM-FTN Control Menus

- ☐ Switch the SM plots to show only sample pressure.
- ☐ Click on Prime from the Control menu. The Prime menu will appear.



- ☐ Choose the default prime settings and click OK.
- ☐ Observe the sample pressure trace during the prime function.

Is there any pressure change during the Wash Solvent prime (if not then why)_____?

Is there any pressure change during the Purge solvent prime (if not then why)_____?

- ☐ Click on Wash Needle from the Control menu. The Wash Needle menu will appear. Choose the default setting and click OK.

Is there any SM pressure change_____?

- ☐ Prime the Wash solvent for a further 45 seconds and the Purge solvent 30 more cycles to fully exchange the solvents in the wash station and syringes.

SM-FTN Diagnostic Tests

- ❑ Perform the Leak test from the Maintain menu. This test is a key diagnostic that determines the condition of the Sample Syringe and the ability of the SM-FTN to inject samples with good run to run precision.
- ❑ Record the results of your leak test results in the field below:

Results		Leak Test
Passed:		
Test pressure:		psi
Compressed volume:		µL
Decompressed volume:		µL
Start pressure:		psi
End pressure:		psi
Pressure change:		psi
Average pressure leak:		psi/sec

- ❑ Run the Characterize needle seal function from the Maintain menu.
- ❑ Record the results below:

Characterize Needle Seal		
Run time:		
	0.0 Min	Start
0.0		<< Results
		Close
Results		
Passed:		Print...
Seal Constant:		N/mm
Distance To Seal:		mm
Foot Offset:		mm

SM-FTN Diagnostic Tests

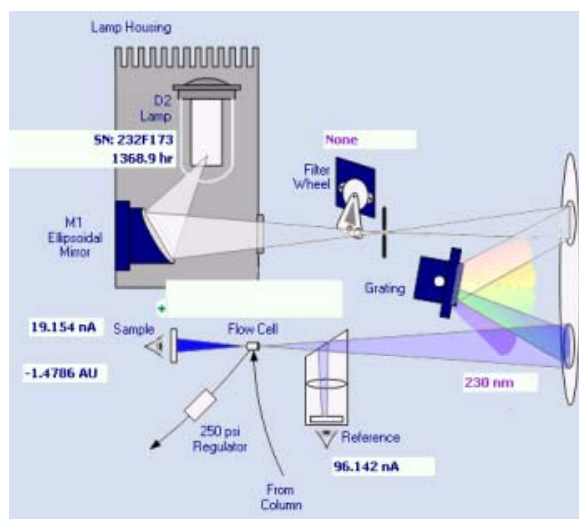
- ❑ Start the QSM pumping with 90% A (Water) and 10% B (Acetonitrile) at a flow rate of 0.6ml/min.
- ❑ Run Needle seal readiness test from the Maintain menu. Search the help menu for a full explanation of the test.
- ❑ After the test is completed zoom in to the QSM Accumulator pressure plot for the previous minute to note the pressure changes that occur during the test. The pressure changes mirror the swing in pressure that occurs during the injection sequence.
- ❑ Record the Needle seal readiness test results below:

Results		
Passed:		
Pressure Difference:		psi
Flow:		ml/min

Please let your instructor know if your system is failing any of the tests or have any issues or questions. You will run the other diagnostic tests for the SM-FTN later in the course.

TUV Detector Menu

- ☐ Switch to the Column top level menu.
The menu consists of two panes: the conditions pane gives a readout of the absorbance as well as the currently selected wavelength and the performance pane which displays the TUV Lamp Life hours and the warning level setting.
- ☐ What channels are available to display in the plot menu?_____.
- ☐ Are the channels currently displaying data?_____.
- ☐ Make sure that the lamp is on. Switch the wavelength to 230nm. Access this menu even if the wavelength is already set to 230nm if the AU readout reads closed as this will open the shutter to the optics if the detector has been idol.
- ☐ Switch to the Interactive Display menu.
- ☐ Record your Reference and Sample energy in the fields below:
Reference energy-_____na
Sample energy-_____na



Column Menu

- ☐ Switch to the TUV Detector top level menu.

The menu consists of four panes and a column history table.

The column pane lists the part number and serial number for the column.

The usage counter pane shows the injection count statistics for the column. The environment pane shows the maximum pressure and history of the column.

The column history table displays the statistics for the last 50 Sample Sets that were run on the column.

- ☐ How many injections have been run on your column?_____.
- ☐ Maximum pressure-_____psi
- ☐ Maximum temperature-_____°C
- ☐ Name of the last Sample Set run_____.
- ☐ Switch to the Column QC menu.
- ☐ What is the batch number of your column_____
- ☐ USP Tangent Efficiency-_____.
- ☐ Switch to the Batch QC menu.
- ☐ Packing material batch number _____.
- ☐ What date was the material QC approved?_____.
- ☐ Switch to the Care and Use menu.
- ☐ Does the menu display support library document links?

Note, this menu will only function if you are connected to the network and have a valid login to the Waters web site.



Section 3

Quick-Start Best Practices Monitoring System Health

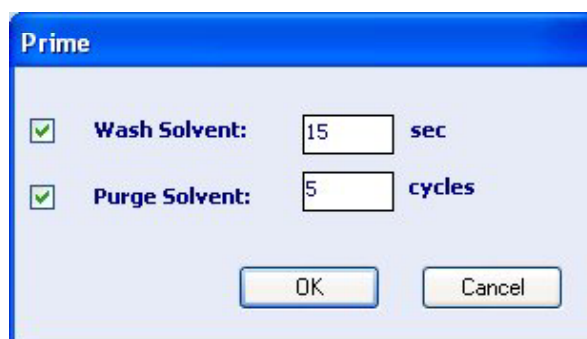


QuickStart- Best Practices

- Objective- to learn the current best practices for restarting the H-Class system after long and short duration shutdown
- Startup prime of the system after a long and short-term shutdown
 - QSM Solvent Lines
 - QSM Seal Wash
 - Solvent Select Valve
 - SM-FTN Wash Solvent
 - SM-FTN Purge Solvent
 - Flow Rate Ramping
 - Setting the CH-A Temperature

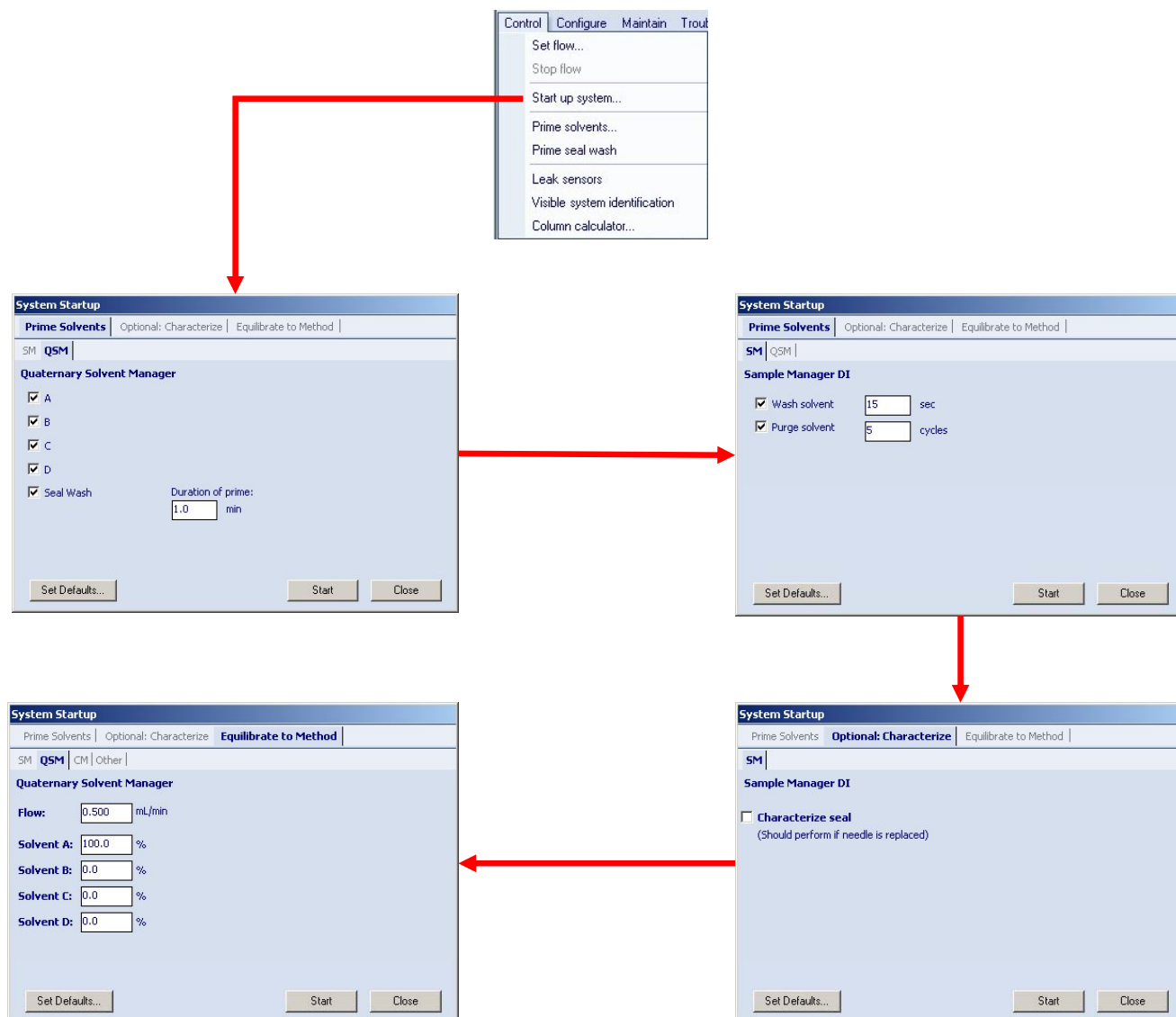
Priming Guidelines

- ❑ Observe the following guidelines when starting up the system after a short-term shutdown:
 - ❑ *Prime all QSM solvent lines being used for 2 minutes if the system has been idle for 4 or more hours and you will use the solvents that are already in the system.*
 - ❑ *Prime all QSM solvent lines being used for 4 minutes if you will use new solvents that are of the same composition of what is already in the system.*
 - ❑ *Prime the Seal wash for 1 minute.*
 - ❑ *Prime the SM-FTN Wash Solvent and Purge Solvent using the default values of 15 seconds and 5 cycles respectively.*
- ❑ Observe the following guidelines when starting up the system after a long-term (greater than 72 hours) shutdown or when completely changing the solvents:
 - ❑ *Prime all QSM solvent lines being used for 5 minutes*
 - ❑ *Prime all QSM solvent lines being used for 7 minutes if changing solvents completely*
 - ❑ *Prime the SM-FTN Wash Solvent for 60 seconds and the Purge Solvent for 10 cycles.*
 - ❑ *When priming a dry system, prime the wash solvent for 60 seconds and the purge solvent for 30 cycles.*
- ❑ Consult the ACQUITY UPLC H-Class System Quick Reference Card for full details.



The System Startup Menu

- ❑ Go to the Console Top Level menu.
- ❑ Click on Startup System from the Control menu. The System Startup menu will appear.
- ❑ Perform the system startup routine using the default values as shown in the screens below. You do not need to equilibrate the system to a flow rate or temperature at this time.



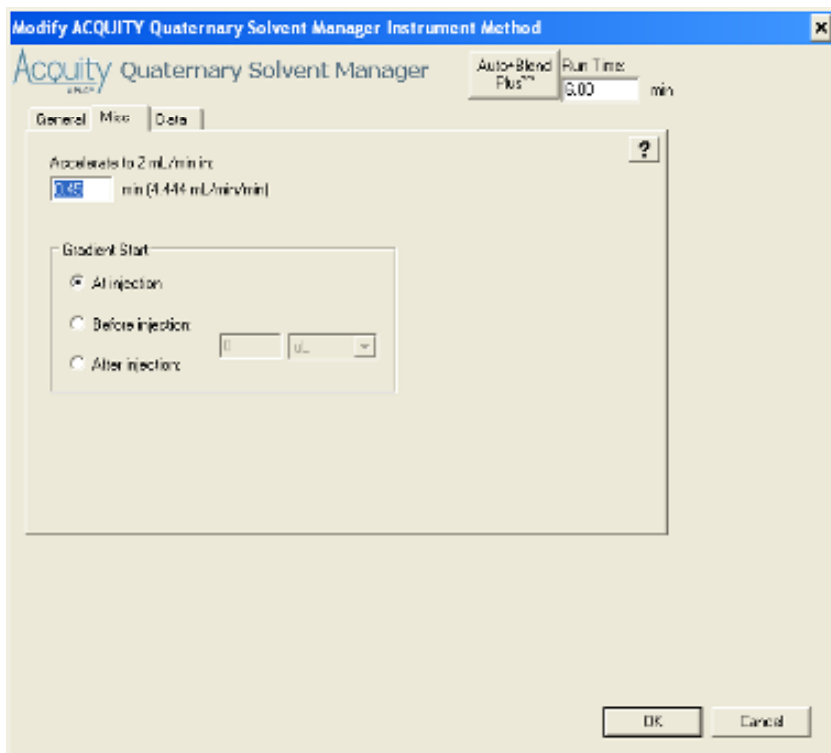
Flow Rate Ramping

The rate at which the flow rate is ramped after a set flow command is given can be controlled by the Accelerate to 2ml/min field in the QSM instrument method. In order for the entered value to be used, the instrument method must be downloaded to the ACQUITY system.

- ☐ Try the default value of 0.5 and set the flow to 0.5 ml/min. Stop the flow rate after 1 minute by switching the flow to 0ml/min.
- ☐ Set the Accelerate to 2ml/min rate to 1.0.
- ☐ Download the method and set the flow to 0.5 ml/min. Stop the flow rate after 1 minute.

Do you notice a difference in the slopes of the system pressure trace?_____.

- ☐ In preparation for running the Performance Verification tests, set the flow to 0.6 ml/min 90% A 10%B.



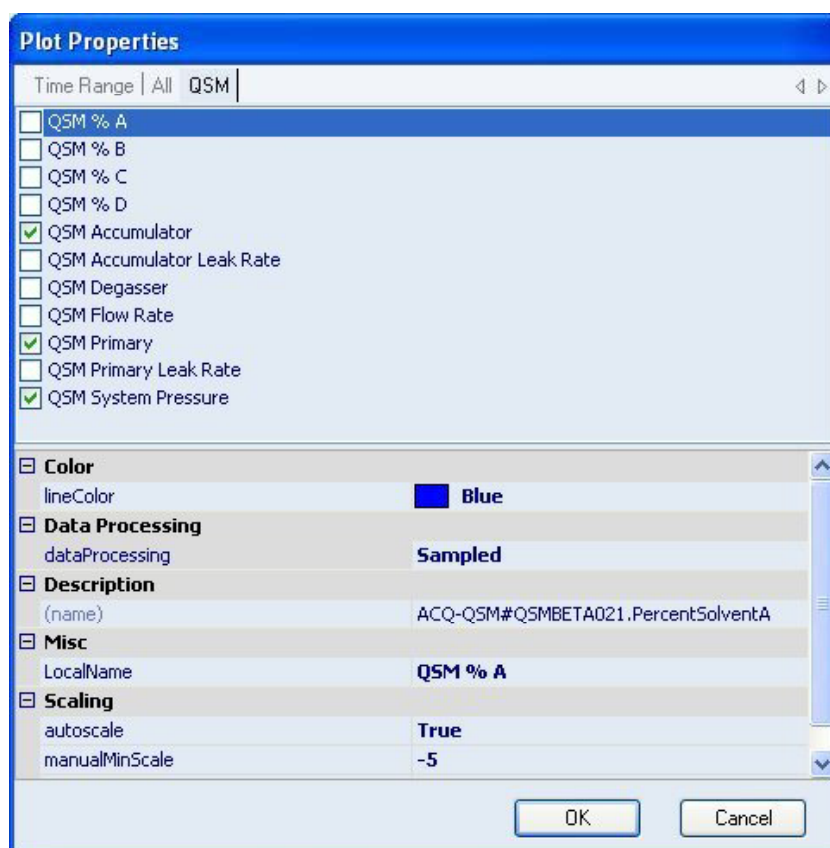
Monitoring H-Class System Health

Most Typical QSM Plots

The most useful plots to monitor the health of the QSM for a typical situation are the System pressure, QSM Accumulator and the QSM Primary traces. The other QSM traces can be added at any time if a particular situation warrants it.

To set up the QSM plots:

- ❑ Go to the QSM Top Level menu.
- ❑ Right-click on the QSM plot menu and choose Plot Properties. The Plot Properties menu will appear.
- ❑ Choose the Plots checked below for routine monitoring of QSM health along with monitoring the Delta Pressure Ripple.



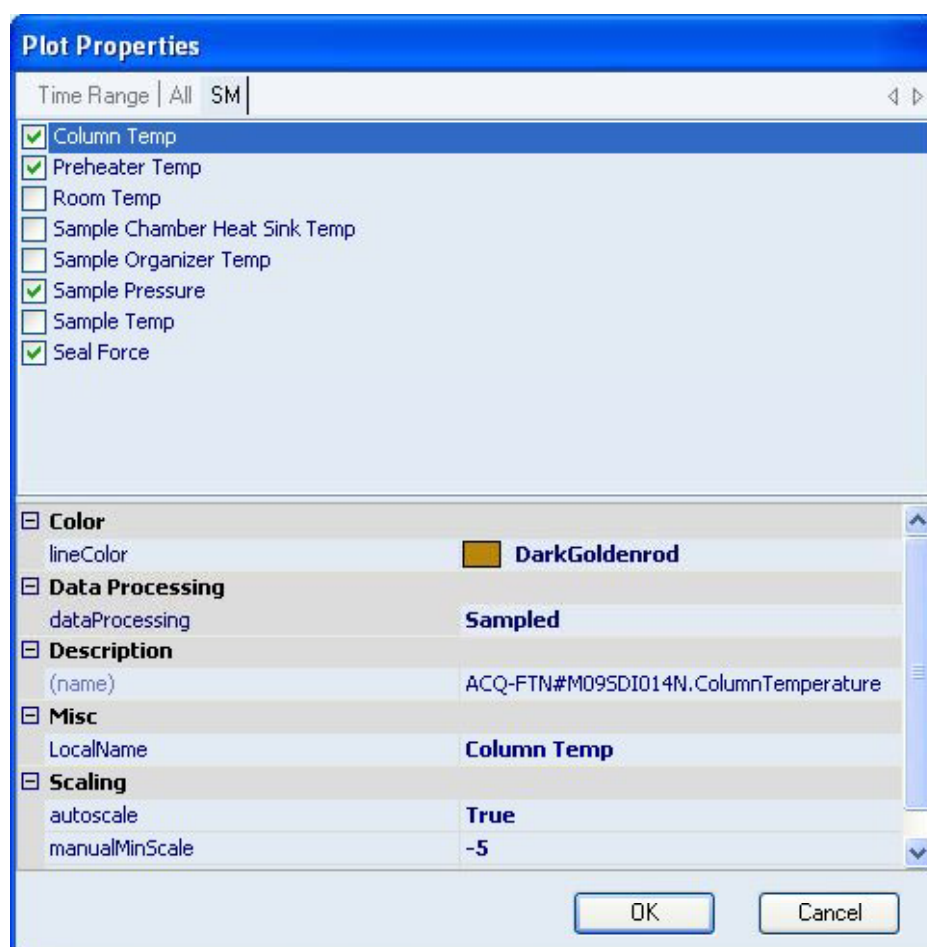
Monitoring SM-FTN System Health

Most Typical SM-FTN and CH-A Plots

The most useful plots to monitor the health of the SM-FTN for a typical situation are the Sample Pressure, Column Temperature, Sample Temperature, Seal Force and Room Temperature traces. The other QSM traces can be added at any time if a particular situation warrants it.

To set up the QSM plots:

- ☐ Go to the SM-FTN Top Level menu.
- ☐ Right-click on the SM-FTN plot menu and choose Plot Properties. The Plot Properties menu will appear.
- ☐ Choose the Plots checked below for routine monitoring of SM-FTN health.

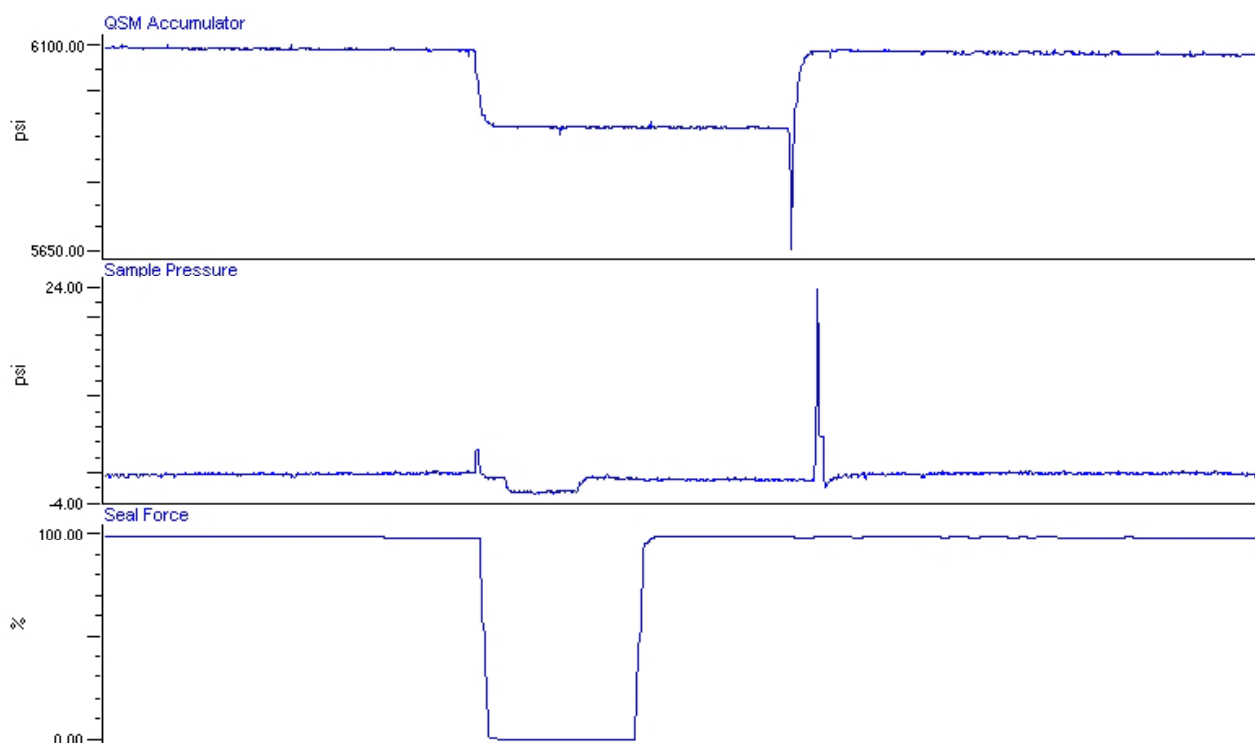


Cross-Module System Health Plot

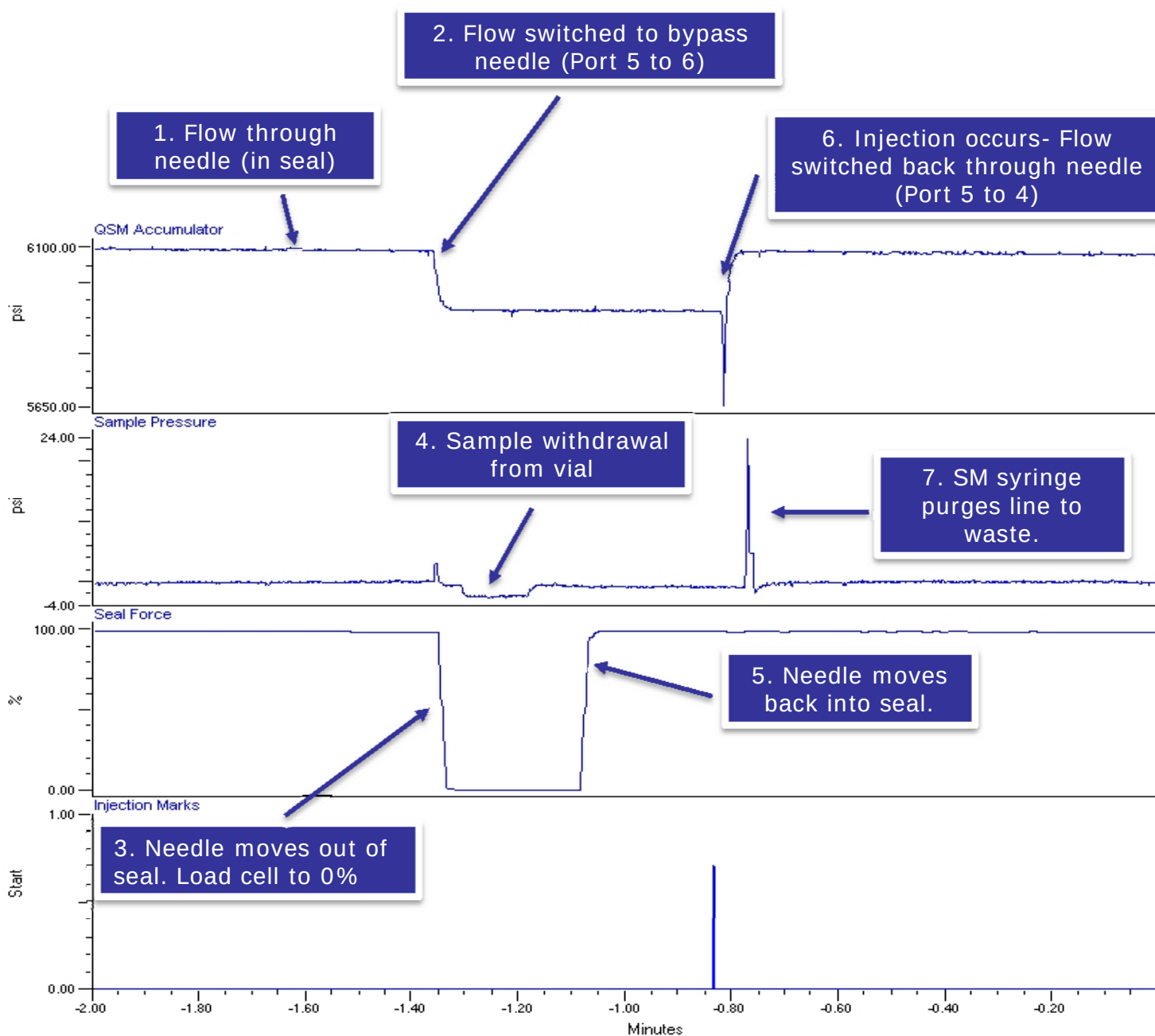
The most useful plots to monitor the health of the system for a typical situation are the System Pressure, Sample Pressure and Seal Force. Injection Marks can be turned on as an option . There are many other cross-module plots that can be set up as well for different purposes, such as Room Temperature versus Column Temperature or Sample Temperature. All traces are recorded for 96 hours whether they are selected or not.

To set up Cross-Module System Health Plot:

- ☐ Go to the Plots Top Level menu.
- ☐ Right-click on the plots menu and choose Plot Properties. The Plot Properties menu will appear.
- ☐ Choose the Plots below for routine monitoring of system health.



Injection Sequence with Plot

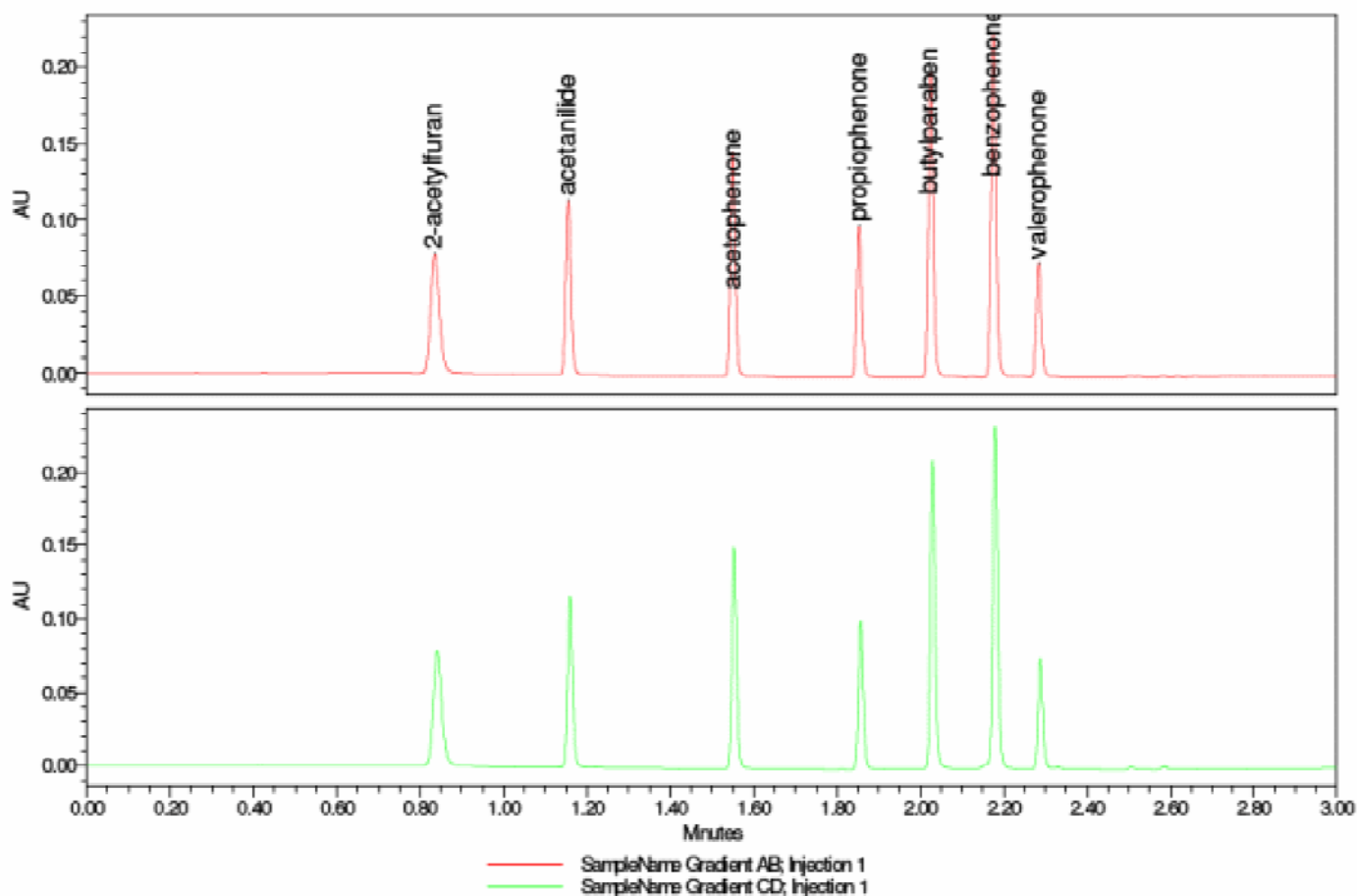




Section 4

Performance Verification Tests

Gradient Performance Chromatogram Overlay



System Performance Test

The ACQUITY H-Class System Performance Test is designed to test the system in the same fashion as the ACQUITY UPLC System. The following tests are performed to determine that the system is performing to specification:

- ❑ System Precision- Performs six replicate injections of a Caffeine Standard. The performance of the QSM is checked by looking at the Standard Deviation of the retention times for the Caffeine peak. The performance of the SM-FTN is determined by looking at the area and height precision (%RSD) of the six replicate injections.
- ❑ Gradient Test- Performs three replicate injections of a 7 component gradient test mixture. The performance of the QSM is checked by looking at the Standard Deviation of the retention times for all peaks. Separate tests will be run for solvent lines AB and CD in order to test the function of all Gradient Proportioning Valves.
- ❑ *The results are reported in the appropriate fields in the Installation Checklist and shown to the customer for approval.*
- ❑ *The verification tests can be repeated any time the performance of the system is in doubt. It is an excellent tool to use to separate a system issue from a potential application or chemistry problem at a customer site.*

When combined with a full set of diagnostics test results from each ACQUITY H-Class module, they give a high degree of confidence that the system is running according to the design specifications.

Precision Test

- ❑ Refer to the ACQUITY H-Class Installation Procedure to run the System Precision test.
You may also use the template projects from the portal for Empower or MassLynx on your system.
- ❑ Run a blank injection consisting of 90% Water and 10% Acetonitrile first followed by a couple of test injections to check that the system is well equilibrated.
- ❑ Run the six replicate injections of the Caffeine Standard.
- ❑ Record the RT precision (STD Dev), area and height precision (%RSD) of the six replicate injections in the table below and fill out the pass / fail fields
- ❑ An example chromatogram and results table are provided on the next page.

Note: You may shorten some of the priming times of the install procedure if you have already primed it but otherwise, please follow the procedure as written.

Caffeine Area and Height Results Table

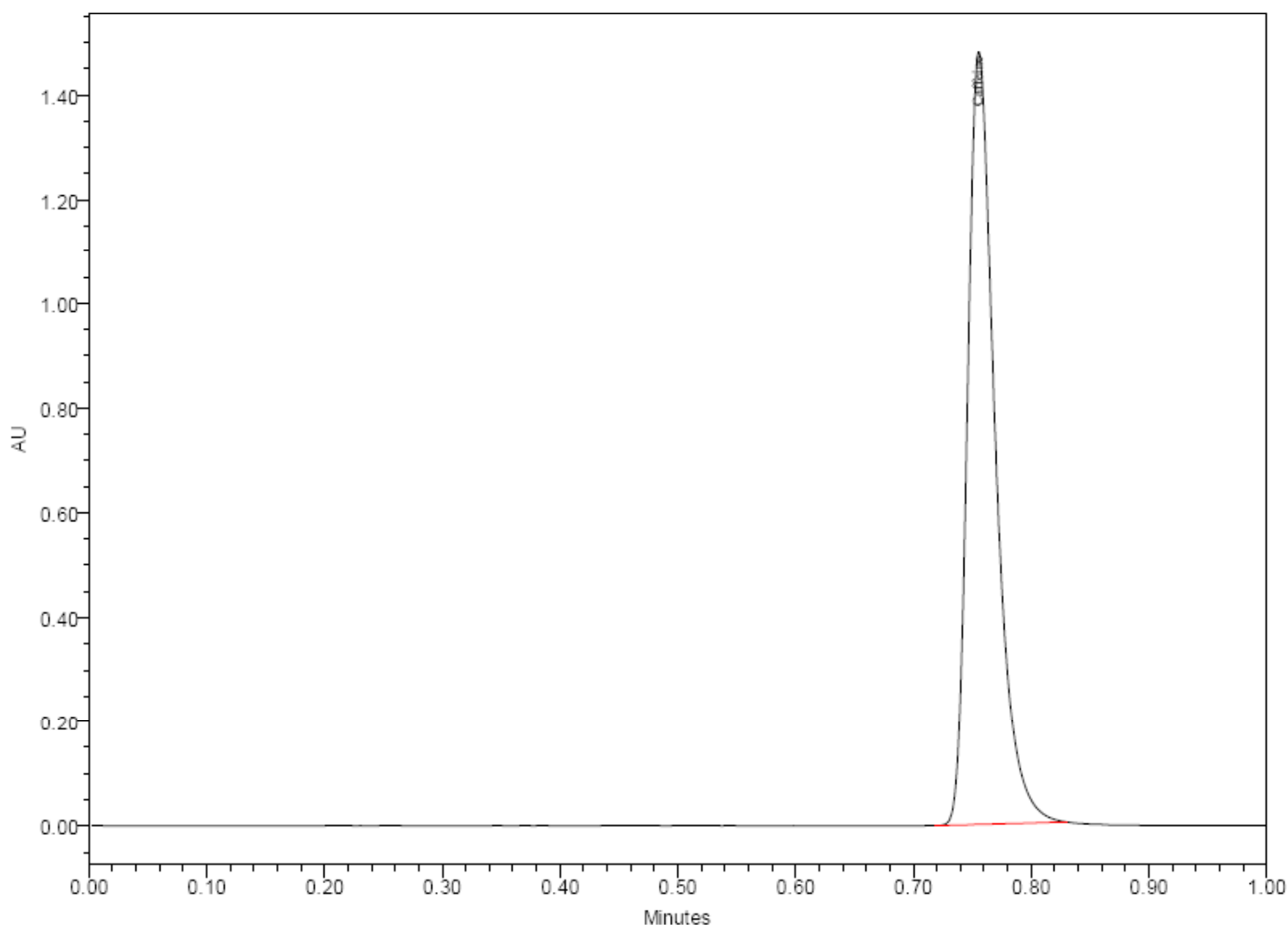
	Area %RSD Specification	Area %RSD	Area %RSD Pass Fail	Height %RSD Specification	Height %RSD	Height %RSD Pass Fail
1	%RSD < or = 0.5			%RSD < or = 1.1		

Caffeine Retention Time (RTsec) Results Table

	Retention time (sec) Standard Deviation Specification	Retention time (sec) Standard Deviation	Retention time (sec) Standard Deviation Pass Fail
1	SD RT < or = 1.0sec		

Precision Test Example Results

System Precision Chromatograms

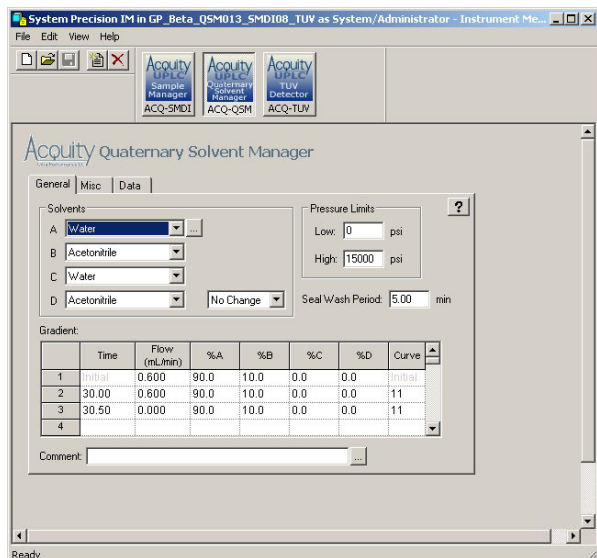


System Precision Peak Results

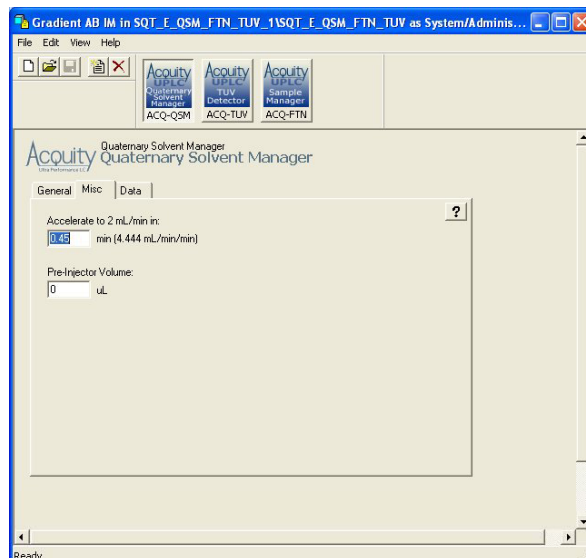
Name: Caffeine

	Vial	Injection	Inj Vol (ul)	Name	RT (min)	Retention time (sec)	Area	Height (µV)	Points Across Peak	Result Id
1	2:E,6	1	5	Caffeine	0.756	45.34	2422500.55	1480032.88	134	3686
2	2:E,6	2	5	Caffeine	0.756	45.33	2421324.73	1491582.87	134	3687
3	2:E,6	3	5	Caffeine	0.756	45.36	2420474.52	1489221.33	133	3688
4	2:E,6	4	5	Caffeine	0.756	45.36	2419922.04	1492776.06	132	3689
5	2:E,6	5	5	Caffeine	0.758	45.47	2421420.72	1488516.45	133	3690
6	2:E,6	6	5	Caffeine	0.759	45.53	2421762.26	1486888.21	133	3691
Mean						45.40	2421234.14	1488169.63		
Std. Dev.						0.08	919.17	4515.41		
% RSD							0.04	0.30		

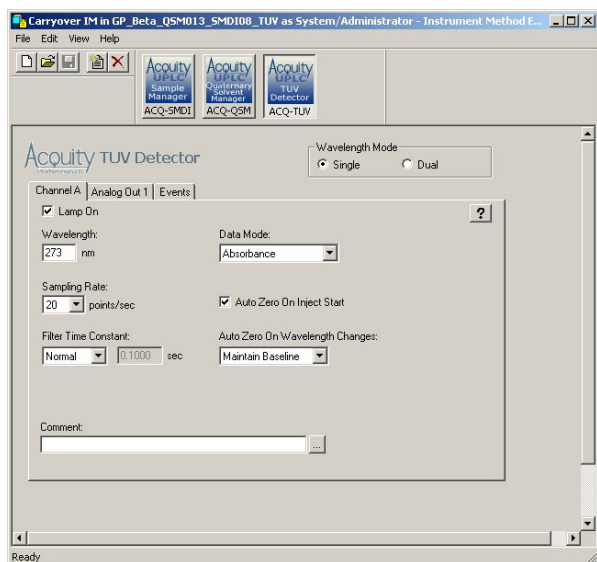
Precision Test Instrument Methods



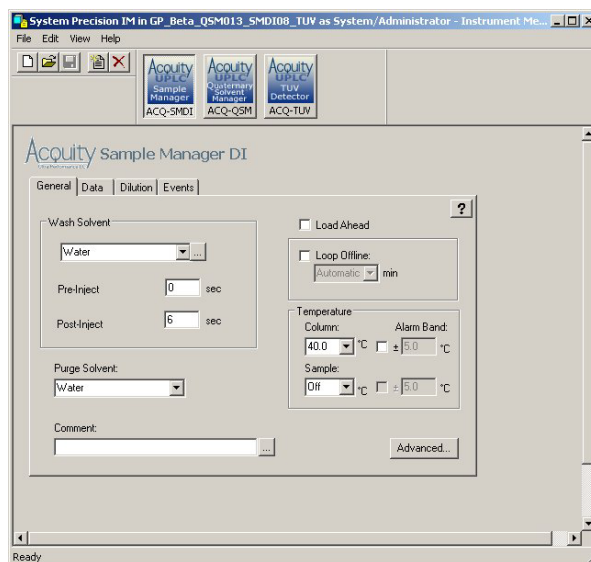
QSM Instrument Method General



QSM Instrument Method Misc Tab



TUV Instrument Method



SM-FTN Instrument Method

Gradient Test

- ❑ Refer to the ACQUITY H-Class Installation Procedure to develop and run the Gradient test.
- ❑ Equilibrate the system for 5 minutes
- ❑ Be sure to run the condition column step as detailed in the procedure.
- ❑ Run the 3 replicate injections of the 7-Component Gradient test mixture.
- ❑ Record the RT precision (STD Dev) of the 3 replicate injections of the 7 Components in the fields provided below.
- ❑ Modify your QSM instrument method to use solvents CD and repeat the above test.

Retention Time Reproducibility AB

	Name	Retention Time (Seconds) Standard Deviation Specification	Retention Time (Seconds) Standard Deviation	Retention Time (Seconds) Standard Deviation Pass Fail
1	2-acetylfuran	SD RT < or = 1.0sec		
2	acetanilide	SD RT < or = 1.0sec		
3	acetophenone	SD RT < or = 1.0sec		
4	propiofenone	SD RT < or = 1.0sec		
5	butylparaben	SD RT < or = 1.0sec		
6	benzophenone	SD RT < or = 1.0sec		
7	valerophenone	SD RT < or = 1.0sec		

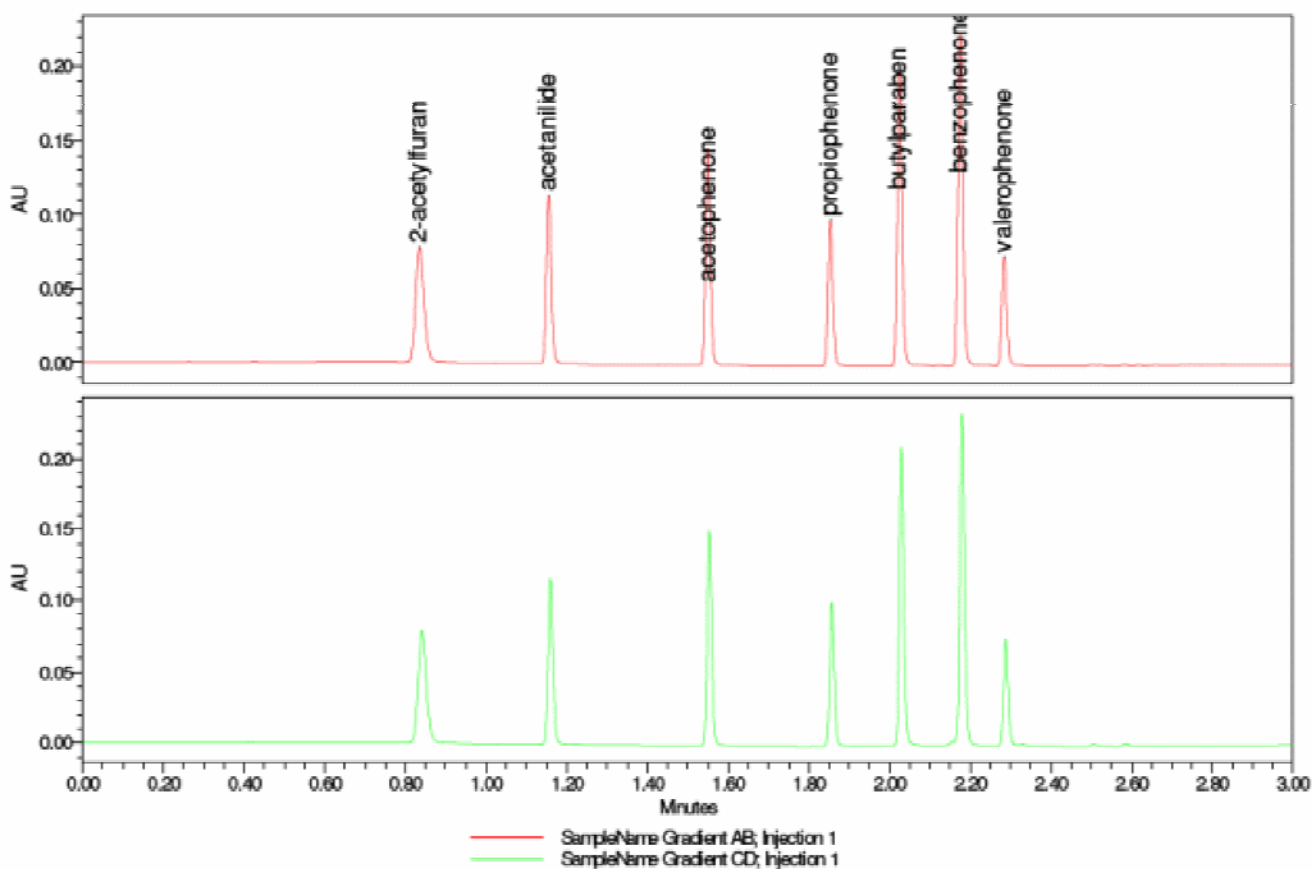
Retention Time Reproducibility CD

	Name	Retention Time (Seconds) Standard Deviation Specification	Retention Time (Seconds) Standard Deviation	Retention Time (Seconds) Standard Deviation Pass Fail
1	2-acetylfuran	SD RT < or = 1.0sec		
2	acetanilide	SD RT < or = 1.0sec		
3	acetophenone	SD RT < or = 1.0sec		
4	propiofenone	SD RT < or = 1.0sec		
5	butylparaben	SD RT < or = 1.0sec		
6	benzophenone	SD RT < or = 1.0sec		
7	valerophenone	SD RT < or = 1.0sec		

Gradient Test Example Results

- ❑ Modify your QSM instrument method to use a Pre-Inject volume of 300ul and run 1 more injection of the gradient mixture.
- ❑ Overlay this injection with one of your previous CD gradient test injections to see the effect of the using a Pre-Inject volume on the chromatography.

Gradient Performance Chromatogram Overlay



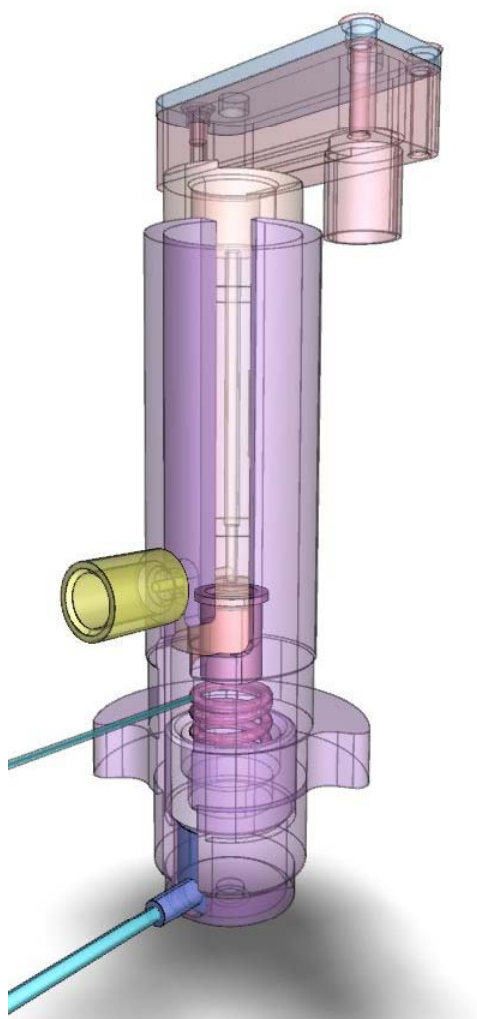
Gradient Performance Summary Results

Component Summary For A RTsec

	SampleName	Inj	Vial	Result Id	2-acetylfuran	acetanilide	acetophenone	propiophenone	butylparaben	valerophenone	benzophenone
1	Gradient AB	1	2:B,8	3511	52.70	68.58	91.43	109.06	118.46	127.65	134.51
2	Gradient AB	2	2:B,8	3512	52.19	68.21	91.14	108.84	118.29	127.50	134.37
3	Gradient AB	3	2:B,8	3513	52.00	68.13	91.10	108.87	118.34	127.53	134.40
Mean					52	68	91	109	118	128	134
Std. Dev.					0.36	0.24	0.18	0.12	0.09	0.08	0.07



Section 5 PM Procedures



Performing the QSM PM

Replace/rebuild procedures/diagnostic tests

- ☐ Familiarize yourself with PM procedures as detailed in the “ACQUITY UPLC® H-Class and H-Class Bio Quaternary Solvent Manager Performance Maintenance Technical Reference” document (715002451) available on the portal.

The following performance maintenance procedures and tests for the ACQUITY UPLC® Quaternary Solvent Manager can be found in the ACQUITY UPLC H-Class Quaternary Solvent Manager Operator's Overview and Maintenance Information, in the ACQUITY UPLC Console online help, or in the performance maintenance protocol.

Make sure all members in your group have a chance to perform the procedures. The Seals and O-rings will need to be replaced when taken out. For all other parts in the PM, just remove it and then reinstall the same part as they are still perfectly functional.

The procedures include:

- ☐ *Checking firmware version*
- ☐ *Inspecting the fan*
- ☐ *Inspecting the waste management*
- ☐ *Reviewing error logs*
- ☐ *Replacing the door air filter*
- ☐ *Replacing the solvent filters*
- ☐ *Replacing the plungers*
- ☐ *Replacing the plunger seals, wash seals and O-rings*
- ☐ *Replacing the accumulator head check valve*
- ☐ *Priming the primary head check valve*
- ☐ *Replacing the low pressure GPV filters*
- ☐ *Replacing the 100 µL mixer/filter assembly*
- ☐ *Performing the dynamic leak test*
- ☐ *Create log entries*

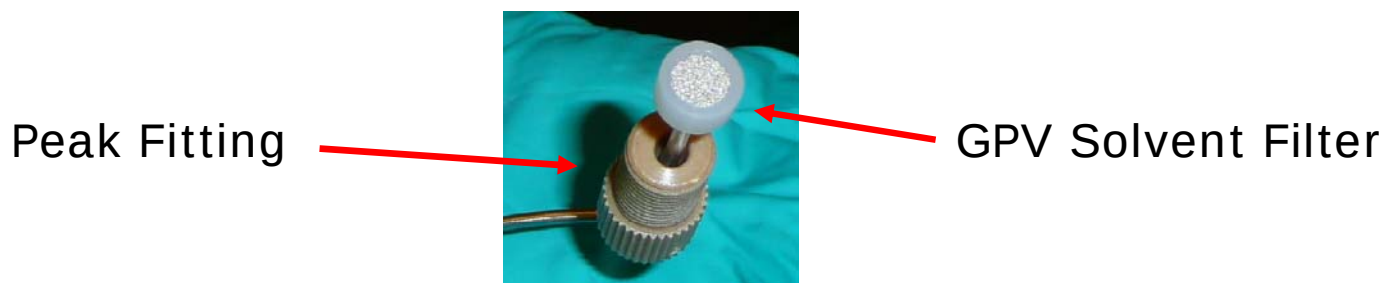
Performing the QSM PM

Special Note-Replacing the GPV Solvent Filters

Important: Wear particulate-free, powder-free non-latex gloves when handling critical clean parts.

- ❑ Before removing the fitting, go to the QSM interactive menu of the console and click on the Control button.
- ❑ Click on the GPV hyperlink and make sure the valves are turned off. This will prevent any solvent flow during the replacement procedure.
- ❑ Each member of the group should practice this procedure a couple of times to become comfortable and proficient at it.

Caution- When reinstalling the outlet tubing ferrule, be careful not to cross-thread the knurled knob fitting. The H-Class valve block threads are easily damaged.



Performing the SM-FTN PM

- ❑ Perform all PM procedures as detailed in the “ACQUITY UPLC® H-Class and H-Class Bio System Sample Manager - Flow Through Needle Performance Maintenance Technical Reference” document (715002449) available on the portal (see figure on next slide).

The following performance maintenance procedures and tests for the SM_FTN can be found in the ACQUITY UPLC H-Class Sample Manager-FTN Operator's Overview and Maintenance Information, in the ACQUITY UPLC Console online help, or in the performance maintenance protocol.

- ❑ The procedures include:
 - ❑ Checking firmware version
 - ❑ Inspecting the fan
 - ❑ Inspecting the waste management
 - ❑ Reviewing error logs
 - ❑ Inspecting the column heater-active
 - ❑ Replacing the pump outlet tubing
 - ❑ Replacing the sample syringe
 - ❑ Replacing the sample needle and needle guide
 - ❑ Replacing the Needle Seat and Seat Port Assembly
 - ❑ Replacing the injection valve cartridge
 - ❑ Priming the Sample Manager-FTN
 - ❑ Calibrating the needle Z-axis
 - ❑ Characterizing the needle seal
 - ❑ Performing the needle seal readiness test
 - ❑ Performing the sample syringe leak test
 - ❑ Performing the leak test
 - ❑ Reset the injection counter
 - ❑ Create log entries

Performing the SM-FTN PM

Procedures for replacing parts, and diagnostic tests that are not included in the Operator's Guide or performance maintenance protocol will appear in the "ACQUITY UPLC® H-Class and H-Class Bio System Sample Manager - Flow Through Needle Performance Maintenance Technical Reference" document.

☐ The Procedures are:

- ☐ Upgrading the firmware using an Ethernet connection
- ☐ Cleaning the inject/wash station
- ☐ Replacing the side panel filter
- ☐ Replacing the seal extension tube

Replacing the Needle Seat and Seat Port Assembly

Important: Wear particulate-free, powder-free, non-latex gloves while handling the Needle Seat, tubing and other critical clean parts.

- ☐ While performing this procedure, take the time to disassemble and reassemble all the components of the inject block assembly. A detailed diagram of the assembly is provided on the next page.

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ACQUITY UPLC H-Class

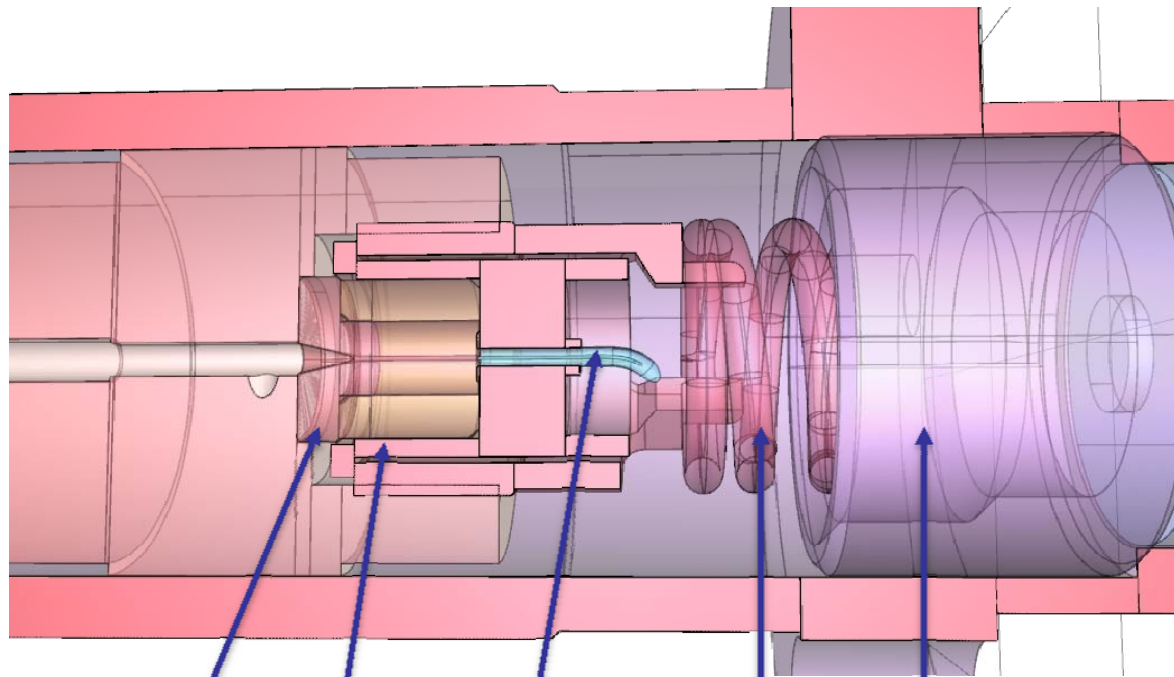
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- [SM-FTN](#)
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 - **PM Technical Reference**
 - [Sensor Interface PCB](#)
 - [CCPU PCB](#)
 - [Motor/HC Driver PCB](#)
 - [Control PCB](#)
 - [Ethernet PCB](#)
- [Quaternary Solvent Manager](#)
- [Sample Organizer](#)

Primary Window

Location of SM-FTN PM Protocol on portal.

Needle Seal Housing Assembly



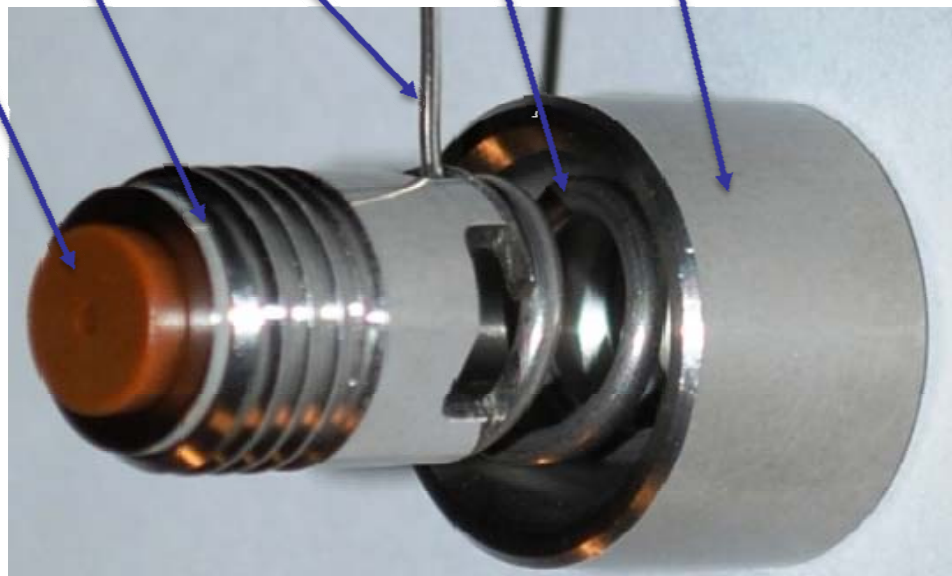
Needle Seat

Seat Port
Assembly Cup y

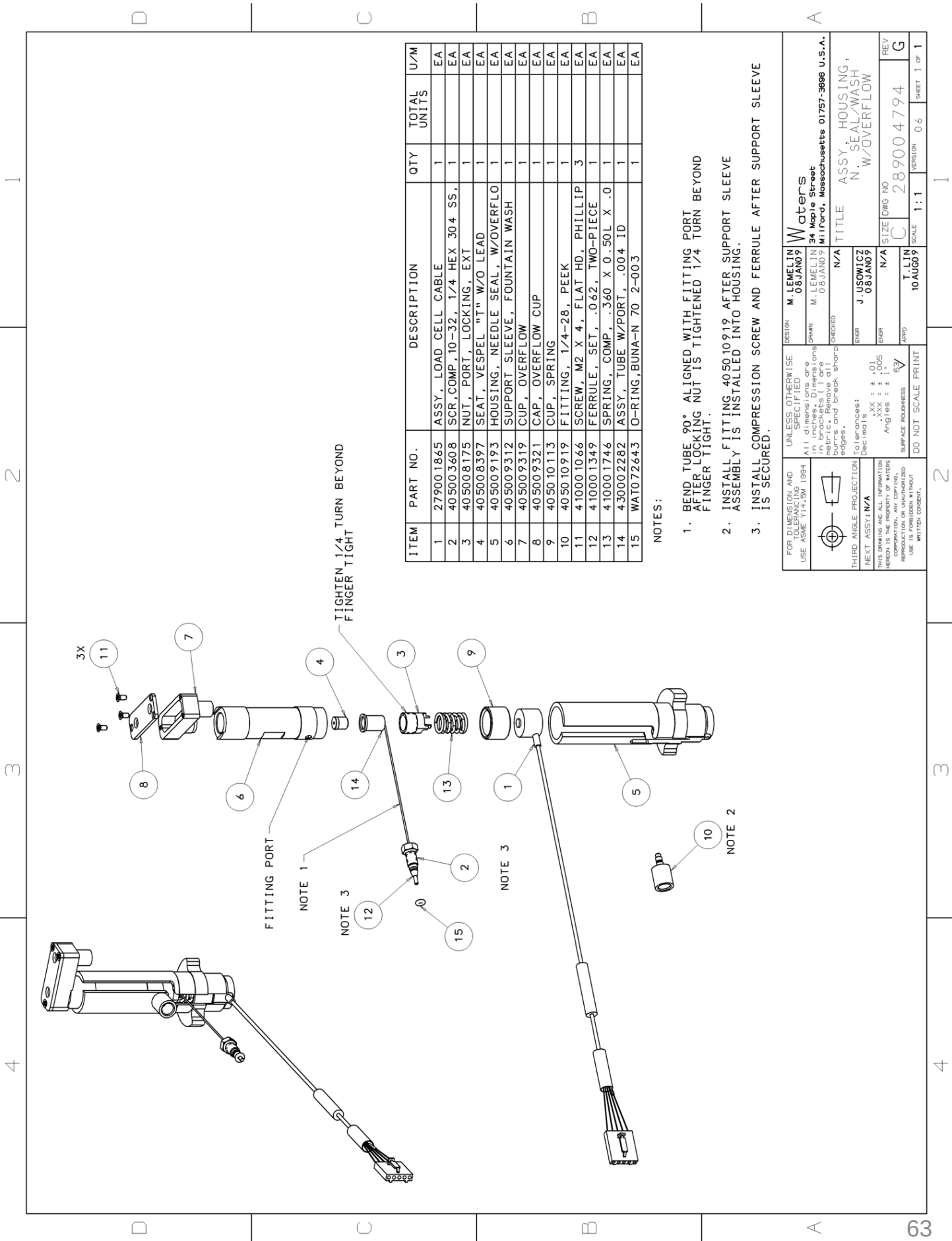
Seat Port Assembly
Tubing (to inject
valve)

Compression
Spring

Spring Cup



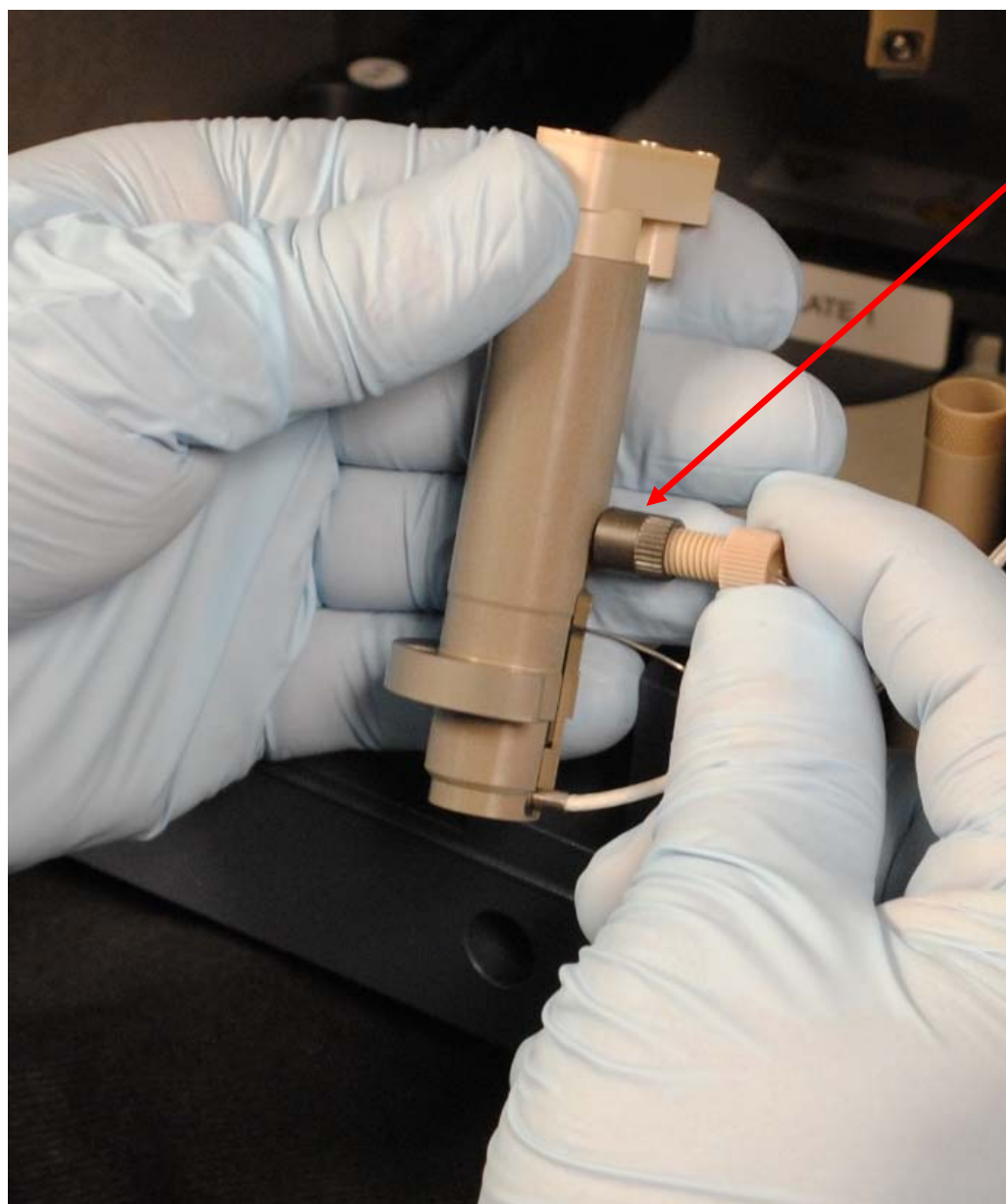
Needle Seal Wash Housing Assembly



FOR DIMENSION AND TOLERANCING USE ASME Y14.5M 1994	UNLESS OTHERWISE SPECIFIED	DESIGN	M. LEVELIN 08JAN09	Waters
THIRD ANGLE PROJECTION	ALL dimensions are in brackets 1 are metric. Remove all leading zeros and break sharp edges.	DOWN	M. LEVELIN 08JAN09	34 Maple Street
NEXT ASSY: N/A	Tolerances: .XX : ± .01 .XXX : ± .005 Angles : ± .63°	CHECKED	N/A	TITLE
THIS DRAWING AND ALL INFORMATION HEREON ARE THE PROPERTY OF WATERS CORPORATION. ANY COPYING, REPRODUCTION OR UNAUTHORIZED USE IS FORBIDDEN WITHOUT WRITTEN CONSENT.	DO NOT SCALE PRINT	ENGR	J. USOWICZ 08JAN09	N. SEAL/WASH
		APPRO	T. LIN 10AUG09	W/OVERFLOW
			SIZE	DWG NO
			C	289004794
			SCALE	1:1
			VERSION	0.6
			SHEET	1 OF 1

Performing the SM-FTN PM

*Important: When reattaching the black peak wash line fitting to the needle wash housing, **do not over-tighten the fitting.** This is a low pressure fitting. Finger tight is sufficient. Over-tightening can result in breakage of the peak fitting.*



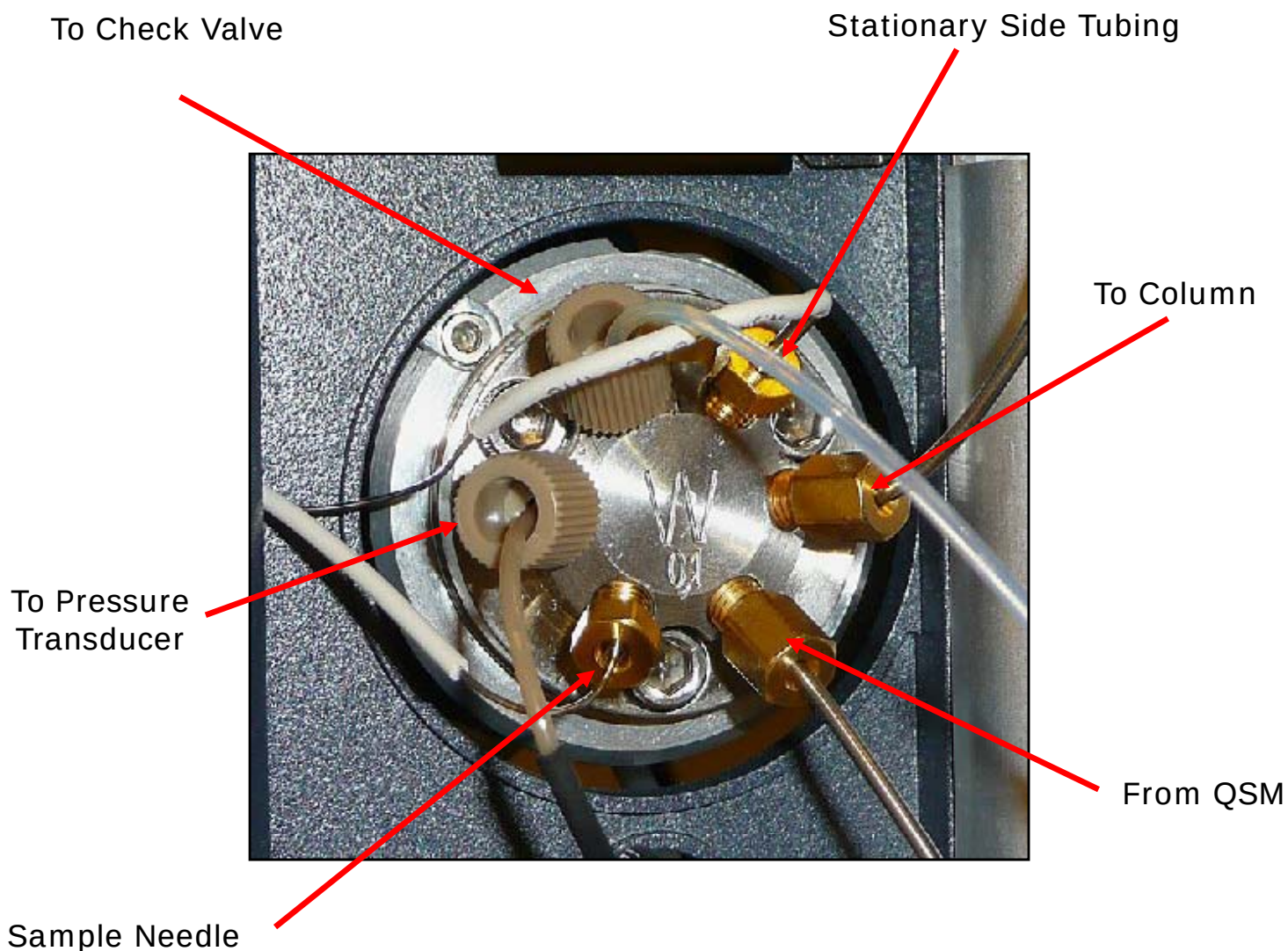
Peak Wash
Line Fitting

Replacing the Injector Pod

Replacing the Injector Pod Assembly

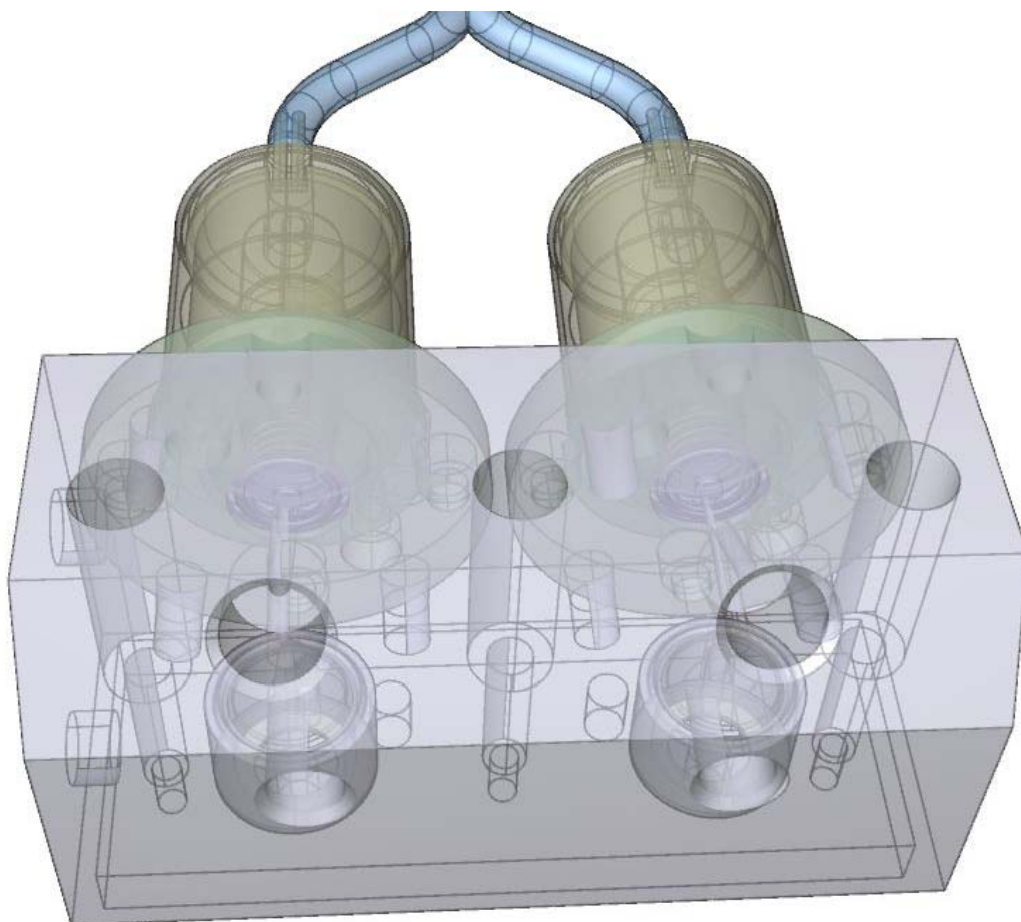
- The details of the Injector Pod fitting attachments are listed below.

Important: The specification for re-attaching the high pressure fittings is ¼ turn past finger tight.





Section 6 QSM Service Procedures



QSM Service Procedures

- ❑ Familiarize yourself with all the major service procedures for the QSM located in the GPL section of the portal as detailed in the figure below.
- ❑ Service & Upgrade Procedures
 - ❑ Replacing the CCPU PCB
 - ❑ Performing a Siphon Check
 - ❑ Replacing the CPU/Personality Card
 - ❑ Replacing the Degasser Pump
 - ❑ Replacing a Dual Channel GPV
 - ❑ Replacing the GPV, Inline Filter, and Degasser Chamber
 - ❑ Replacing the GPV Tray Assembly
 - ❑ Replacing the Inline GPV Filters
 - ❑ Replacing the Power Supply
 - ❑ Replacing a Single-channel Degasser Chamber
 - ❑ Installing a Solvent Select Valve
 - ❑ Replacing the Vacuum Transducer PCB

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ACQUITY UPLC H-Class

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 - [Replacing the Vacuum Transducer PCB](#)
- [Sample Organizer](#)

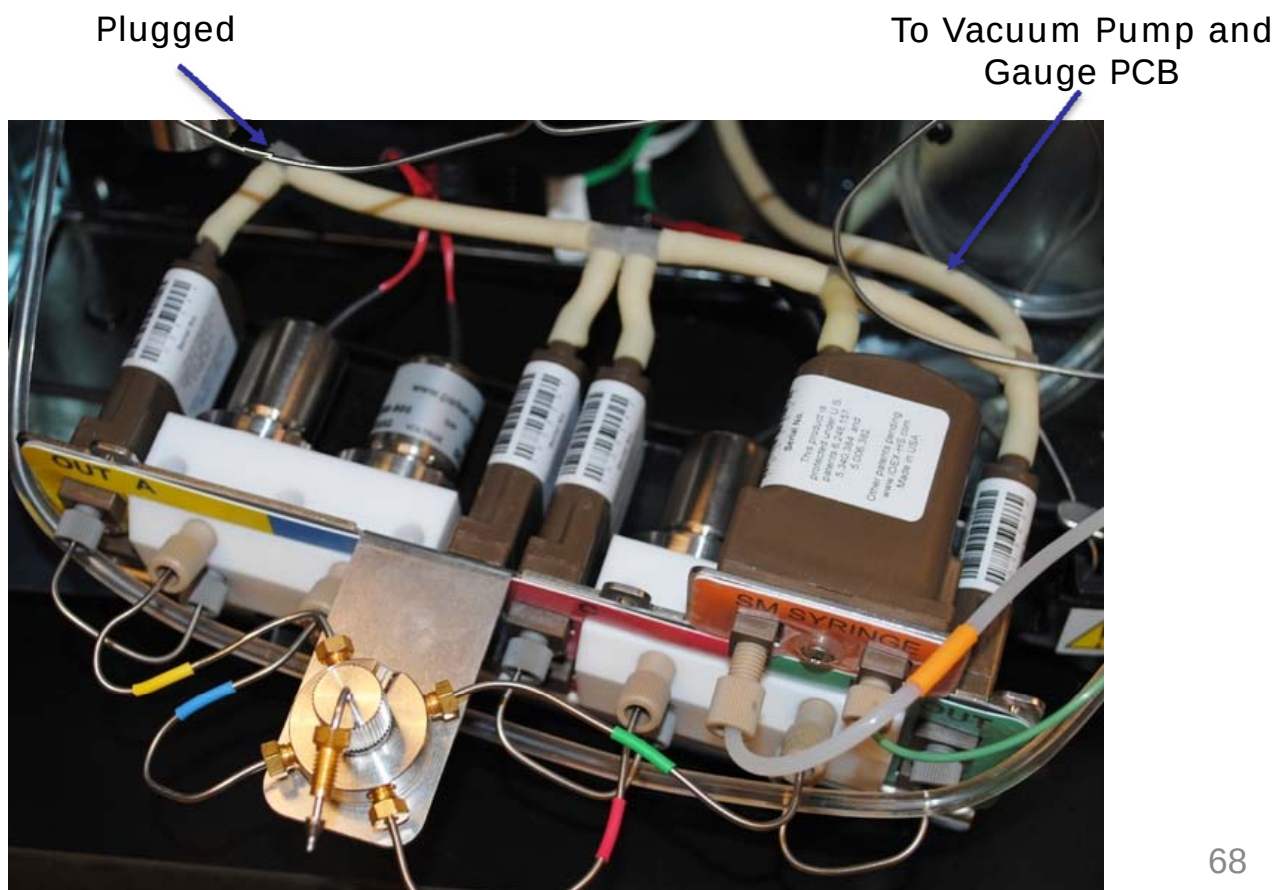
Primary Window

Degasser Chamber Assembly

- ❑ Following the Replacing a Dual Channel GPV procedure, remove the GPV Assembly.
- ❑ Once you have the assembly out of the QSM. Remove and replace the C and D GPV pair.
- ❑ Remove and replace the degasser chamber for solvent line A. **Do not take it apart. It is not a serviceable item!**
- ❑ Re-install the degasser chamber and GPV valve pair and re-connect the vacuum and electrical connections.
- ❑ Leave the GPV assembly outside the QSM for now.

Troubleshooting Degasser Issues

- ❑ Remove the vacuum line from the SM degasser chamber.
- ❑ Open up the console and then power up the QSM. You should get a degasser related error message.



Troubleshooting Degasser Issues

Did you receive a degasser related error message?

Error message-_____.

- ☐ Power down the QSM.
- ☐ Open the side panel of the QSM
- ☐ Remove the vacuum pump line from the GPV degasser assembly (see picture on previous page).
- ☐ Remove the vacuum line from degasser gauge.
- ☐ Attach the vacuum pump line directly to the degasser gauge.
- ☐ Power up the QSM again and check the console. Did you get a degasser related error message this time?

This test will determine if the vacuum pump is pumping correctly and that the vacuum inlet line holds sufficient pressure.

You can check the vacuum gauge line by connecting it straight to the vacuum pump.

The vacuum gauge can also be checked separately by connecting the tubing and pulling a vacuum using a priming syringe while watching the Degasser plot in the ACQUITY console.

- ☐ Power down the QSM.
- ☐ Re-attach the vacuum line from the SM degasser chamber.
- ☐ Re-install the GPV assembly back into the QSM.

Removing the Degasser Pump

- ☐ Following the proper procedure, remove the Degasser pump from the rear of the chassis.
- ☐ Re-install and reconnect the vacuum tubing.

Removing the Electronics

Removing the CCPU and Personality PCB

- ❑ Following the proper procedure from the Portal, remove the CCPU and Personality PCB.

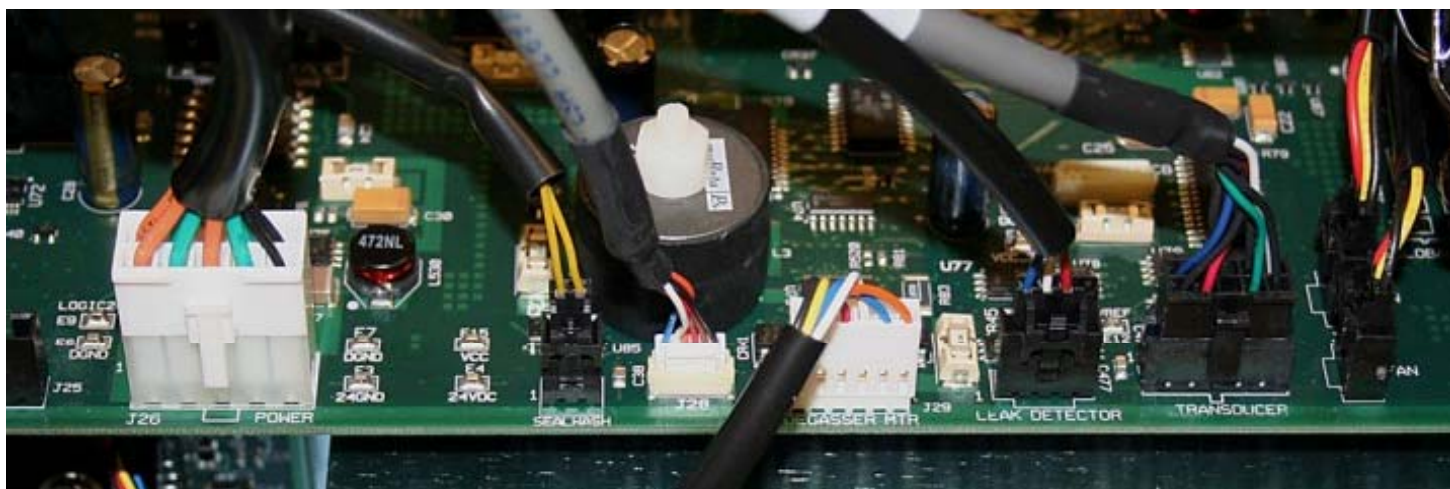


Warning- Beware of live AC and DC voltages when troubleshooting and servicing with side panels removed. Always remove the power cord from the QSM before touching any of the electronics. Make sure you are properly grounded against static discharge.

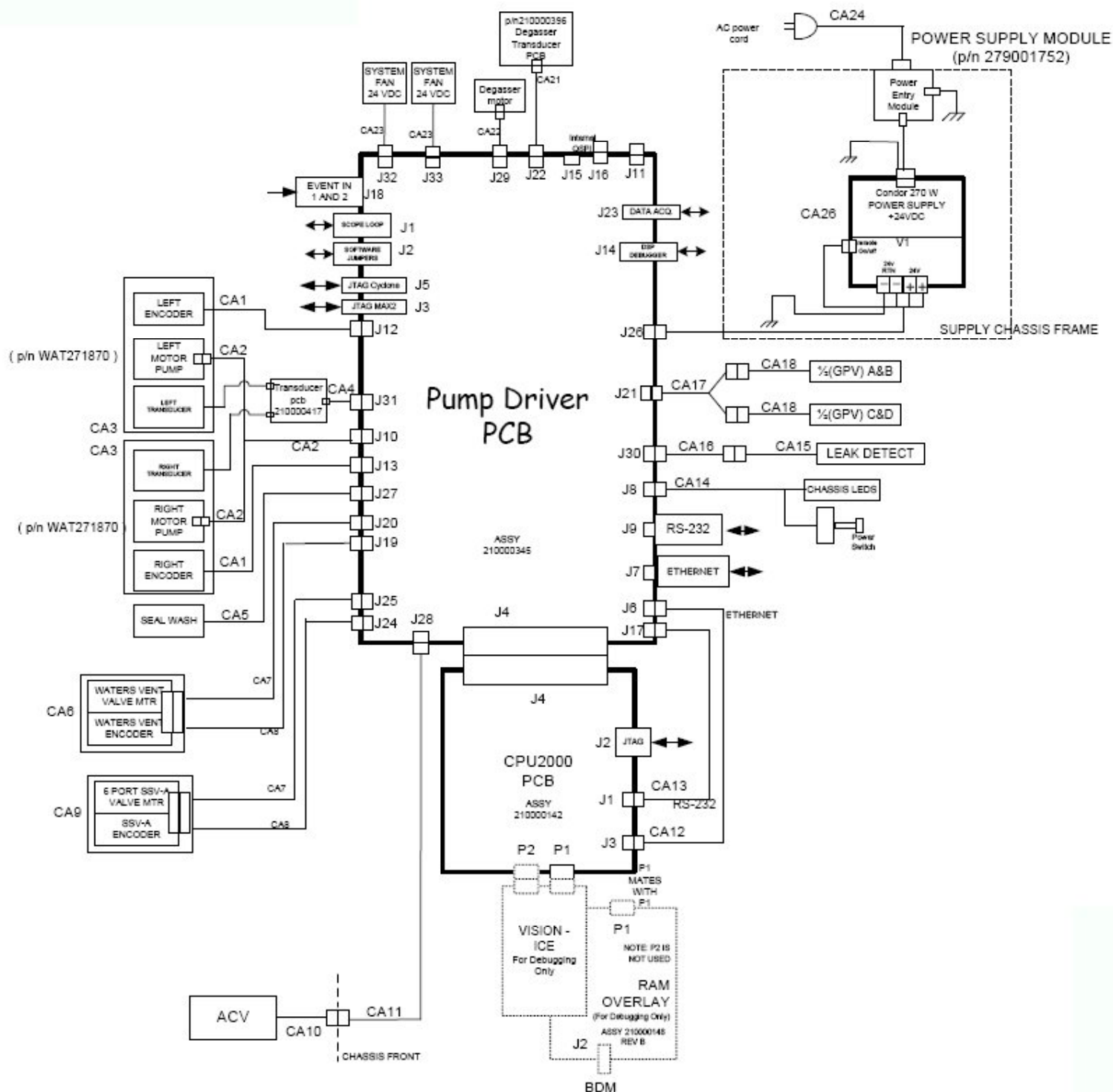
- ❑ You can try this procedure from the side panel only and alternately with the top panel open as well.
- ❑ Re-install the boards and reconnect all electrical cables except for the power connector (the picture below will show you some of the connection locations).

Removing the Power Supply

- ❑ Following the proper procedure from the Portal, remove the Power Supply from the back of the QSM.
- ❑ Re-install the Power Supply and reconnect all electrical cables.
- ❑ Plug in the unit and check that the unit is functioning properly in the console. You will re-prime and test the system after all service procedures are completed.

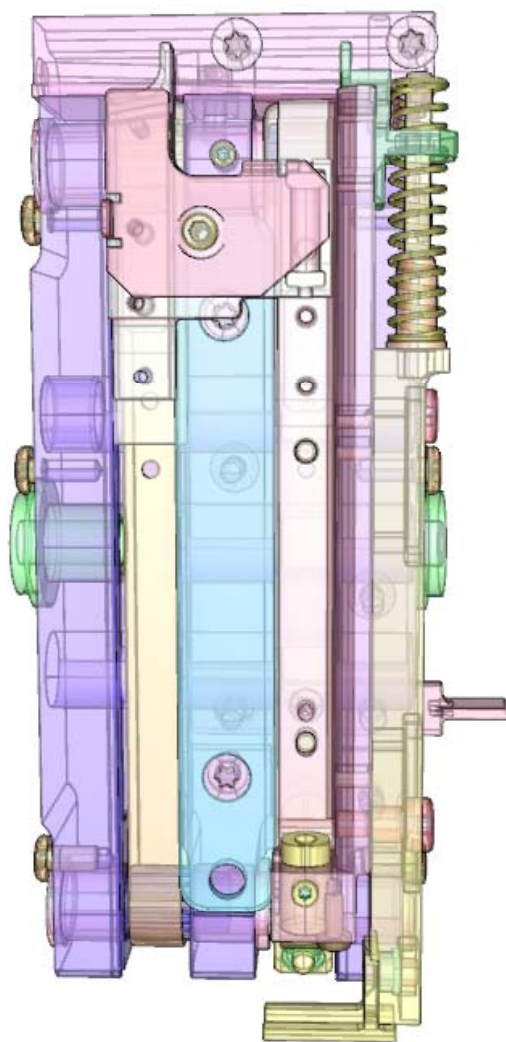


QSM Interconnect Diagram





Section 7 SM-FTN Service Procedures



SM-FTN Service Procedures

- ☐ Familiarize yourself with all the major service procedures for the SM-FTN located in the GPL section of the portal as detailed in the figure below.
- ☐ Service & Upgrade Procedures
 - ☐ Cleaning the SM-FTN
 - ☐ Installing the Audible Noise Fan Kit
 - ☐ Replacing the Flex Cable on the SM-FTN or SM-FL Needle Carriage
 - ☐ Replacing the Metering Syringe Drive
 - ☐ Replacing the Needle Carriage
 - ☐ Replacing the Needle Wash Pump
 - ☐ Replacing the Power Supply
 - ☐ Replacing the Pressure Transducer
 - ☐ Retrofitting the SM-FTN Sample Compartment
 - ☐ Zeroing the Pressure Transducer
- ☐ The following procedures will be performed as part of the next procedures “Taking apart the SM-FTN”. You should still read over them to see how they differ from the subsections of the other procedures.
 - ☐ Replacing the CPU, Control, and Driver PCBs
 - ☐ Replacing the Ethernet Switch PCB



Warning- Beware of live AC and DC voltages when troubleshooting and servicing with side panels removed. Always remove the power cord from the SM-FTN before touching any of the electronics.

Taking apart the SM-FTN

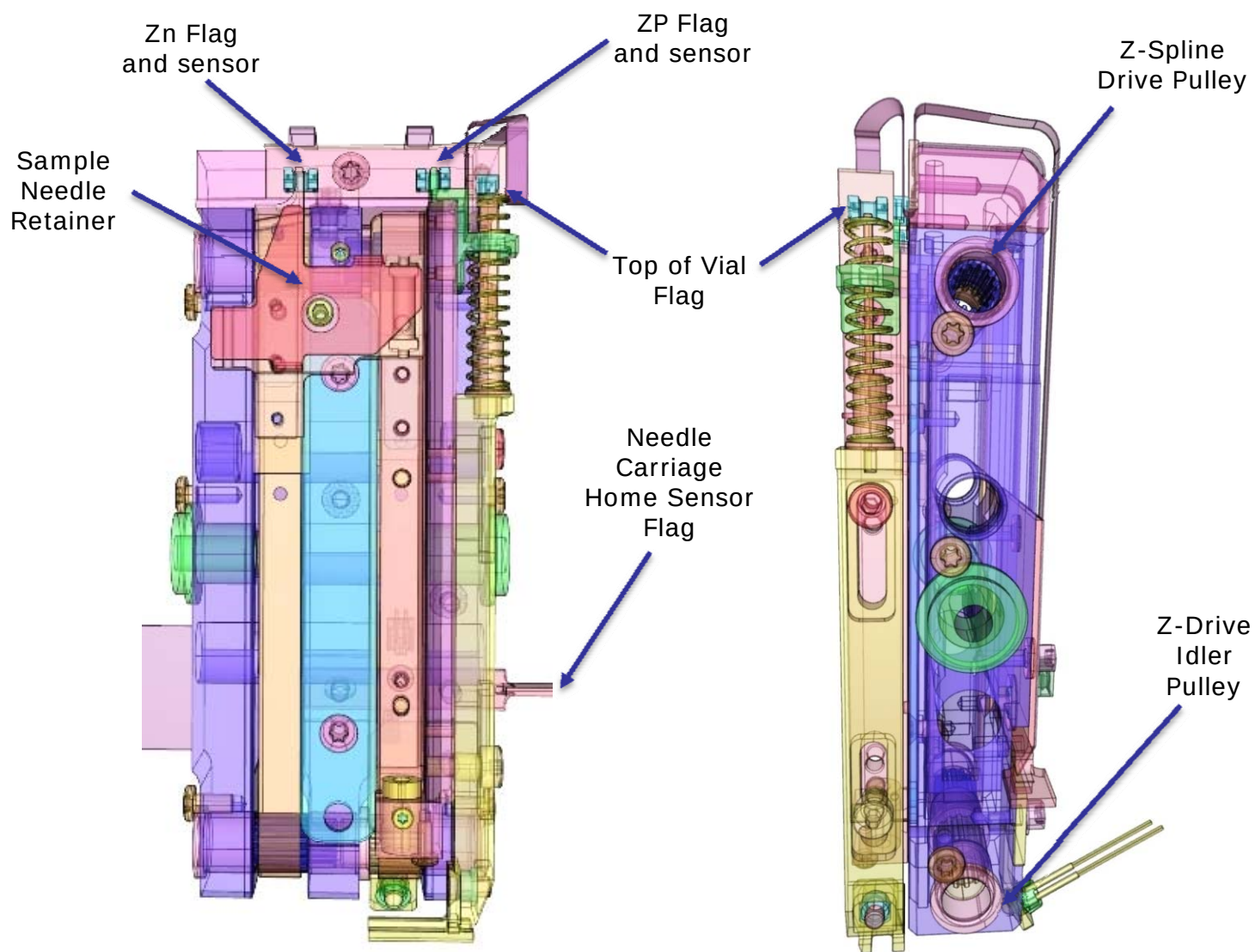
- ❑ Perform the procedure “Replacing the Sample Manager Heater/Cooler” by printing it or loading it on your computer. Follow it up to the section “Installing the new heater/cooler”
- ❑ Perform the procedure “Replacing the Sample Manager Rotary Tray Drive” starting at the section “Removing the rotary tray drive, belt and motor”. This will essentially carry on from where you left off in the previous procedure.
- ❑ After thoroughly examining the disassembled SM_FTN Reassemble the unit by continuing to follow the Replacing the Sample Manager Rotary Tray Drive”

Warning- Be very careful handling disconnecting the Needle Carriage flex cable and the Load Cell cable as they are easily damaged.

- ❑ Examine the assembly diagram on the next page and identify all the major parts on the actual assembly.

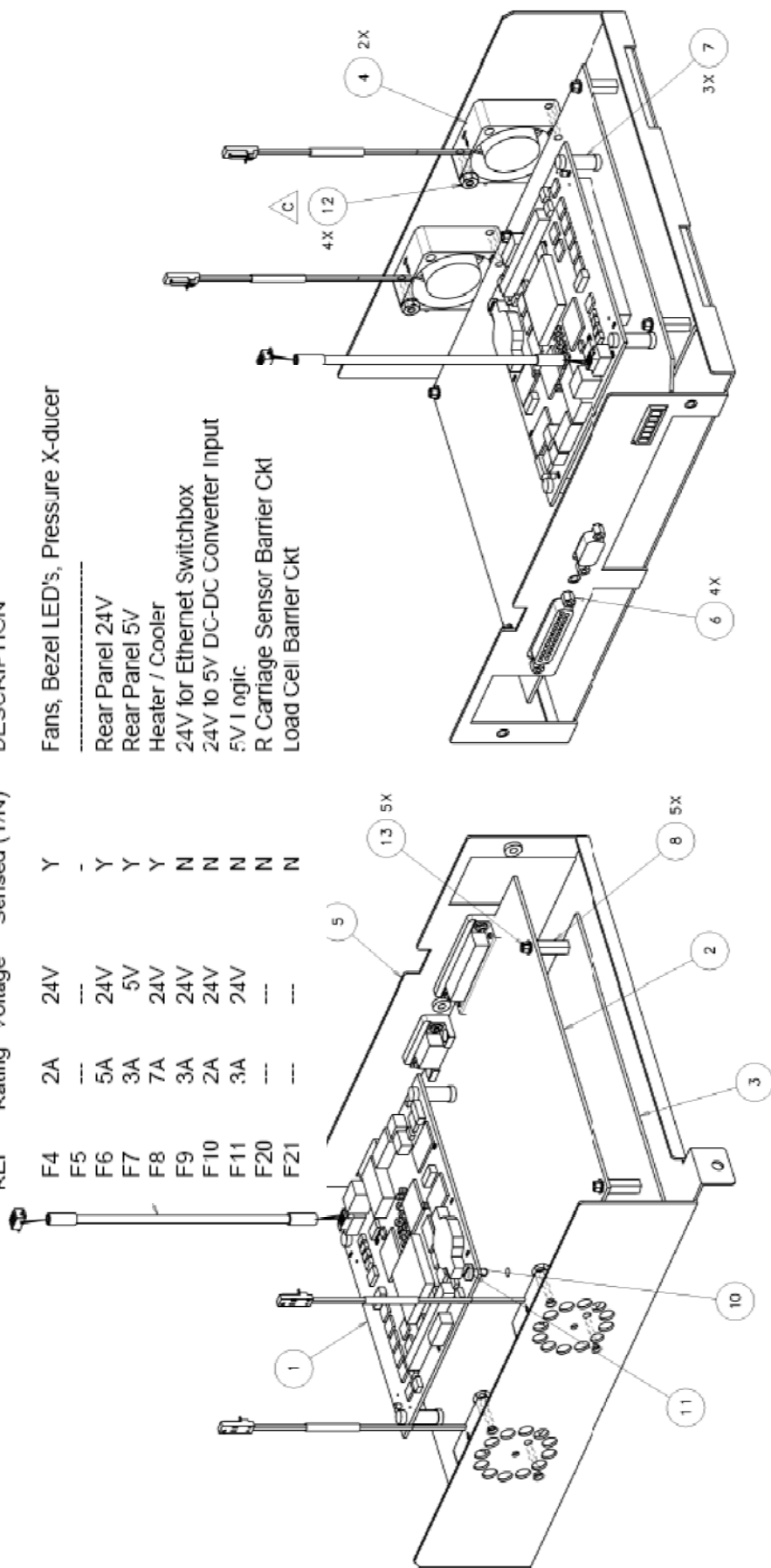
SM-FTN Service Procedures

The Needle Carriage Assembly



Control PCB Fuses

Panel	Rating	Voltage	Sensor (mV)
F4	2A	24V	Y
F5	---	---	-
F6	5A	24V	Y
F7	3A	5V	Y
F8	7A	24V	Y
F9	3A	24V	N
F10	2A	24V	N
F11	3A	24V	N
F20	---	---	N
F21	---	---	N



ITEM	PART NO.	DESCRIPTION	QTY	TOTAL UNITS	U/M
1	210000273	ASSY. PCB, CRU2K, 3V	1		EA
2	210000367	PCB, CONTROL, CFSM	1		EA
3	210000368	PCB, MOTOR/HC DRIVER, CFSM	1		EA
4	279001786	ASSY, FAN, 24V, 8.1 CFM	2		EA
5	400003513	BRACKET, MOUNTING, PCB	1		EA
6	410000954	SCREWLOCK, FEMALE, 4-40/4-40	4		EA
7	410001195	STANDOFF, PCB, .625 LONG	3		EA
8	410002758	STANDOFF, 6MM HEX X 16MM LG, M3 M	5		EA
9	441000957	ASSY, CABLE, RS232, CPU TO PERS	1		EA
10	WAT022007	SCREW, 6-32X.05, BINDER HD	1		EA
11	WAT050938	WASHER, LOCK, #6, EXT	1		EA
12	WAT251620	NUT, M4 X 0.7, KEP	4		EA
13	WAT271463	SCREW, M3 X 6 LG, SENS	5		EA

FOR DIMENSION AND TOLERANCING INFO USE ASME Y14.5M 1994		THIRD ANGLE PROJECTION	NEXT ASSY: N/A		UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES, FRACTIONS IN PARENTS, DECIMALS IN BRACKETS. FINISH IN PARENTS, MATERIAL IN BRACKETS. HOLE EDGES, AND BREAK SHOTS		SECTION	E-DE NECKE 26MAR09	Waters		
			THIS DRAWING AND ALL INFORMATION CONTAINED HEREIN IS THE PROPERTY OF WATERS CORPORATION. NO REPRODUCTION, REPRODUCTION, OR DISTRIBUTION WITHOUT THE WRITTEN PERMISSION OF WATERS CORPORATION.		DRAWN	G. BERTONE 26MAR09	34 Maple Street Milford, Massachusetts 01757-3000 U.S.A.				
			TITLE ASSY, MODULE, PCB		DRAWN	N/A					
			DATE 01/01/2009		DATE 01/01/2009	DATE 01/01/2009	DATE 01/01/2009				
			DATE 01/01/2009		DATE 01/01/2009		SCALE	N/A	C	27900 1726	REV
			DATE 01/01/2009		DATE 01/01/2009		SCALE	N/A	C	27900 1726	REV
			DATE 01/01/2009		DATE 01/01/2009		SCALE	N/A	C	27900 1726	REV

Reassembling the SM-FTN

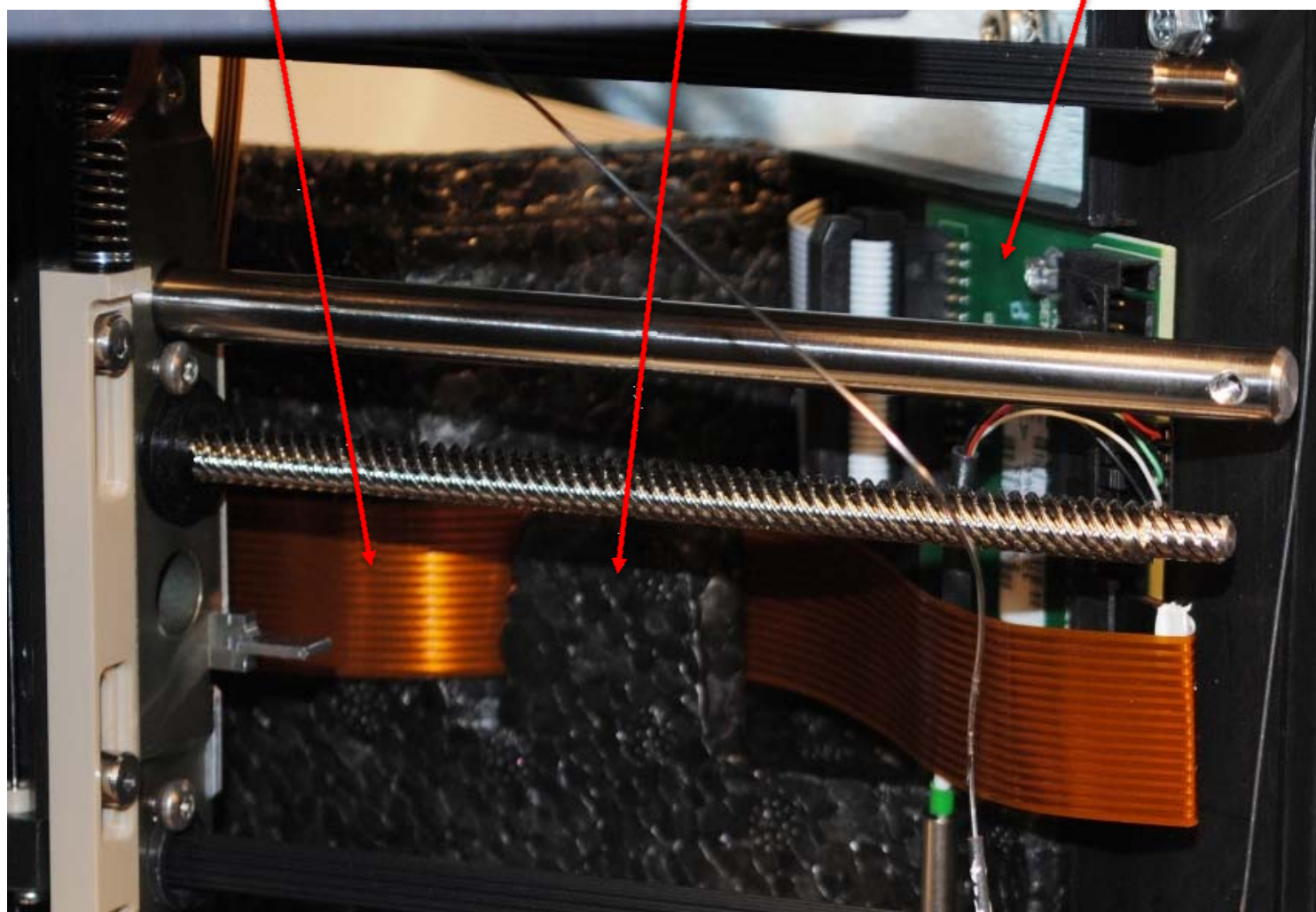
Proper Routing of the Needle Carriage Flex Cable

Warning- Make sure to route the needle carriage flex cable through the channel on the foam housing near the Interconnect PCB. Failure to do so could damage the cable on power up! (See picture below).

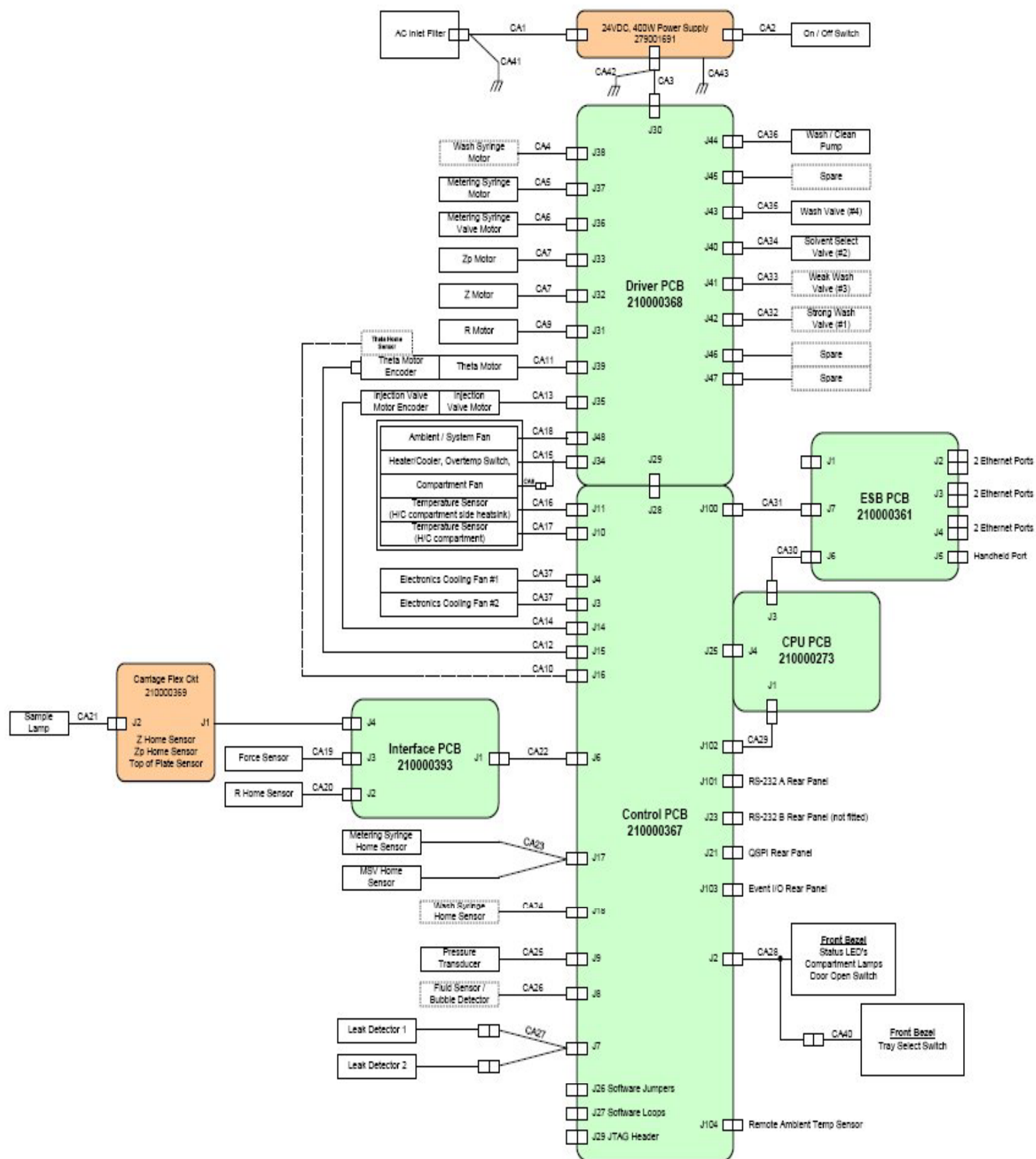
Needle Carriage
Flex Cable

Flex Cable Guide in
Foam Housing

Interface PCB

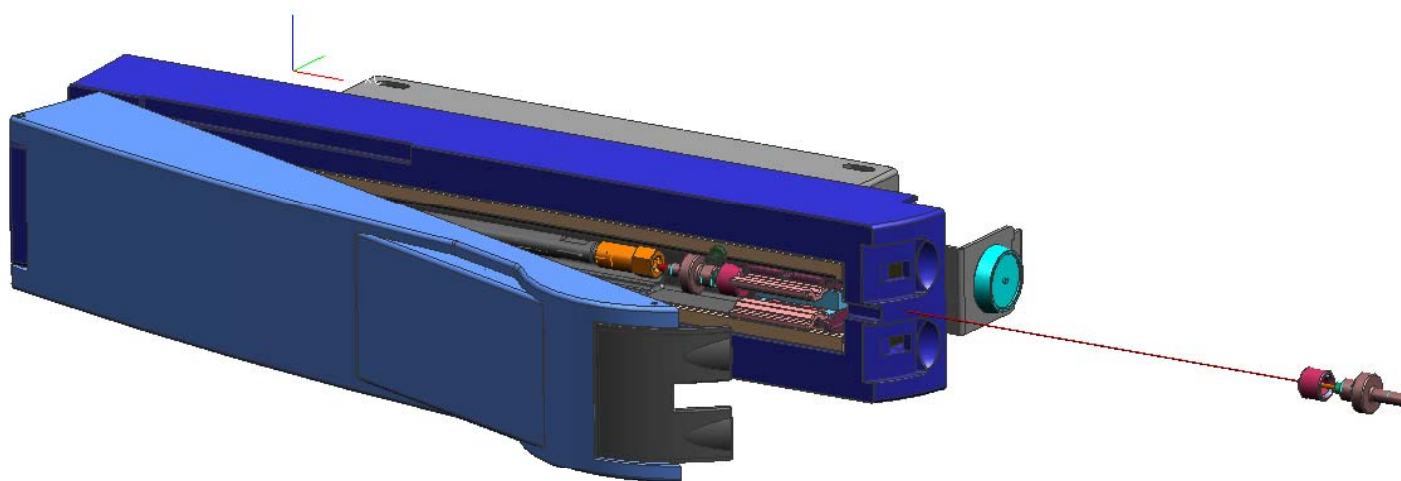


SM-FTN Electrical Interconnects





Section 8 ACQUITY H-Class CH-A



CH-A Service Procedures

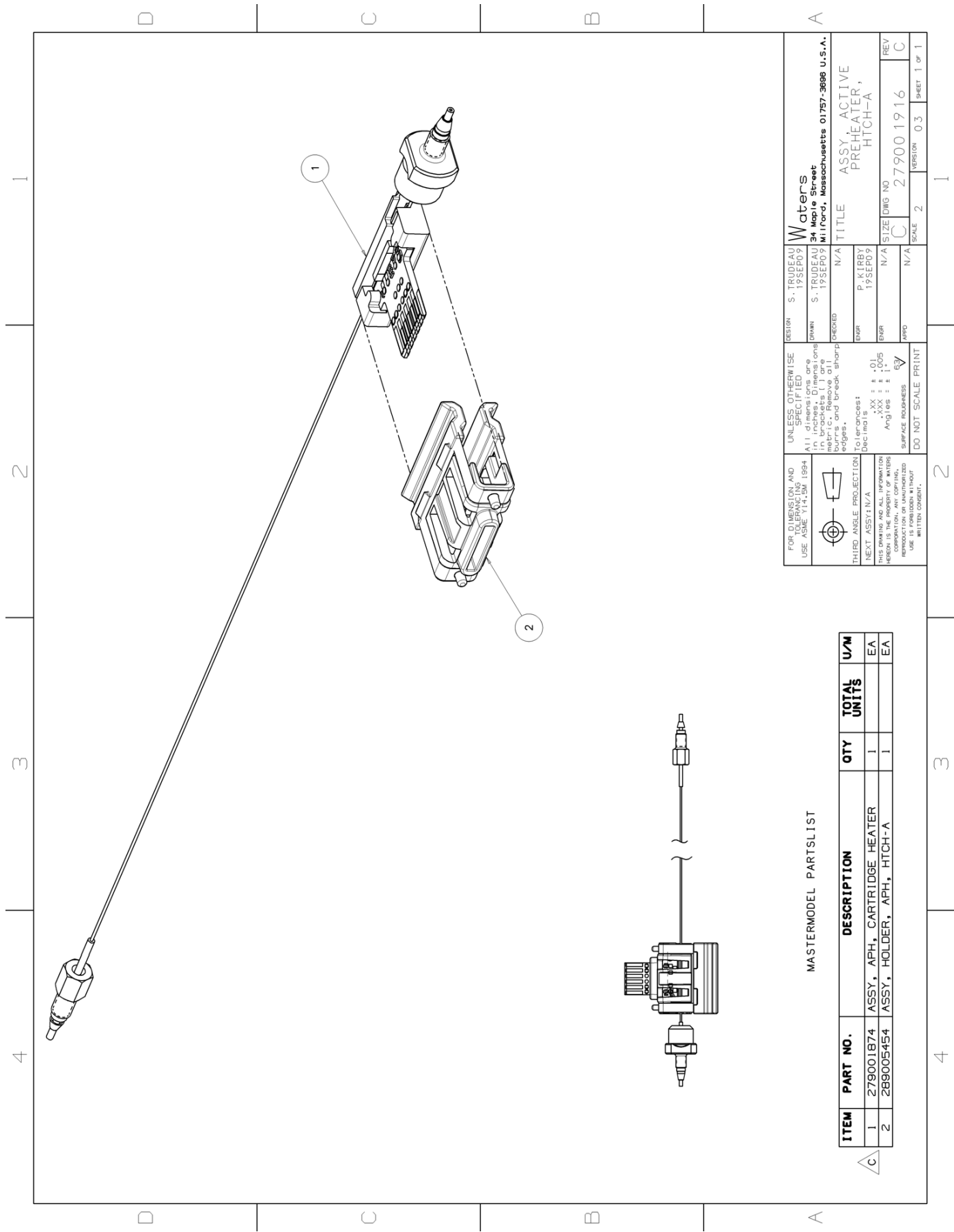
Removing the CH-A Assembly

- ❑ Borrow the CH-A Extension Kit for MS and familiarize yourself with the procedure “Installing the CH-A Extension Kit for MS”
- ❑ Reinstall the CH-A back into its normal position when done.

Remove this T20
Torx screw



CH-A Active Pre-heater



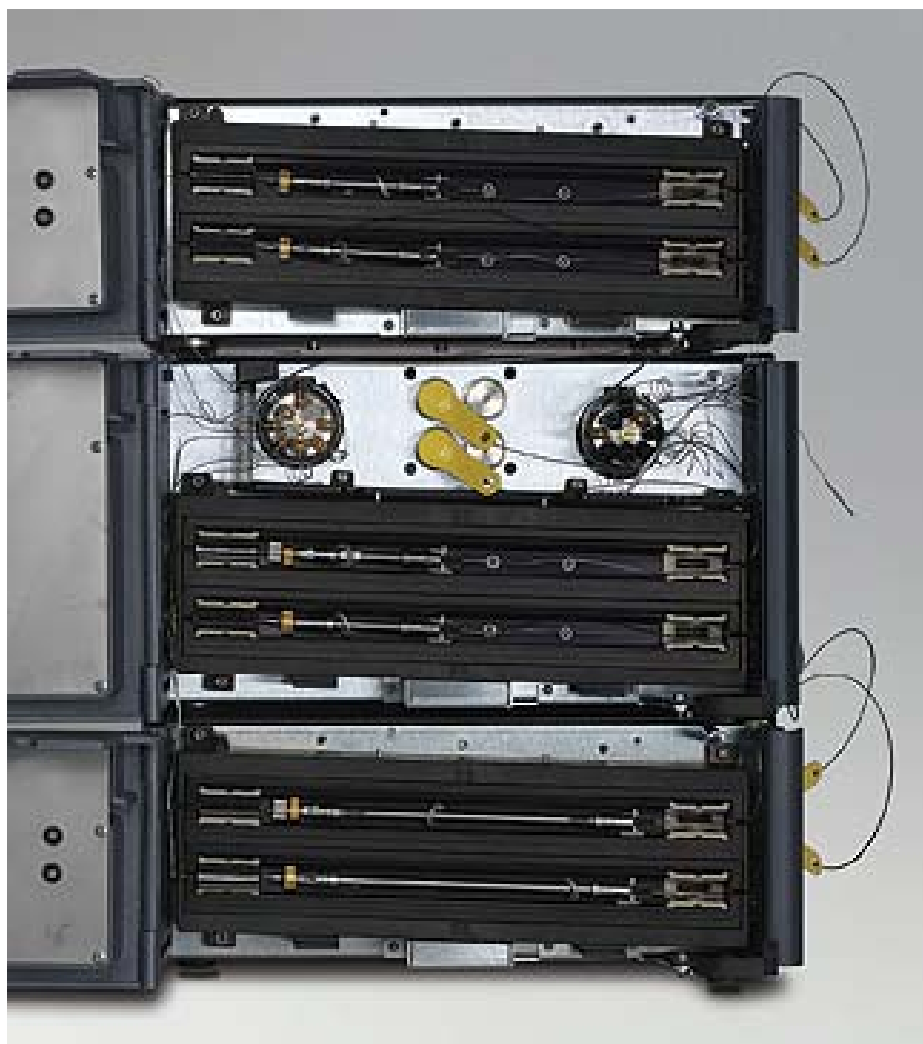
FOR DIMENSION AND TOLERANCE INFORMATION, SEE ASME Y14.5M 1994		UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES, DIMENSIONS IN BRACKETS () ARE IN MILLIMETERS. DIMENSIONS ARE TO BE MAINTAINED TO THE CLOSEST TOLERANCE POSSIBLE.		DESIGN: S. TRUDEAU 19SEP09		Waters 34 Maple Street Milford, Massachusetts 01757-3698 U.S.A.	
THIRD ANGLE PROJECTION		Tolerances: Decimals: .XX : ± .01 XXX : ± .005 Angles : ± 1°		DRAWN: S. TRUDEAU 19SEP09		TITLE: ASSY. ACTIVE PREHEATER, HITCH-A	
NEXT ASSY: N/A		SURFACE FINISH: RZ		CHECKED: N/A		SIZE: DWG NO. C 27900 1916	
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				APPRO: N/A		SCALE: 2	
				VERSION: 03		SHEET: 1 of 1	

MASTERMODEL PARTSLIST

ITEM	PART NO.	DESCRIPTION	QTY	TOTAL	U/M
1	279001874	ASSY. APH, CARTRIDGE HEATER	1	EA	EA
2	2890005454	ASSY. HOLDER, APH, HITCH-A	1	EA	EA



Section 9 Column Manager CM-A and CM-Aux



CM-A Install Procedure

Due to the lower number of Column Managers and Sample Organizers available for this course, your group should alternate this section with the Sample Organizer section following this chapter. Rotate on to the units as they become available.

Reviewing the Sample Organizer Installation Procedure

- While in front of the unit, review the procedure “Installing an H-Class System or H-Class Bio System Column Manager-A / Auxiliary Column Manager (715002684). Thoroughly familiarize yourself with all steps that are in bold below.

The CM-A / CM-Aux Installation Process

- **Step1 Determine the stack position(s) – see "Determining the stack position" on page 4.**
- Step 2 Prepare mobile phases and solvents as described in the ACQUITY UPLC® H-Class System and H-Class Bio System with TUV, PDA, ELS, or FLR Detectors Installation Manual (P/N 715002258), or the ACQUITY UPLC® H-Class System and H-Class Bio System with SQD/3100 or TQD Performance Test (P/N 715002380).
- **Step 3 Position all H-Class modules as required – refer to “Installing the ACQUITY UPLC H-Class System modules” in the ACQUITY UPLC® H-Class System and H-Class Bio System with TUV, PDA, ELS, or FLR Detectors Installation Manual (P/N 715002258).**

CM-A Install Procedure

The CM-A / CM-Aux Installation Process

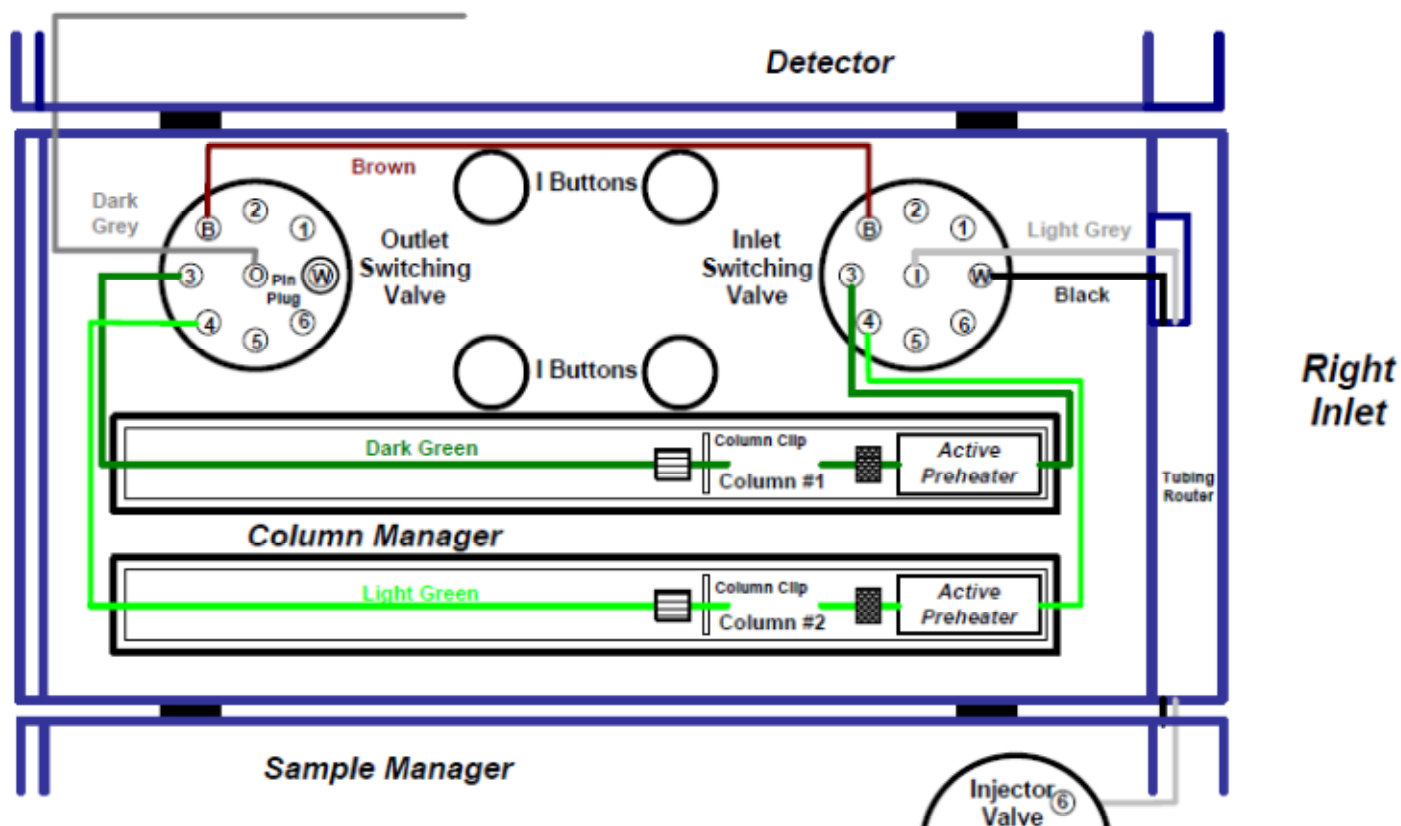
- ❑ Step 4 Install and plumb the QSM, SM-FTN, and any detectors (optical and/or massspectrometer) according to the ACQUITY UPLC® H-Class System and H-Class Bio System with TUV, PDA, ELS, or FLR Detectors Installation Manual (P/N 715002258) and if applicable, the appropriate mass spectrometer installation manual.
- ❑ **Step 5 Install the inlet and outlet switching valve cartridges, as described in "Installing the inlet and outlet switching valve cartridges" on page 7.**
- ❑ Step 6 Make all H-Class module power and electronic connections.
- ❑ **Step 7 Power on all system components, confirm communications, set the desired CM-A / CM-Aux column configuration, confirm CM-A valve positions, and activate the preheaters, as described in "Setting the column configuration, confirming the valve position, and activating the preheaters" on page 8.**
- ❑ **Step 8 Plumb the CM-A / CM-Aux module(s) in preparation for the system performance test, as described in the 2-, 4-, and 6-column installation sub-section(s) in this document.**

CM-A Plumbing Diagrams

The CM-A / CM-Aux Installation Process

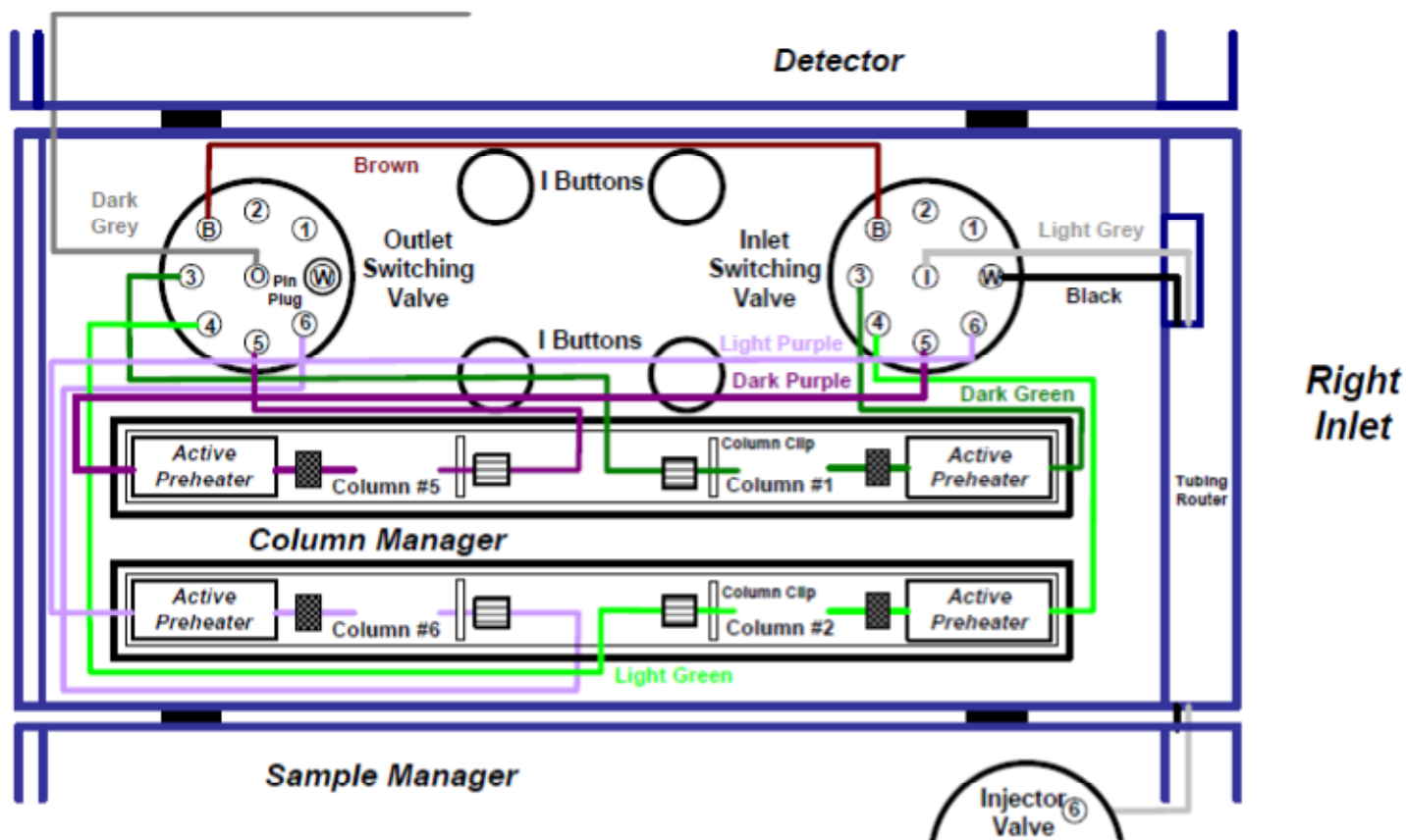
- Familiarize yourself with all plumbing diagrams for the CM-A and CM-Aux combinations as supplied on the next few pages.

2 x 150mm Configuration



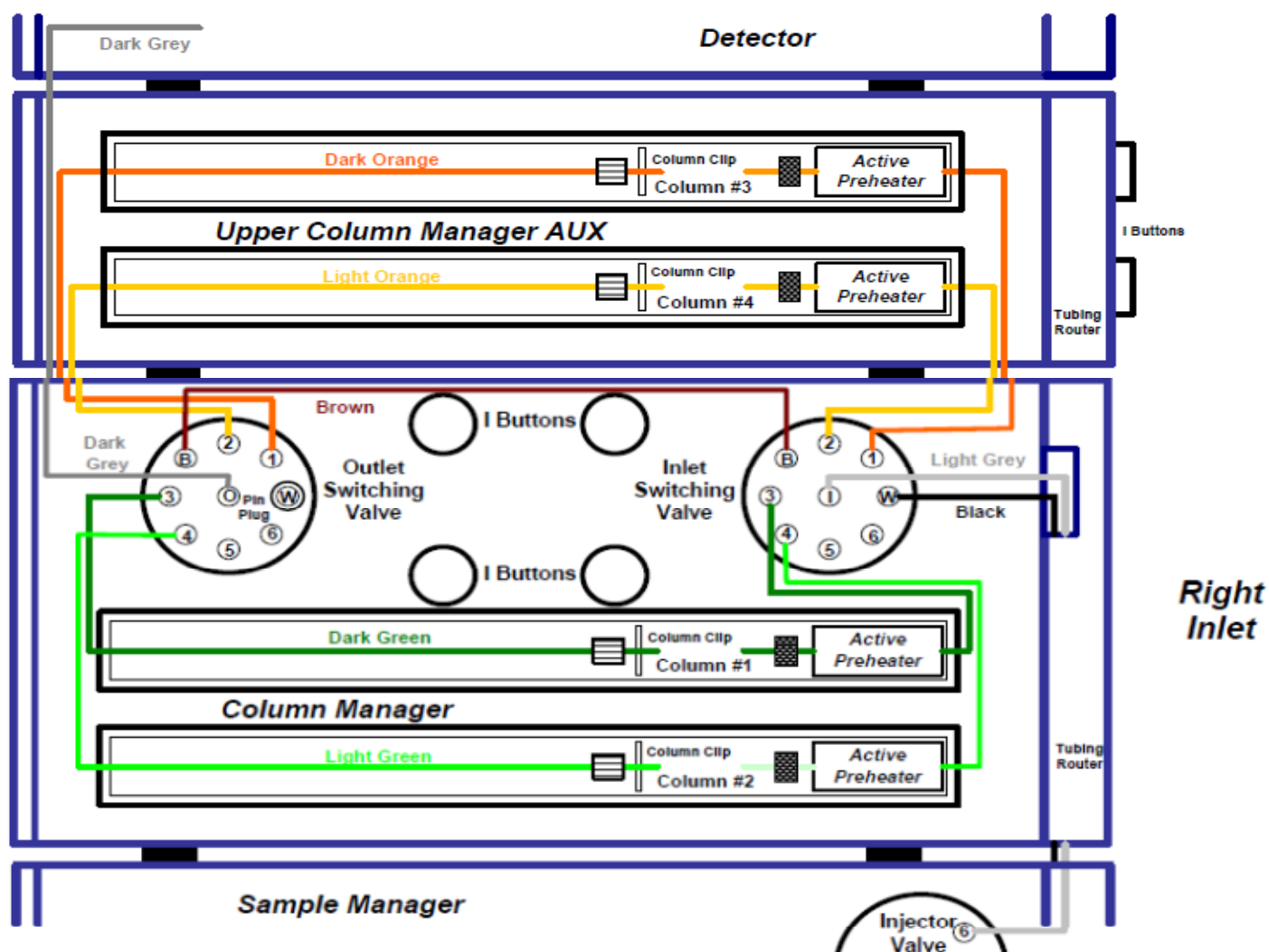
CM-A Plumbing Diagrams

4 x 50mm Configuration



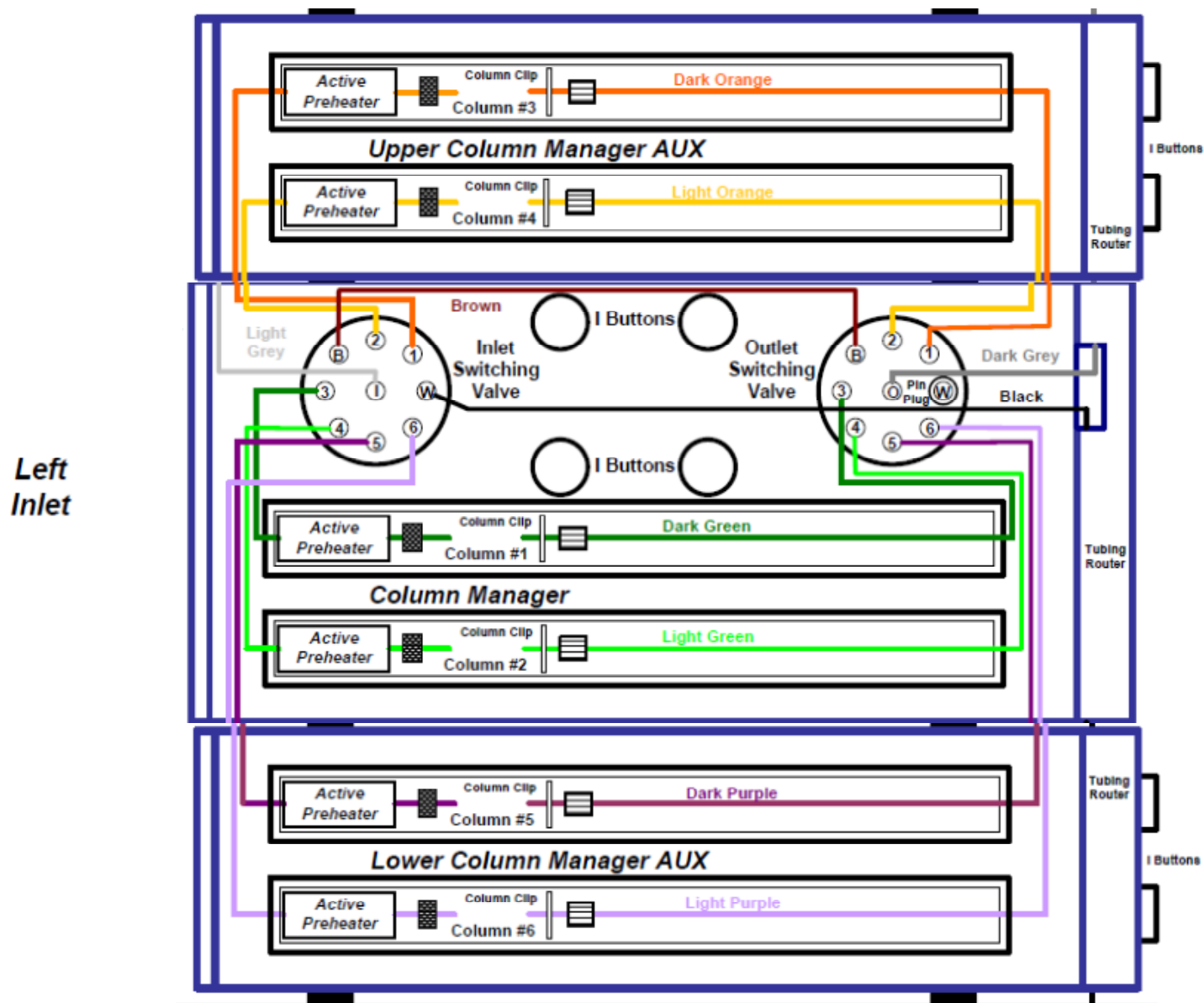
CM-A Plumbing Diagrams

4 x 150mm Configuration



CM-A Plumbing Diagrams

6 x 150mm Configuration



CM-A Replacing the Heater / Cooler

Replacing the Heater / Cooler Engine Assembly

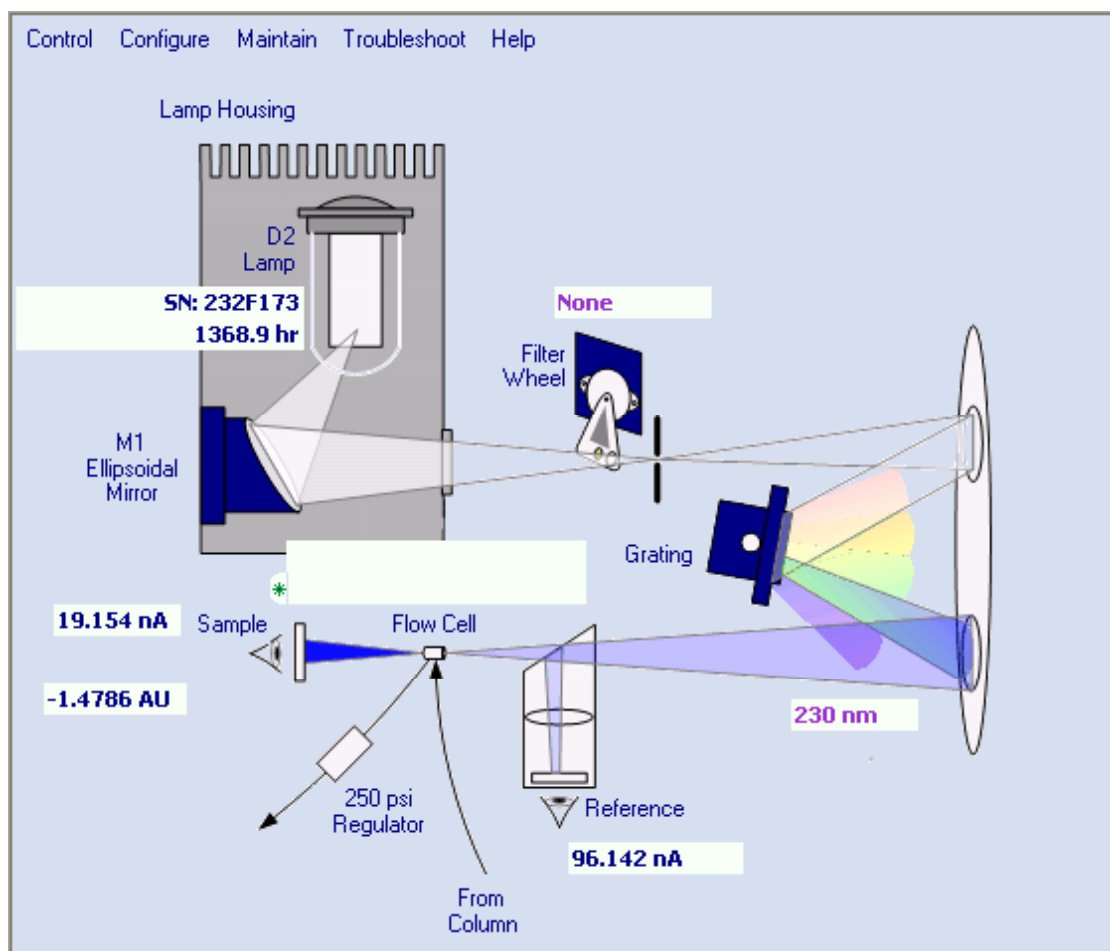
- ❑ While in front of the unit, perform the procedure “Replacing the Heater/Cooler Engine Assembly or the Dual Column Trough Assembly (715002938). Pull the unit apart to the point of Step 14- Separate the trough assembly from the engine assembly as shown in Figure 8 (as seen below).
- ❑ Reassemble the CM-A completely and test for proper function. The unit needs to be left in working order for the next group.



Figure 8 - Separating trough and engine assemblies



Section 10 TUV Service Procedures



Initial TUV Energy Readings

- ☐ Make sure that the lamp is on. Switch the wavelength to 230nm. Access this menu even if the wavelength is already set to 230nm if the AU readout reads closed as this will open the shutter to the optics if the detector has been idled.
- ☐ Switch to the Interactive Display menu.

Pre-Service TUV Energy Readings

- ☐ Using the TUV Shunt cell (you can obtain one from the instructor) record the Reference and Sample energy in the fields below:

Reference energy-_____na

Sample energy-_____na

Post-Service TUV Energy Readings

- ☐ Record the Reference and Sample energy readings from your TUV after completing the Service Procedures in the fields below:

Reference energy-_____na

Sample energy-_____na

Your goal is to get an equivalent or better energy reading after doing the service procedures.

TUV Service Procedures

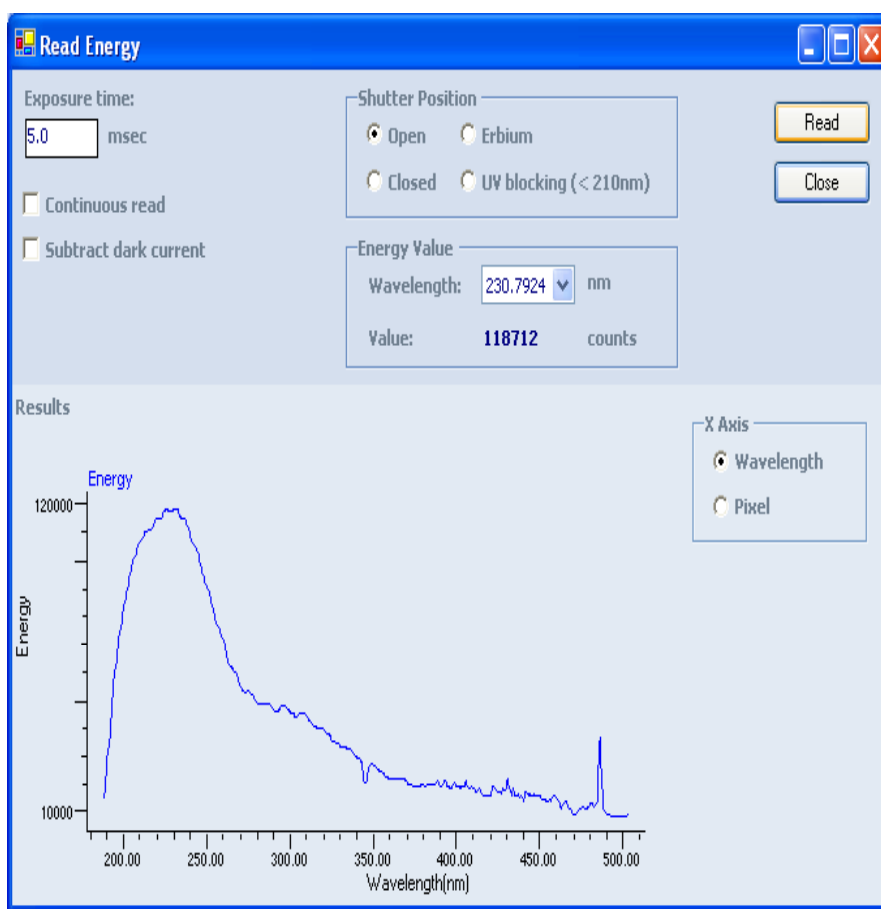
- ☐ Familiarize yourself with all the major service procedures for the TUV located in the GPL section of the portal as detailed in the figure below.
- ☐ Service & Upgrade Procedures
 - ☐ Replacing the Lamp
 - ☐ Replacing the Flow Cell
 - ☐ Replacing the Fan
 - ☐ Replacing the Filter Wheel
 - ☐ Replacing the Optics Bench
 - ☐ Replacing the Grating
 - ☐ Replacing the M1 Mirror
 - ☐ Replacing the Photodiodes
 - ☐ Replacing the CPU 2000/Personality PCB
 - ☐ Replacing the Preamplifier Board
 - ☐ Replacing the Low Voltage Power Supply
 - ☐ Replacing the Lamp Power Supply



Warning- Beware of live AC and DC voltages when troubleshooting and servicing with panels removed. Always remove the power cord from the TUV before touching any of the electronics.

Section 11

PDA Service Procedures



Initial PDA Energy Readings

- ☐ Make sure that the lamp is on. Switch the wavelength to 230nm. Access this menu even if the wavelength is already set to 230nm if the AU readout reads closed as this will open the shutter to the optics if the detector has been idled.
- ☐ Switch to the Interactive Display menu.

Pre-Service PDA Energy Readings

- ☐ Using the PDA Shunt record the Sample energy in the field below:

Sample energy-_____na

Post-Service TUV Energy Readings

- ☐ Record the Sample energy reading from your PDA after completing the Service Procedures in the fields below:

Sample energy-_____na

Your goal is to get an equivalent or better energy reading after doing the service procedures.

PDA

- ☐ Access the ACQUITY Console.
- ☐ Go to the PDA main console menu.
- ☐ From the Portal, download “**Acquity UPLC PDA Console**” pdf file and take a look at the video.
- ☐ From the Portal, download the PM Protocol for the PDA , 715000955
- ☐ Perform all tasks describe in this Protocol.
- ☐ Referring to the procedures available in the portal. Note that you may have spares optic bench to work on it.
 - ☐ Replace the Filter Flag
 - ☐ Replace the Charge Amplifier board
 - ☐ Replace / Align M1
 - ☐ Replace / Align M2
- ☐ How would you check the status of M1 ?

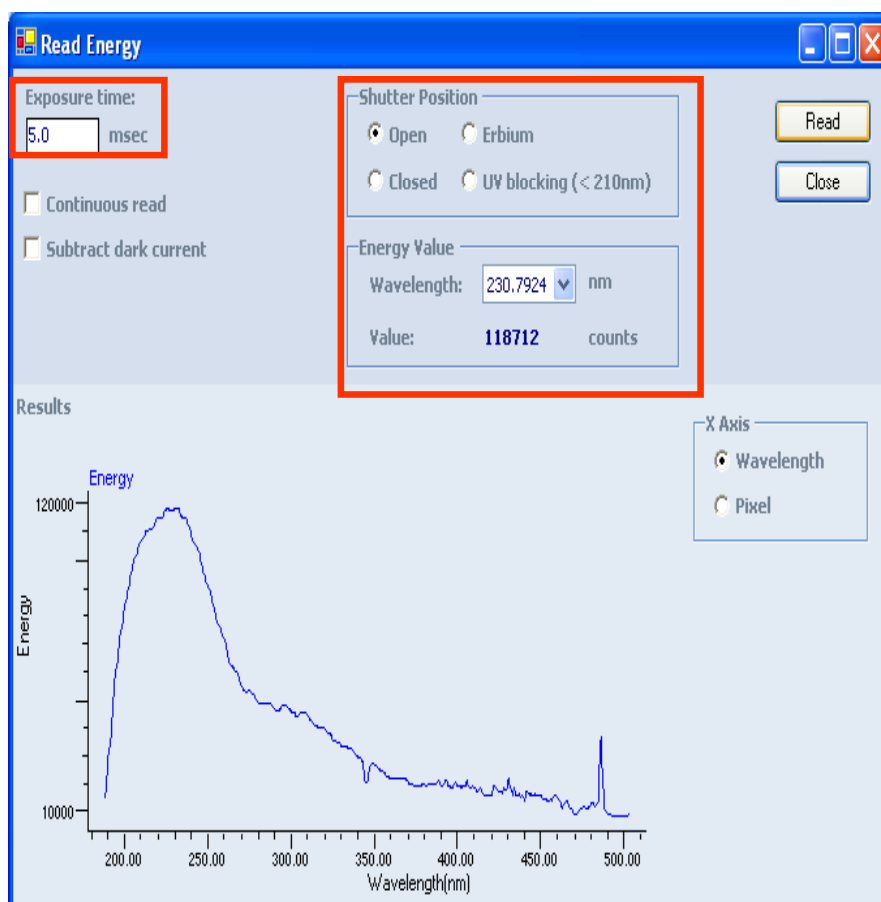
- ☐ How would you check the status of M2 ?

PDA Detector

- ❑ How do you optimize energy ?

Read Energy

- ❑ Open the **Read Energy** Utility
- ❑ Select the following settings:
 - ❑ exposure time of 5ms
 - ❑ Continuous read
 - ❑ Shutter is Open
 - ❑ Selected wavelength of 230nm from the pull down menu from 190-500nm



PDA Detector

- ❑ The Energy Value
 - ❑ Value: 118712 counts
- ❑ Notice that the 230nm peak apex is just under the 120000 energy counts of the Y Axis.
- ❑ Typical readings with a medium shunt cell range from 80,000 to 120,000 counts. With a fully wetted analytical cell with transparent mobile phase the energy reading would be approximately half of that of the medium shunt cell reading.
- ❑ Optimize energy and note the value
 - ❑ Energy @230nm _____
- ❑ Select Erbium shutter position and notice how the spectrum has changed as the shutter has moved to the Erbium filter position.
- ❑ Select Shutter Closed.
 - ❑ When the Shutter position is in the Closed position you are monitoring the signal of an un-illuminated PDA device or DARK Current.
 - ❑ A typical range for a DARK current signal is usually the following:
 - @230nm
 - Exposure time of 8ms
 - Value Counts < or equal to 600 counts
 - ❑ Dark current value @230nm _____

PDA Detector

- ❑ Select UV Blocking
 - ❑ UV Blocking Filter – At 210 nm and lower it blocks 50% of the UV wavelengths.
 - ❑ Why UV blocking - low wavelength UV light may behave as a catalyst for oxidation, which is detected at the Mass Spectrometer.
 - ❑ Phenomenon is affected by the following:
 - The sequence and identity of peptides present.
 - The proclivity of the compound to oxidation
 - The presence of low UV wavelengths
 - Residence time in the flow cell
 - The presence of oxidation agents within the sample and mobile phase

Calibration Verification

- ❑ Select Maintain > Verify Calibration
- ❑ Used to check and verify against last calibration.
- ❑ Once selected it will run through a 1.5 minute verification.
- ❑ Selecting Results confirms pass or fail and Maximum Deviation.

PDA Detector

Erbium Calibration

- ☐ This is where you check the Erbium Calibration. The instrument is calibrated at the time of manufacture and is verified at each power up.
- ☐ Subtract dark current is always default.
- ☐ Select Optimize Exposure first.
- ☐ Then Select START.
- ☐ From Current window you will see the
 - ☐ 2 Erbium peaks, 256.7nm, 379.0nm
 - ☐ 1 Deuterium peak at 486nm
 - ☐ Peak found at lambda
 - ☐ Lambda Error (nm) deviation
- ☐ Deviation must be within 1 nm to be successful.
- ☐ Wavelength Calibration L1 and L512 values can be viewed and new values saved if needed.

Perform an Erbium Calibration

- ☐ Used to view and verify current calibration parameters.
- ☐ To perform a Calibration
 - ☐ Cell must be filled and flowing with a transparent mobile phase.
 - ☐ Always select the Optimize Exposure button before selecting START.
 - ☐ Select Erbium Absorbance as graph type
- ☐ Note Wavelength values
 - ☐ L1 _____ L512 _____

Calibration Constants

- ☐ This utility is used to set the Lambda 1 and Lambda 512 values.
- ☐ Selecting Retrieve gives you the current Calibration Constants for L1 and L512
- ☐ If you replaced a CPU 2000 PCB you would need to re-enter the Calibration Constants from this screen.

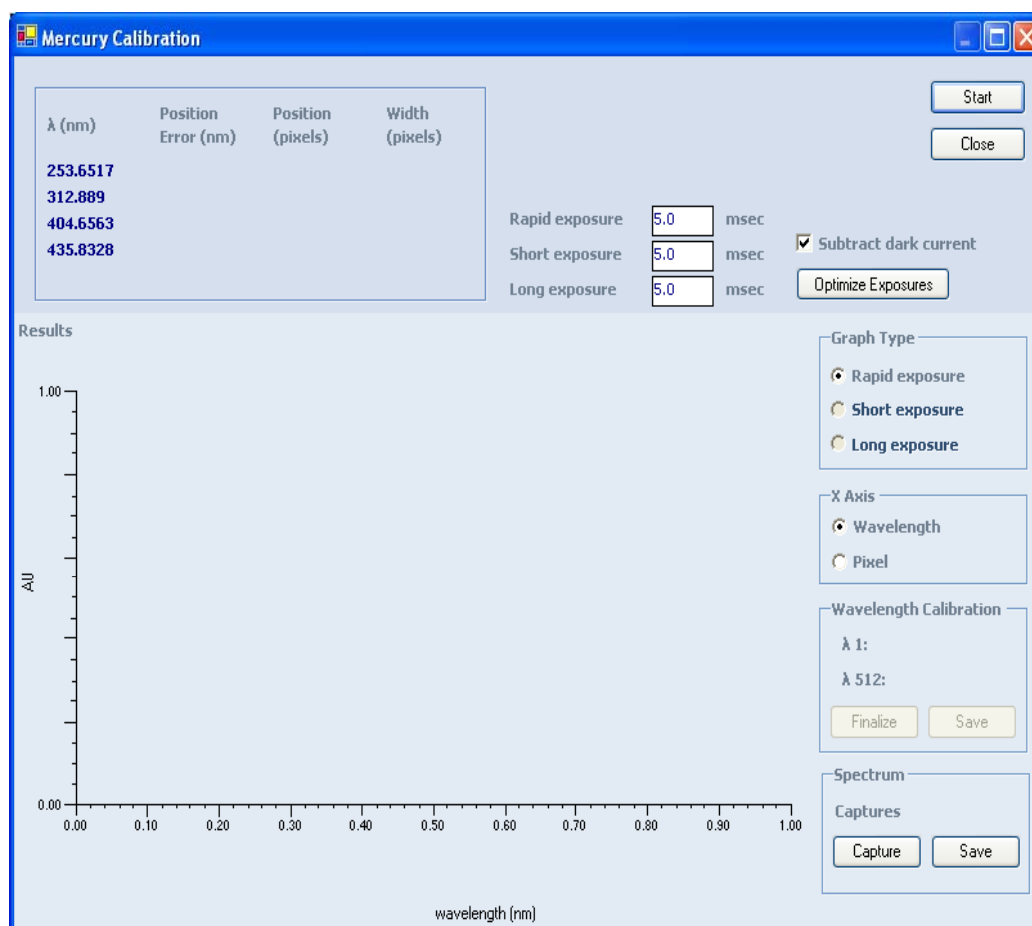
Service Mode

- ☐ Enter 1147 service code.
- ☐ Allows access to additional service modes.
 - ☐ Mercury Calibration
 - ☐ Noise and Drift tests
 - ☐ Reset NV Ram

PDA Detector

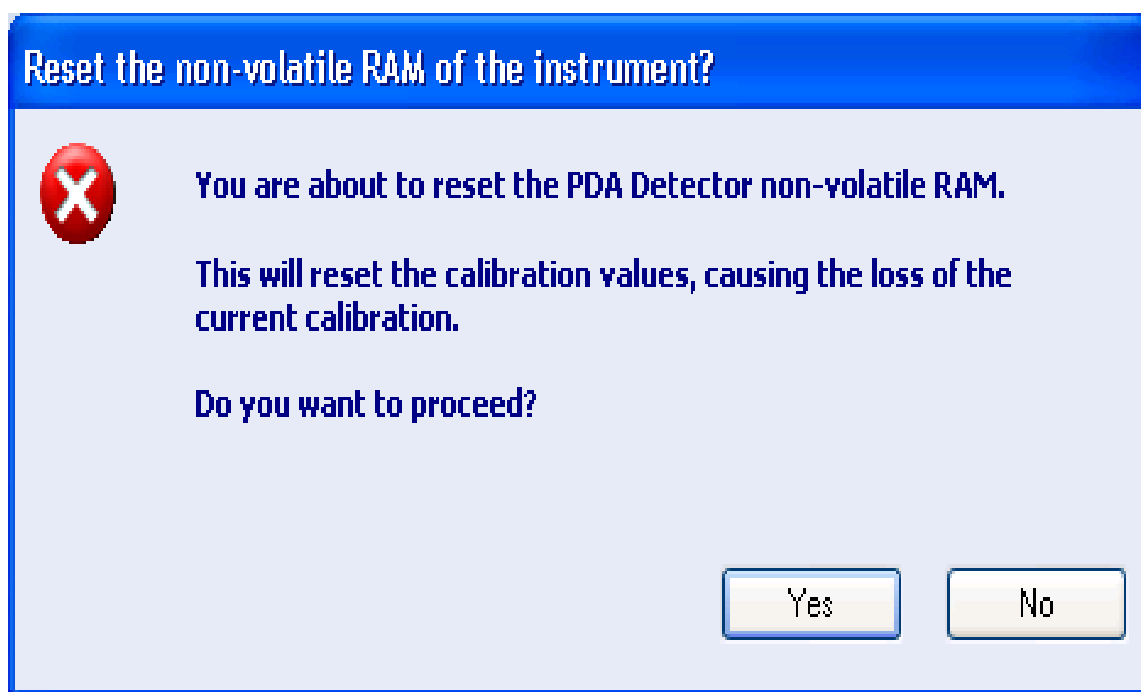
Mercury Calibration – FOR INFORMATION ONLY

- ❑ Used **ONLY** when aligning a grating in the manufacturing or repair departments.
 - ❑ The grating IS NOT a serviceable item in the field.
 - ❑ If needed we can also capture the spectrum and save it for later review.
- ❑ Not to be used for normal calibration. USE THE ERBIUM CALIBRATION.



Reset Non-Volatile RAM

- ☐ This utility allows you to reset the PDA Detector non-volatile RAM.
- ☐ Recommend you perform a erbium calibration after a reset of NVRAM.



PDA Detector

Noise and Drift

- ☐ Noise and Drift in Service Diagnostic Mode
- ☐ Requirements:
 - ☐ Medium Shunt flow cell must be installed to meet the 10uAU specification for Noise. Ask your trainer if he has one.
 - ☐ Parameters are set specifically as per design specifications.
- ☐ Lamp and Instrument on at least 30 minutes and stable.
- ☐ Each field is selectable and some have a pull down menu for various parameters.
- ☐ There is also a wet noise test specification.

The screenshot shows a software window titled "Noise and Drift Diagnostic". At the top, there is a progress bar labeled "0.0 min" and a small "0.0" value. Below this, several parameters are listed with input fields and units:

- Run time: 15.0 min
- Wavelength: 230.0 nm
- Resolution: 3.6 nm (with a dropdown arrow)
- Filter time constant: Normal (with a dropdown arrow) and 0.4000 sec
- Sampling rate: 10 Hz (with a dropdown arrow)
- Exposure time: Auto (with a dropdown arrow) and msec

At the bottom right of the parameter section are three buttons: "Start", "<< Results", and "Close". Below these is a "Results" section with two labels: "Total drift:" and "Segment peak noise:", each followed by a "µAU" unit. A "Print..." button is located to the right of the "Results" section.



Section 12

Post Service Diagnostic Tests



Post Service Diagnostic Tests-

Post Service Diagnostic Tests for QSM

- ❑ Following the “ACQUITY H-Class System Installation Manual” (located online and on the workstation), put the modules back together.
- ❑ Make sure you closely follow the instructions on how to plumb the system together and route the tubing up the side.
- ❑ Make sure all solvent lines back in there proper solvents for the verification tests.
- ❑ Prime all lines for 2 minutes if they still contain solvent otherwise prime for 3 minutes.
- ❑ Start a flow rate of 0.5ml/min with 50% A and 50% B and allow the pressure to stabilize for at least 2 minutes. Record the current pressure and delta pressure ripple in the table below.
- ❑ Repeat the above test with 50% C and 50% D and record the results below.

Solvent Line	System Pressure	Pressure Ripple	Pass / Fail
A-B			
C-D			

The Delta pressure ripple should be below 1% of the system pressure for a passed test result.

Post Service Diagnostic Tests

- ☐ Perform a dynamic leak test using line A to a pressure of 14000 psi.
- ☐ Record the results in the fields below for a passed test.
- ☐ If the test fails, prime line A with 100% MEOH and repeat test to 14000 psi.
- ☐ If it continues to fail troubleshoot the problem to the failing component and replace with a new one.

Leak Test

Parameters | Status | **Results**

	Accumulator	Primary
Result:		
Leak Rate:	nL/min	nL/min
Maximum Pressure:	psi	psi
Percent of Stroke:	%	%
Compressed Volume:	uL	uL
Compression Attempts:		
Test Attempts:		

Print Start Close

QSM Diagnostic Tests Overall Results (Pass/Fail)_____

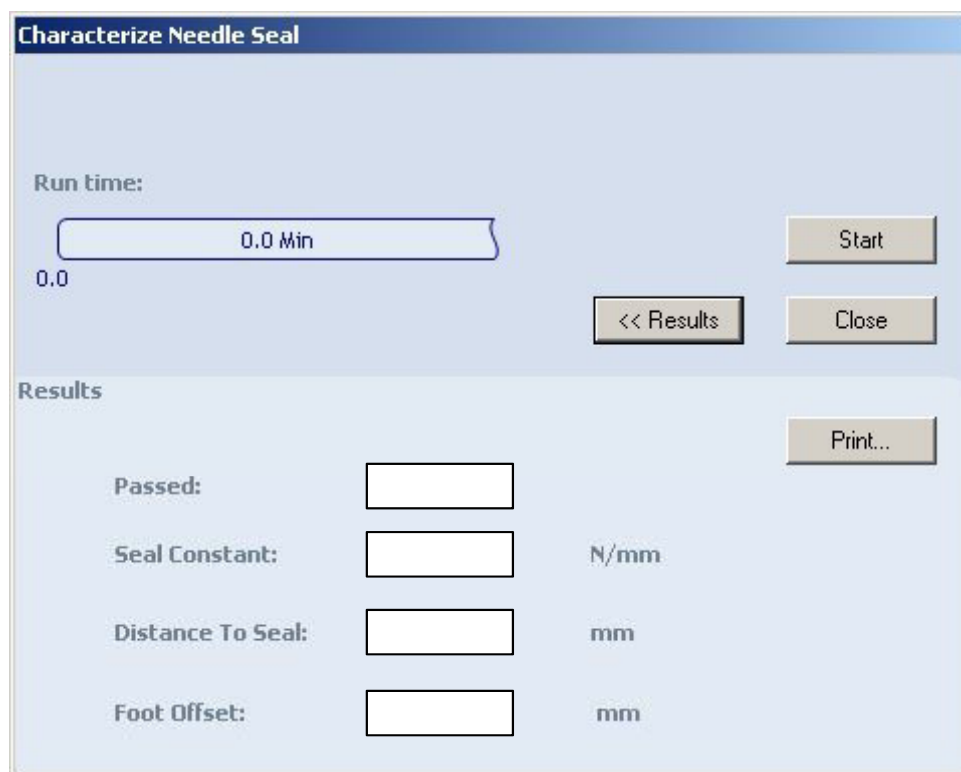
Initials_____

Date_____

Post Service Diagnostic Tests

Post Service Diagnostic Tests- SM-FTN

- ☐ Reset the SM-FTN from the console menu.
- ☐ Prime the Wash Solvent for 1 minute and the Purge Solvent for 10 cycles.
- ☐ Calibrate the Needle Z-axis and enter the result below.
Needle Z-axis Offset: _____mm.
- ☐ Check the plot properties menu in the SM-FTN top level console and make sure the Seal Force plot is enabled.
- ☐ Characterize the Needle Seal and enter the results below.



The image shows a software dialog box titled "Characterize Needle Seal". It has a light blue background and a dark blue title bar. The dialog is divided into two main sections: "Run time:" and "Results".

Run time: This section contains a text input field with "0.0 Min" and a "Start" button to its right. Below the input field is a small "0.0" label.

Results: This section contains four rows of labels and input fields, each followed by a unit label:

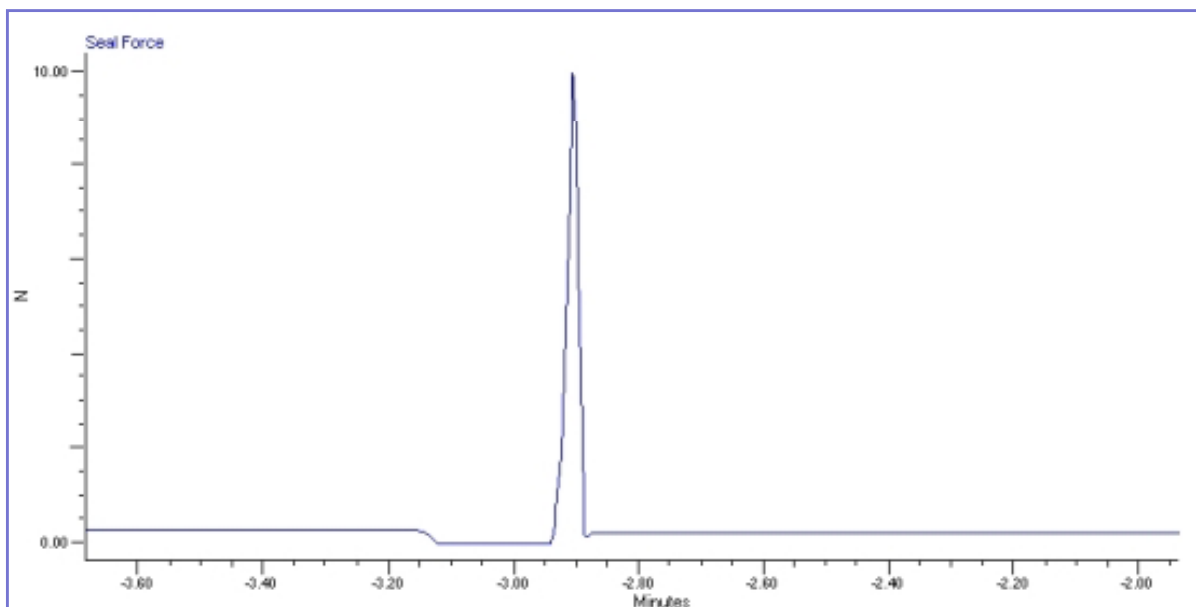
- Passed:** [input field]
- Seal Constant:** [input field] N/mm
- Distance To Seal:** [input field] mm
- Foot Offset:** [input field] mm

Navigation buttons are located on the right side of the dialog:

- "<< Results" button is below the "Start" button.
- "Close" button is to the right of the "<< Results" button.
- "Print..." button is to the right of the "Results" section.

Post Service Diagnostic Tests

- Examine the Seal Force plot after the Characterize Needle Seal function is completed. It should look similar to the below plot.



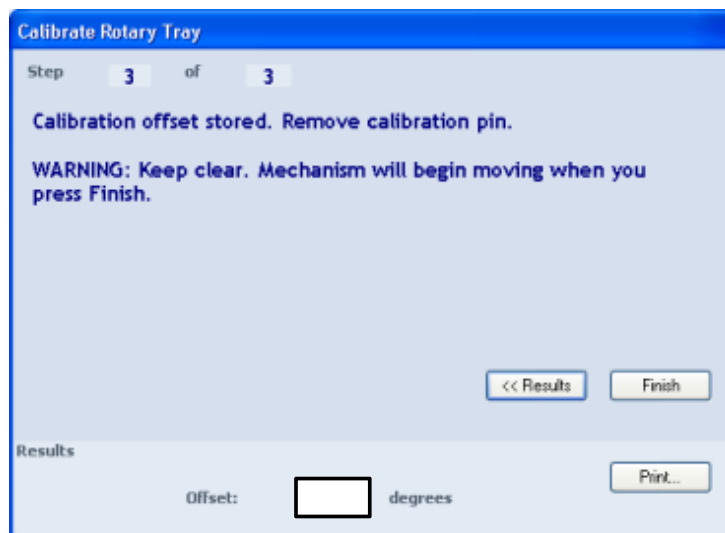
- Start a flow rate of 0.5ml/min with 90%A 10% B and allow the pressure to stabilize.
- Run the Needle Seal Readiness test and enter the result below.

Results		
Passed:		
Pressure Difference:		psi
Flow:		ml/min

Post Service Diagnostic Tests

Calibrate Rotary Tray

- ❑ Calibrate the Rotary Tray following the procedure on the portal. You must enter the service password to access this function from the Maintain menu.
- ❑ Enter the Calibration Offset in the field below:



Calibrate Rotary Tray

Step 3 of 3

Calibration offset stored. Remove calibration pin.

WARNING: Keep clear. Mechanism will begin moving when you press Finish.

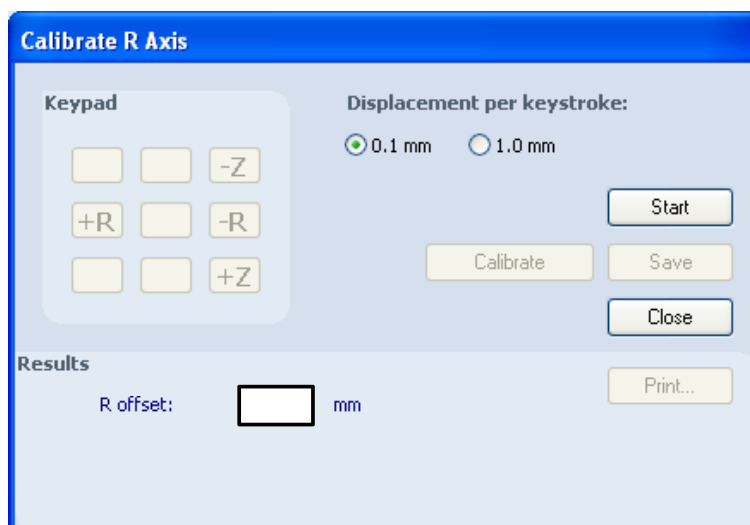
<< Results Finish

Results

Offset: degrees Print...

Calibrate R-Axis

- ❑ Perform the Calibrate R-Axis function by following the procedure on the portal.
- ❑ Enter the R Offset in the field below:



Calibrate R Axis

Keypad

Displacement per keystroke:

☒ 0.1 mm ☐ 1.0 mm

+R -R +Z -Z

Start

Calibrate Save

Close

Results

R offset: mm Print...

Post Service Diagnostic Tests

- ❑ Run the Sample Syringe static leak test and record the results in the blank fields below.

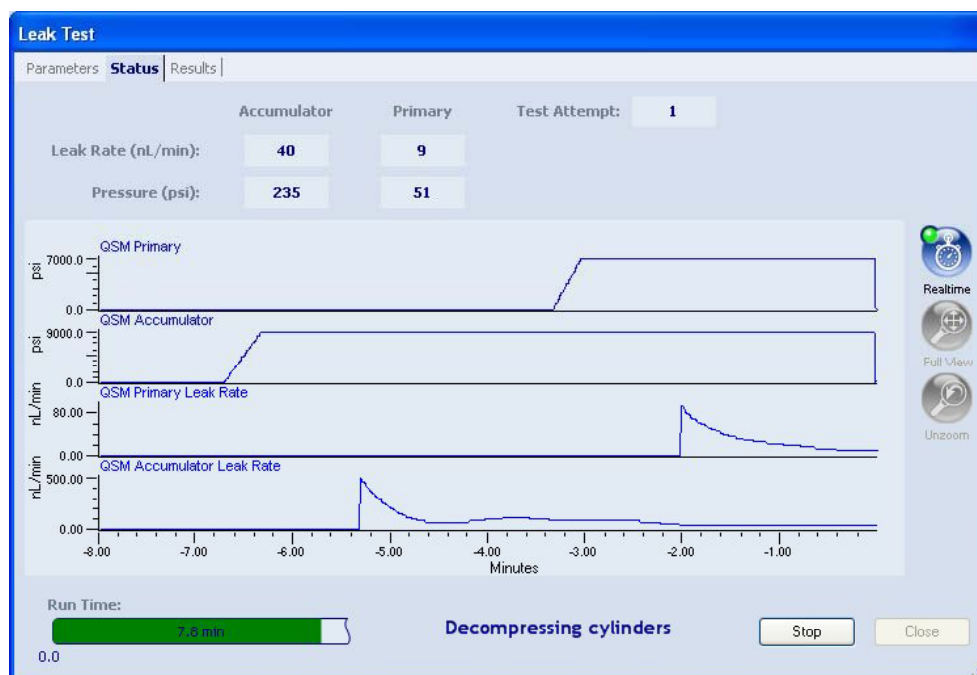
Results	
Leak Test	
Passed:	
Test pressure:	psi
Compressed volume:	μ L
Decompressed volume:	μ L
Start pressure:	psi
End pressure:	psi
Pressure change:	psi
Average pressure leak:	psi/sec

Running the QSM / SM-FTN Dynamic Leak Test

- ❑ Stop the flow and disconnect the column inlet line from the column.
- ❑ Connect a v-detail union and a plug to the active pre-heater outlet (APH) to plug the line.
- ❑ Run the Dynamic Leak Test from the QSM menu.
 - ❑ Set the pressure 9000 PSI.
 - ❑ Choose Column (active pre-heater outlet) as the end point and Include SM Needle and Seal
 - ❑ Record the results below.

Leak Test	
Parameters Status Results	
Accumulator	
Result:	
Leak Rate:	nL/min
Maximum Pressure:	psi
Percent of Stroke:	%
Compressed Volume:	μ L
Compression Attempts:	
Test Attempts:	

Post Service Diagnostic Tests



Do the results correlate well with the QSM leak tests?

This test should give a good level of confidence that the Stationary Side Seal, tubing and fittings are holding pressure and functioning correctly.

- ☐ If the test failed, recheck all fittings and try the test again. Troubleshoot the problem by changing the location of the pin plug if necessary to port 6.
- ☐ Once the test has passed, disconnect the plug and reconnect the column to the inlet line.
- ☐ Fill in the fields below and initial and date it.

SM-FTN Diagnostic Tests Overall Results
(Pass/Fail) _____

Initials _____

Date _____

System Installation Procedure

- ☐ Run the system performance tests to check the system as a whole.
- ☐ Record the results below.

Note- The before and after service results for the system are a key part of the certification exam.

Caffeine Area and Height Results Table

	Area %RSD Specification	Area %RSD	Area %RSD Pass Fail	Height %RSD Specification	Height %RSD	Height %RSD Pass Fail
1	%RSD < or = 0.5			%RSD < or = 1.1		

Caffeine Retention Time (RTsec) Results Table

	Retention time (sec) Standard Deviation Specification	Retention time (sec) Standard Deviation	Retention time (sec) Standard Deviation Pass Fail
1	SD RT < or = 1.0sec		

Precision Tests Overall Results (Pass/Fail)_____

Initials_____

Date_____

Gradient Test Results

Retention Time Reproducibility AB

	Name	Retention Time (Seconds) Standard Deviation Specification	Retention Time (Seconds) Standard Deviation	Retention Time (Seconds) Standard Deviation Pass Fail
1	2-acetylfuran	SD RT < or = 1.0sec		
2	acetanilide	SD RT < or = 1.0sec		
3	acetophenone	SD RT < or = 1.0sec		
4	propiophenone	SD RT < or = 1.0sec		
5	butylparaben	SD RT < or = 1.0sec		
6	benzophenone	SD RT < or = 1.0sec		
7	valerophenone	SD RT < or = 1.0sec		

Retention Time Reproducibility CD

	Name	Retention Time (Seconds) Standard Deviation Specification	Retention Time (Seconds) Standard Deviation	Retention Time (Seconds) Standard Deviation Pass Fail
1	2-acetylfuran	SD RT < or = 1.0sec		
2	acetanilide	SD RT < or = 1.0sec		
3	acetophenone	SD RT < or = 1.0sec		
4	propiophenone	SD RT < or = 1.0sec		
5	butylparaben	SD RT < or = 1.0sec		
6	benzophenone	SD RT < or = 1.0sec		
7	valerophenone	SD RT < or = 1.0sec		

Gradient Tests Overall Results (Pass/Fail)_____

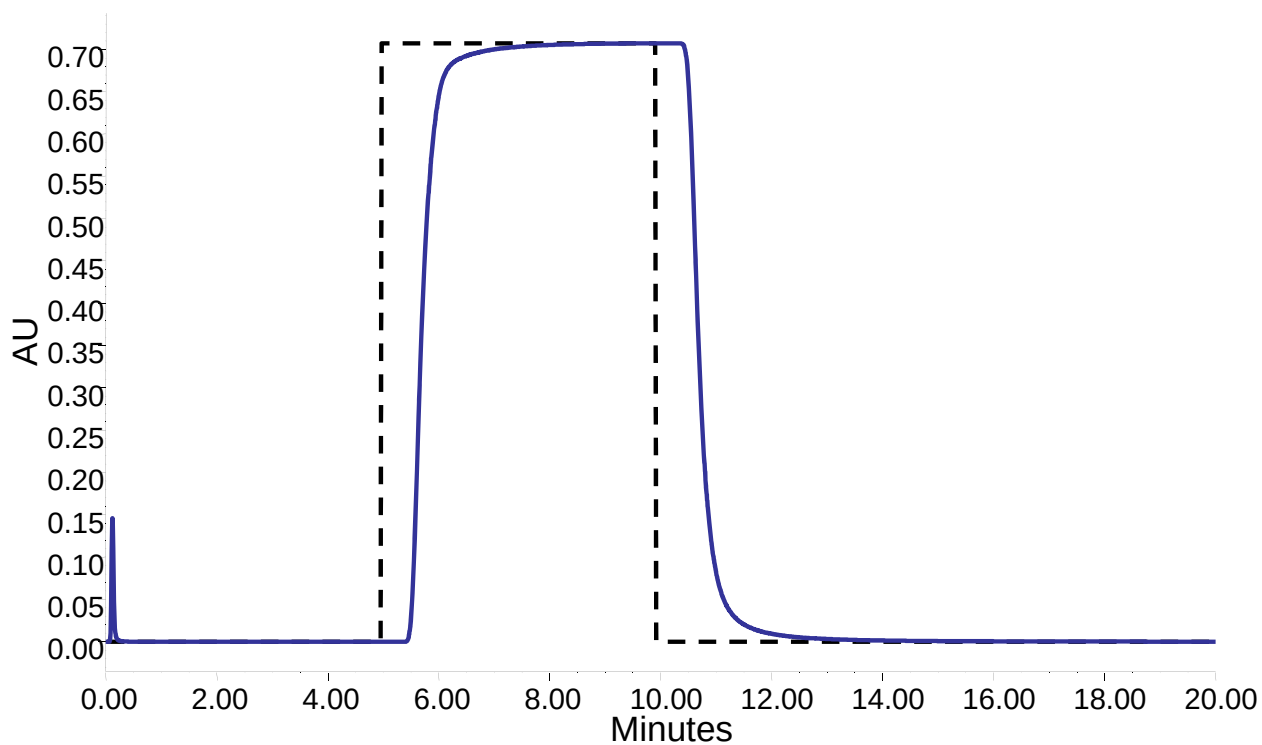
Initials_____

Date_____



Section 13

Bandspredding and Extra-Column Volumes



Extra-Column Volume

The extra-column volume comprises the volume of the system from the point of the injection to the point of detection. It is an important consideration for getting the maximum efficiency from a small column.

To determine the extra-column volume, we measure the RT of a peak injected by the SM with a zero volume union in place instead of the column. A more accurate determination would include all parts of the column (the connectors and frits) minus the packing material. However this is quite difficult to measure without sophisticated equipment.

- ☐ Remove the ACQUITY column and install a v-detail union in its place.
- ☐ Modify the Precision (Caffeine) method to the following parameters and then save it as Bandspreading.
 - ☐ Switch the flow in the Gradient table to isocratic using 90% A 10%B at 0.5 ml/min.
 - ☐ Switch the TUV method sampling rate to 40 pts/sec and the filter to none.
- ☐ Use the Caffeine sample from the system precision test.
- ☐ Run 3 replicate **1ul** injections of the test with a Run Time of 30 seconds.
- ☐ Calculate the extra-column volume in ul, using the following formula:

$$X = R_t * F * 1000 \text{ (ul / ml)}$$

R_t = Average Retention time of the peak from the 3 replicate injections

F = flow rate in ml/min

H-Class Extra-Column Volume = _____ul

Bandspreading

Bandspreading is the broadening of the peaks as they flow through the extra-column volume of the system. It is an important measure of the system impact on the efficiency of the chromatography.

- ☐ Pick one of the injections and calculate the system bandspreading volume (in ul), using the following formula:

$$B = W * F * 1000 \text{ (ul / ml)}$$

W= Width of the peak at 4.4% height

F= flow rate in ml/min

H-Class SM-FTN Bandspreading = _____ul

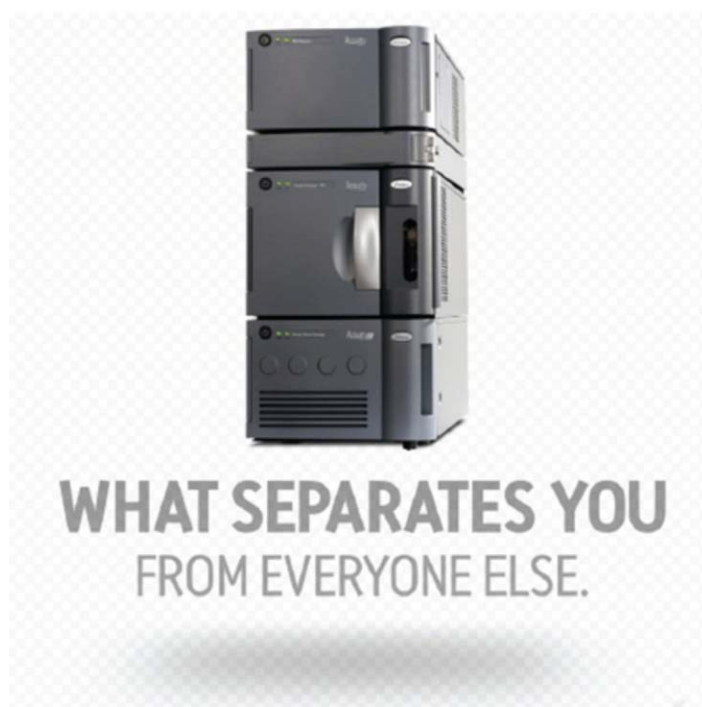
- ☐ Enter your values on the checklist provided by the instructor.

Shutting Down the H-Class System

- ☐ Reinstall the ACQUITY column.
- ☐ Put all QSM lines that are in water (A and C) into the 10%/90% Acetonitrile/Water bottle.
- ☐ Prime the lines you just moved for 3 minutes.
- ☐ Flush the system with 100% Acetonitrile for 10 minutes.
- ☐ Shut down the whole system once you are done flushing it. Cap the column and detector ports if plugs are available.
- ☐ This concludes the H-Class section.

Section 14

I-Class System Overview

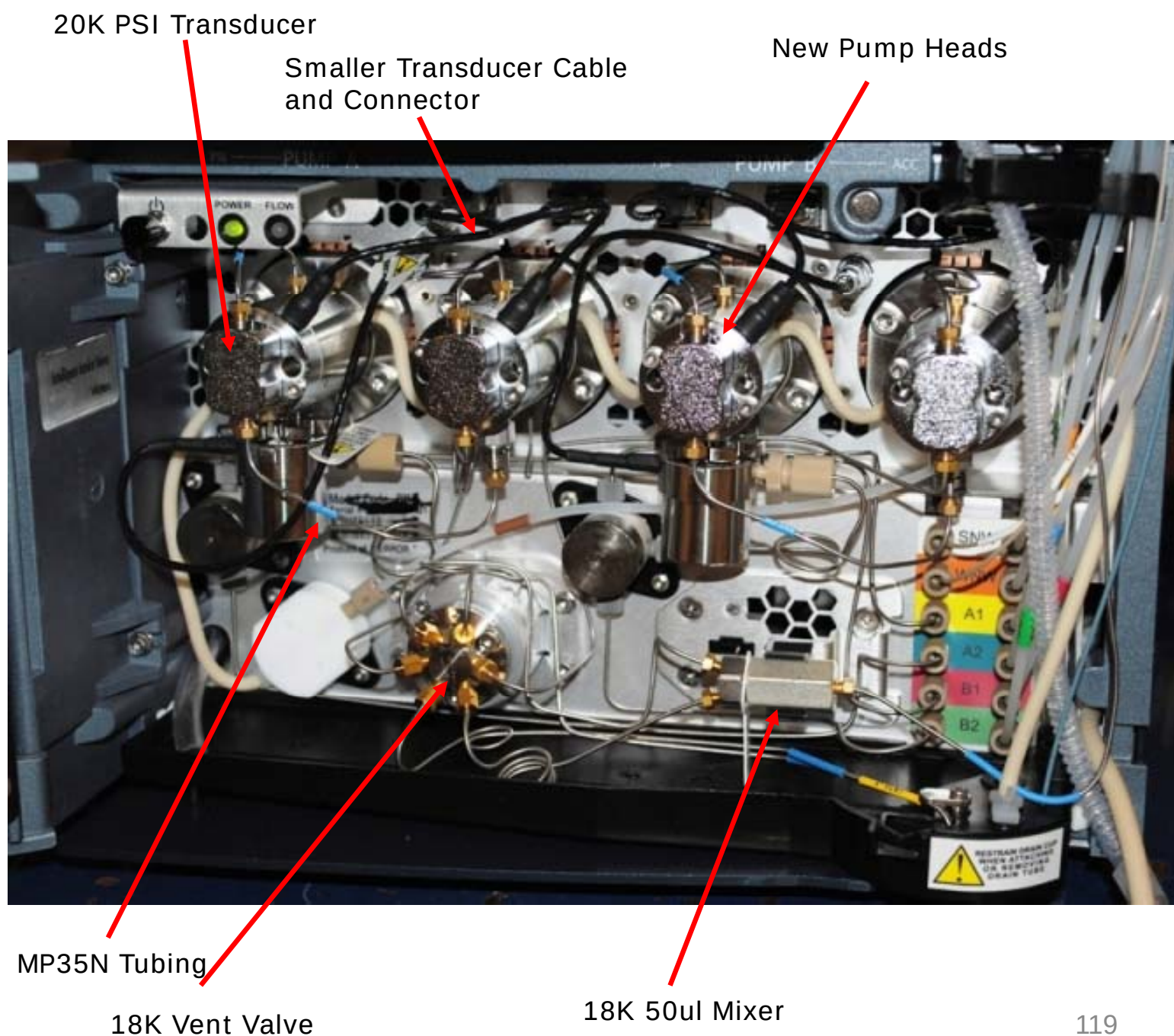


Connecting to the I-Class System

- ☐ If there is no computer hooked up to your designated I-Class system, move the PC from your H-Class system and connect it to the I-Class system. For information specific to your training session, ask your instructor.
- ☐ Using the most current driver pack (installed on your computer) remove the H-Class components (if the detector is the same model as was installed on your H-Class you leave that installed).
- ☐ Install the I-Class drivers specific to the modules on your system.
- ☐ Restart the system.
- ☐ Log into Empower or MassLynx.
- ☐ If you are running MassLynx, reconfigure the system to the I-Class modules on your system from the Inlet Editor.
- ☐ If you are running Empower, create a new system with the I-Class modules specific to your system.
- ☐ Open the ACQUITY Console to the top level menu.

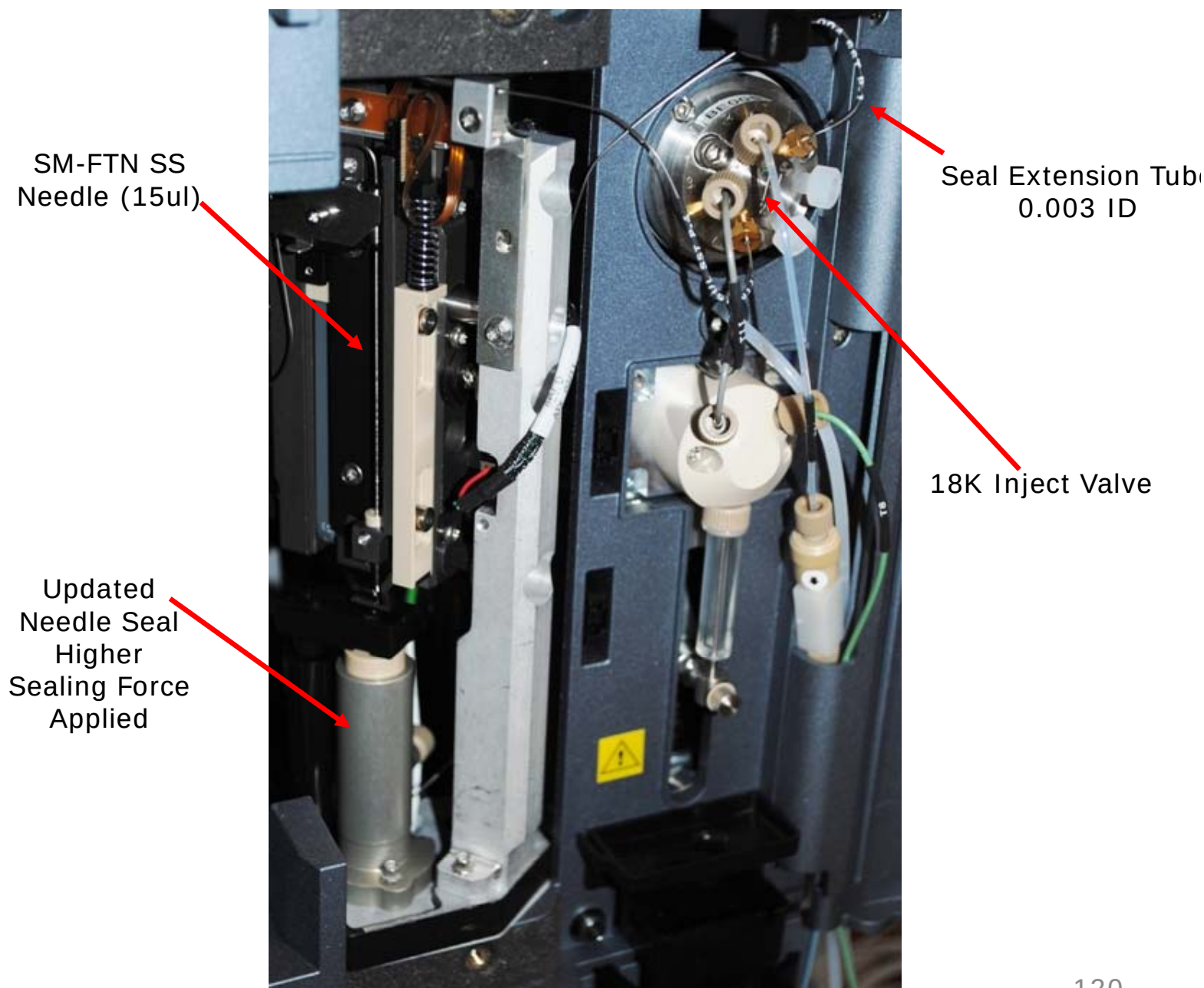
I-Class BSM Component Changes

- Open the front panel of the BSM and observe the major differences from the original BSM as detailed in the diagram below.



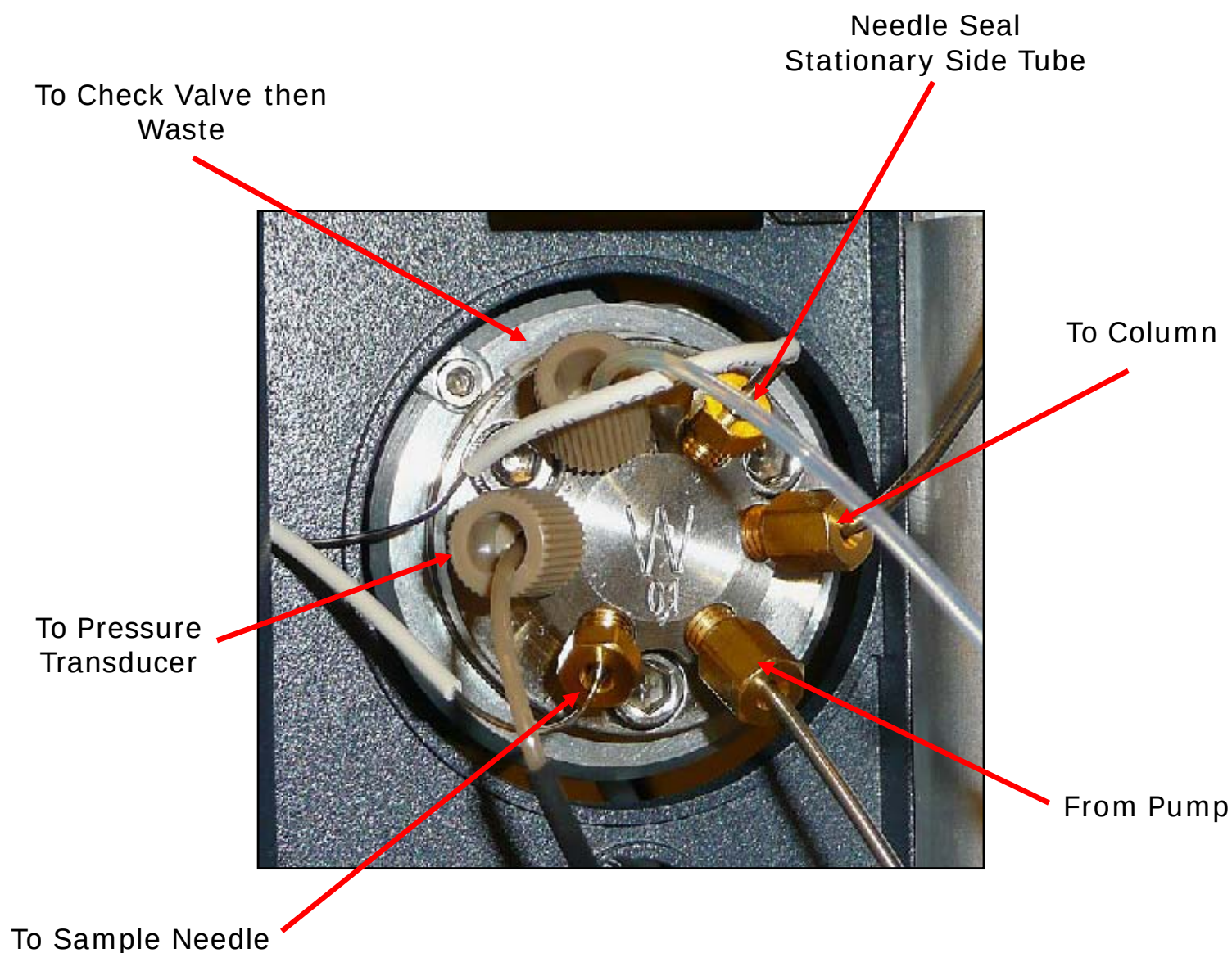
I-Class SM-FTN Changes

- ❑ Remove the 2 T20 screws securing the access panel in front of the Inject Block and remove the panel.
- ❑ Observe the main component changes of the Needle and the Needle Seal Housing Assembly as seen below.
- ❑ Where possible, trace the solvent lines and SS tubing line back to their origins.



SM Inject Valve Connections

- Observe the main connections to the Inject Valve and as seen below and trace each line to its end point. You will need to open the right side panel of the SM to see some of the connection terminations. The internal fluidic components are detailed on the next page.



Internal Fluidic Connections

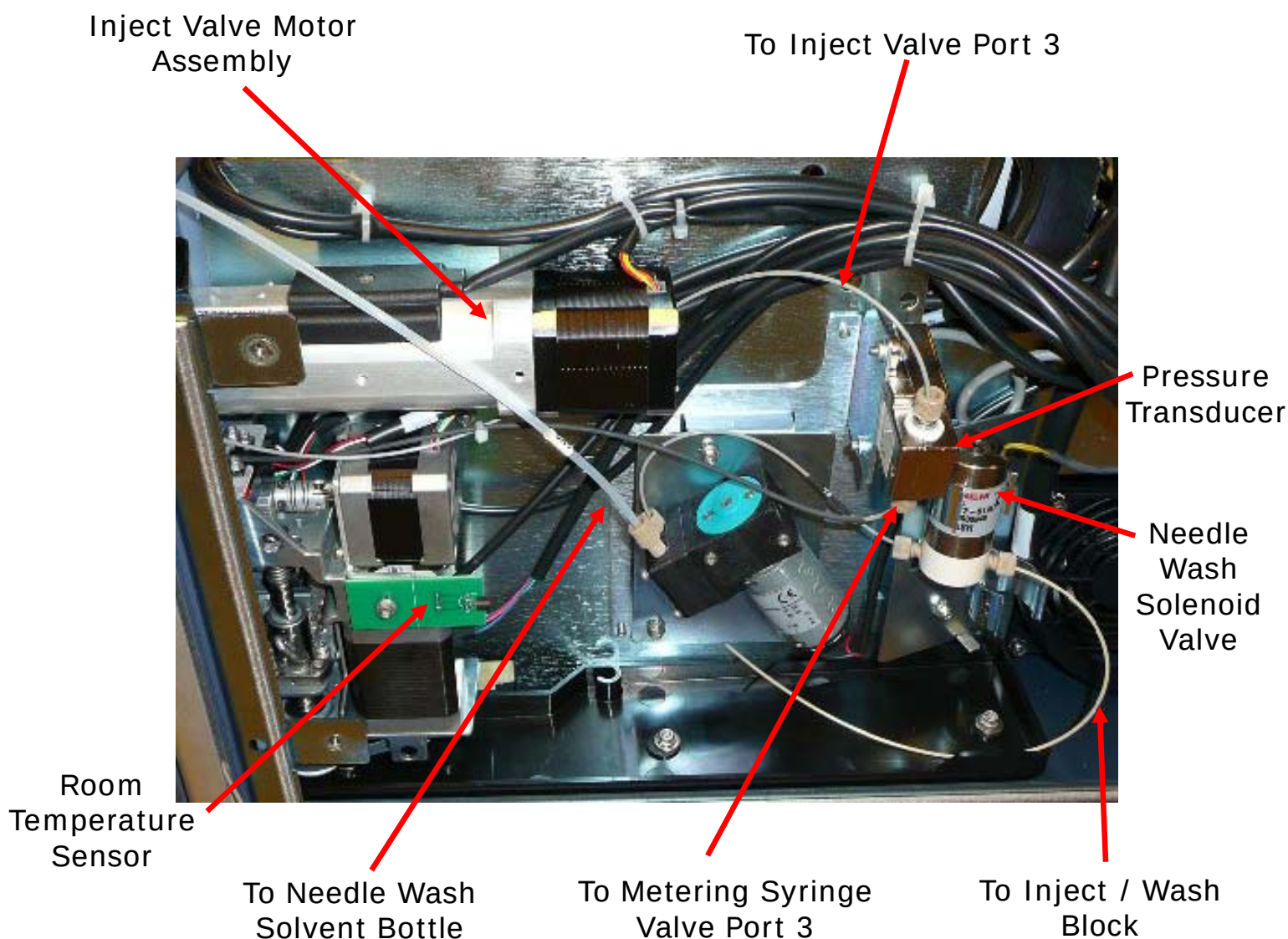
- ❑ Remove the 2 T20 screws securing the access panel in front of the Inject Block and remove the panel.



Warning- Beware of live AC and DC voltages when troubleshooting and servicing with side panels removed.

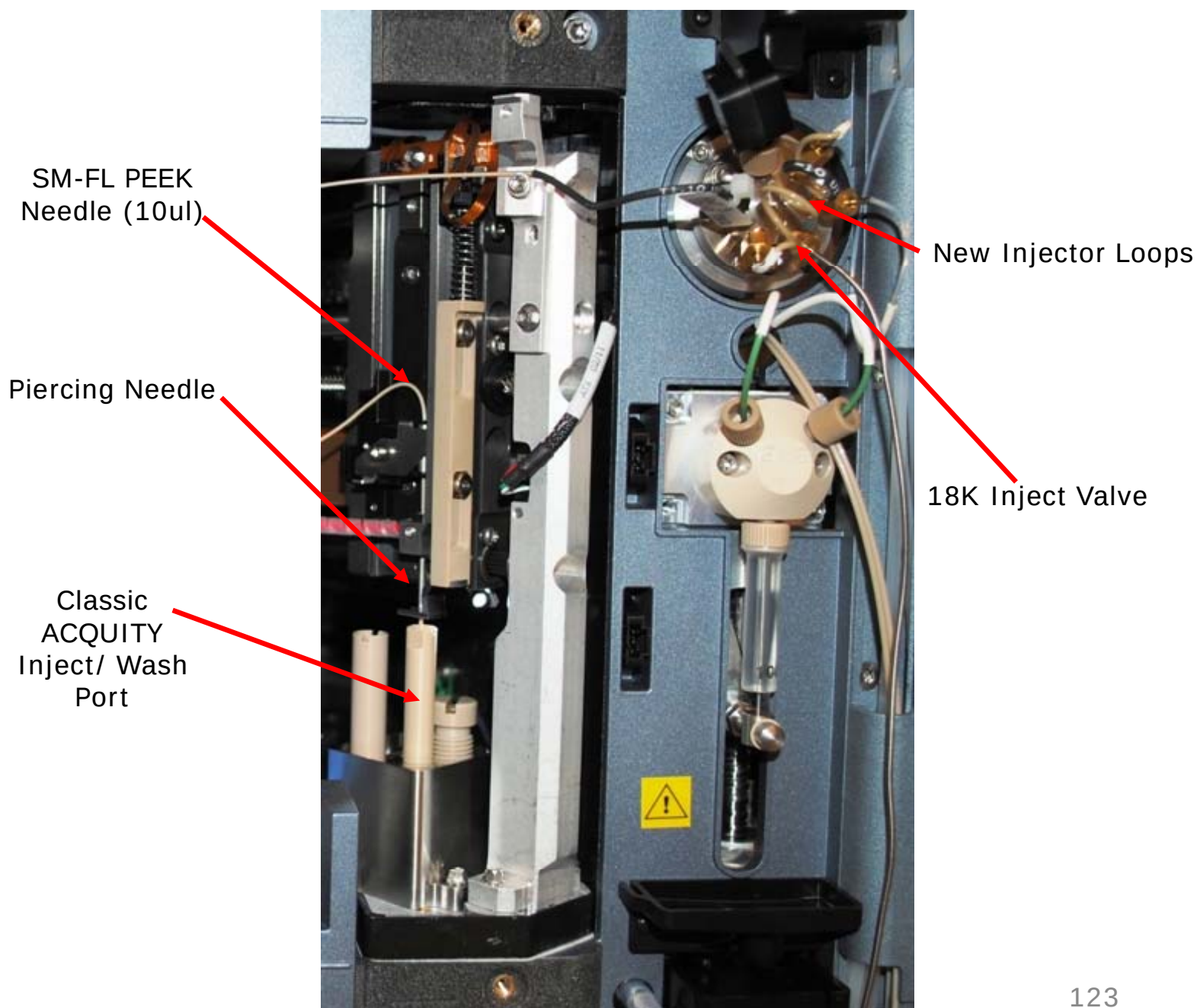
Observe the internal fluidic components as detailed in the picture below.

- ❑ As mentioned on the previous page, trace each line to its end point.
- ❑ When you have finished tracing the lines, reinstall the front and side panels.



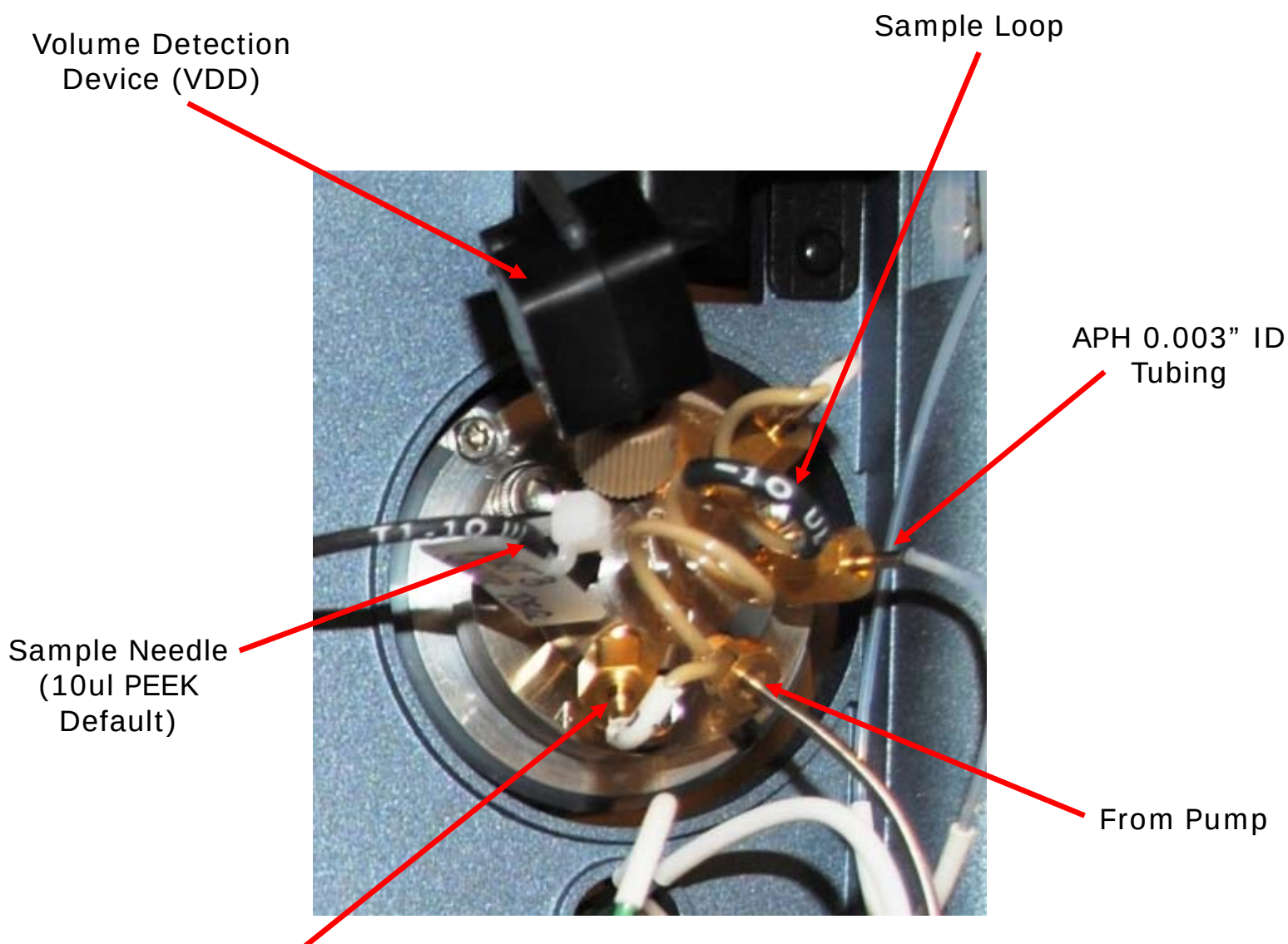
I-Class SM-FL Changes

- ❑ Remove the 2 T20 screws securing the access panel in front of the Inject Block and remove the panel.
- ❑ Observe the main component changes to adapt the fixed loop injection technique of ACQUITY Classic SM to the common platform SM.
- ❑ Where possible, trace the solvent lines and SS tubing line back to their origins.



SM-FL Inject Valve Connections

- Observe the main connections to the SM-FL Inject Valve and as seen below and trace each line to its end point. You will need to open the right side panel of the SM to see some of the connection terminations. The internal fluidic components are detailed on the next page.



SM-FL Internal Fluidic Connections

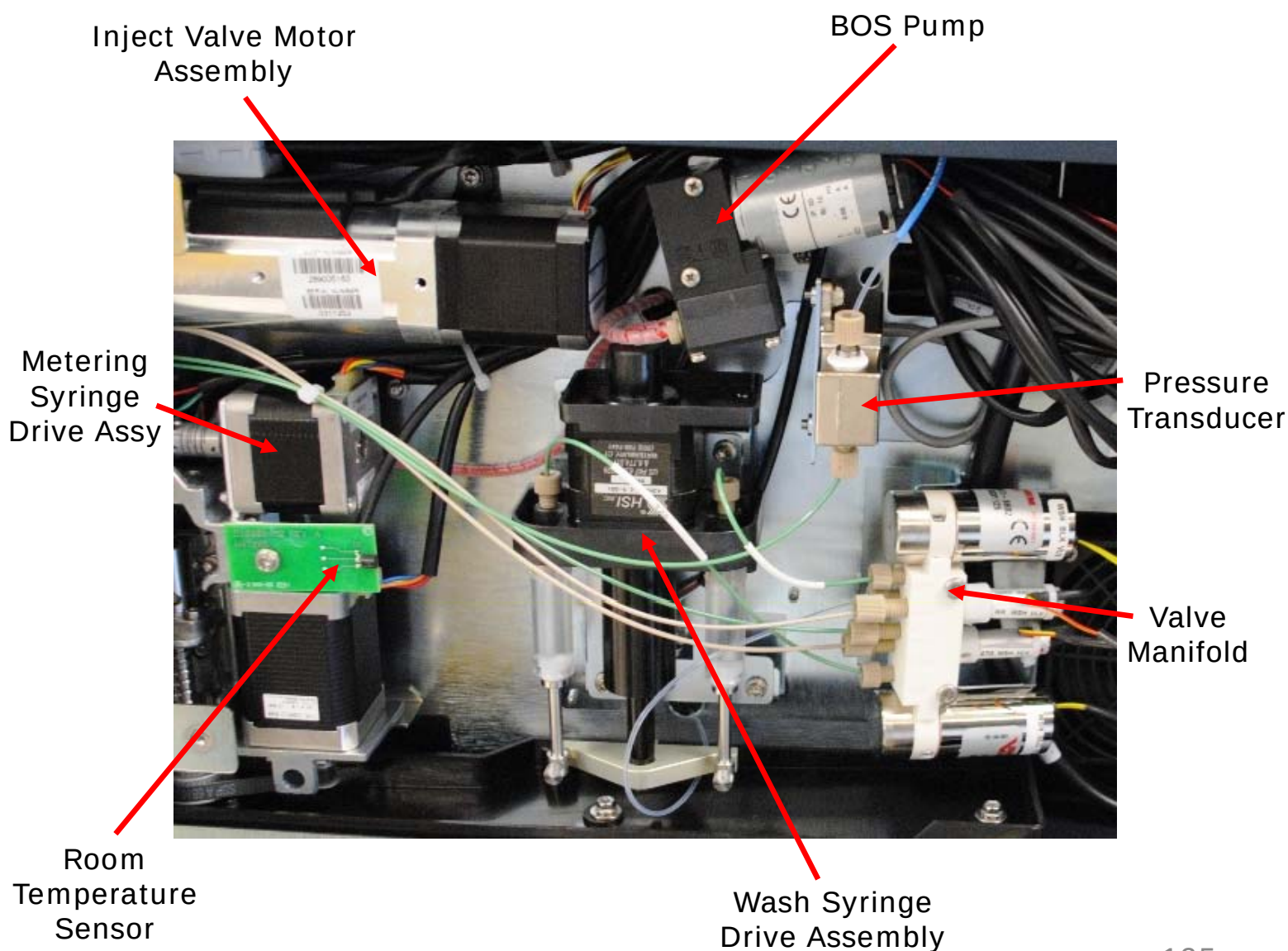
- ❑ Remove the 2 T20 screws securing the access panel in front of the Inject Block and remove the panel.



Warning- Beware of live AC and DC voltages when troubleshooting and servicing with side panels removed.

Observe the internal fluidic components as detailed in the picture below.

- ❑ As mentioned on the previous page, trace each line to its end point.
- ❑ When you have finished tracing the lines, reinstall the front and side panels.



Priming Up the BSM

- ❑ Obtain some new filtered water for your system from the appropriate labeled bottle in the lab or from the Lab Water filtration device.
- ❑ Make sure that the solvent lines are inserted to the bottles as follows:

Water	Lines A1, A2
Acetonitrile	Lines B1 and B2
10% ACN 90% H ₂ O	Strong Wash, Weak Wash and Seal Wash lines

- ❑ Prime each solvent line for 3 minutes.

What is the total time it takes to prime the BSM lines_____?

Is the total time longer, shorter or the same as priming four solvents for the QSM_____?

_____?

- ❑ Start the BSM pumping with 90% Water and 10% ACN at a flow rate of 0.5ml/min.
- ❑ Switch the channel plots to view the Primary Pressure and Accumulator Pressure for the A and B pumps.
- ❑ Give the pressure at least 3 minutes to settle down and record the Pressure Ripple
Delta Pressure Ripple-_____PSI

Seal Wash and Leak Test

- ☐ Prime the Seal Wash for about 1 minutes.
- ☐ Observe that there is a steady flow of solvent coming out indicating a good prime then stop the prime.
- ☐ Switch the console menu to the top level BSM menu so you can see the pressure plots.
- ☐ Run the Dynamic Leak test for pump A using solvent A1 at 17000 PSI with the Vent Valve as the end point.
- ☐ On the status page, you can right-click the plots and show the Accumulator and Primary pressure plots.
- ☐ Run the Leak test using solvent B1 at 17000 PSI with the Vent Valve as the end point.
- ☐ Record the results in the fields on the next page.
- ☐ What is the range of pressures you can test the Accumulator head on each pump_____?

The screenshot shows a software window titled "Dynamic Leak Test" with three tabs: "Parameters", "Status", and "Results". The "Parameters" tab is active. It contains three main sections: "Pressure", "Pump", and "End Point".

- Pressure:** Two input fields. "Accumulator:" is set to "17000" psi, and "Primary:" is set to "15000" psi.
- Pump:** Two radio buttons, "A" (selected) and "B". Below them is a checkbox labeled "Prime" which is currently unchecked.
- End Point:** Two radio buttons, "Vent Valve" (selected) and "Column".

At the bottom of the window, there is a text field with the label "Retry the test if it fails, up to a maximum of" followed by a numeric input field set to "0" and the text "additional attempts.".

At the bottom right of the window are two buttons: "Start" and "Close".

Leak Test Results

The pass criteria for an individual pump test is a leak rate of less than 200 nL/min. The pass criteria for a system test is a leak rate of less than 600 nL/min.

The new leak test can use multiple strokes to compress fluids to the test pressure condition, which accommodates highly compressible fluids and the additional fluid volume compressed during a system test.

- ❑ Record your results in the appropriate fields:

Pump A Results

The screenshot shows the 'Dynamic Leak Test' software window with the 'Results' tab selected. The interface is divided into two columns: 'Accumulator' and 'Primary'. Each column has a 'Result' field at the top. Below these are fields for 'Leak Rate' (with a unit of nL/min), 'Maximum Pressure' (with a unit of psi), 'Percent of Final Stroke' (with a unit of %), 'Compressed Volume' (with a unit of uL), and 'Compression Strokes'. A 'Test Attempts' field is located at the bottom left. On the bottom right, there are 'Print', 'Start', and 'Close' buttons.

	Accumulator	Primary
Result:		
Leak Rate:	nL/min	nL/min
Maximum Pressure:	psi	psi
Percent of Final Stroke:	%	%
Compressed Volume:	uL	uL
Compression Strokes:		
Test Attempts:		

Pump B Results

This screenshot is identical to the one for Pump A, showing the 'Dynamic Leak Test' software window with the 'Results' tab selected. It features the same layout with 'Accumulator' and 'Primary' columns, each containing fields for 'Result', 'Leak Rate', 'Maximum Pressure', 'Percent of Final Stroke', 'Compressed Volume', and 'Compression Strokes'. A 'Test Attempts' field is at the bottom left, and 'Print', 'Start', and 'Close' buttons are at the bottom right.

	Accumulator	Primary
Result:		
Leak Rate:	nL/min	nL/min
Maximum Pressure:	psi	psi
Percent of Final Stroke:	%	%
Compressed Volume:	uL	uL
Compression Strokes:		
Test Attempts:		

Static Leak Test

- ❑ Enter Service mode in the console by entering the normal service password.
- ❑ Set up the BSM console plots to show just the Accumulator A and Primary A plots.
- ❑ Run the Static Decay test for pump A using solvent A1 at 5000 PSI with the Vent Valve as the end point.
- ❑ Record the results in the fields below.
- ❑ Do the plots resemble the normal plots of a static leak test_____?

Note from the release notes: Because of improvements to the dynamic leak test, the static leak test is no longer available. While the menus are still available in the June 2011 DP, the test functions as a dynamic leak test.

The screenshot shows a software window titled "Static Decay Test". It is divided into several sections:

- Test Parameters:** A light blue box containing:
 - Module:** A dropdown menu with "A" selected.
 - Accumulator:** A text input field with "5000" and the unit "psi" next to it.
- Run Time:** A digital display showing "0.0 min" with "0.0" below it.
- Buttons:** "Start", "<< Results", "Close", and "Print..." are located on the right side.
- Results:** A section at the bottom with two columns:
 - Primary:**
 - Decay Rate: psi/min
 - Leak Rate: µL/min
 - % of Stroke: %
 - Final Pressure: psi
 - Accumulator:**
 - Decay Rate: psi/min
 - Leak Rate: µL/min
 - % of Stroke: %
 - Final Pressure: psi

Section 15

I-Class BSM PM Procedures



Performing the BSM PM

Since the prerequisite for this course is the ACQUITY Systems course, it will be assumed that you already have knowledge of the basic BSM PM procedures. We will therefore only focus on the parts of the I-Class BSM that differ from the original BSM.

- ❑ Parts Replaced (only items in bold will be performed in this training as the others are the same as the BSM)
 - ❑ Solvent Reservoir Filters
 - ❑ Solvent Filters
 - ❑ **Primary and Accumulator Check Valve Cartridges**
 - ❑ **Primary and Accumulator Head Seals (do not remove seals from heads)**
 - ❑ Primary and Accumulator Plungers
 - ❑ High Pressure Filter Assembly
 - ❑ Air Filter

Primary and Accumulator Check Valve Cartridges

Important: Wear particulate-free, powder-free non-latex gloves when handling critical clean parts.

- ❑ Following the proper procedure from the Operators guide, remove then replace both the Primary and Accumulator check valves from the A pump.

Note: It is necessary to install a new check valve. Just reinstall the old check valve.

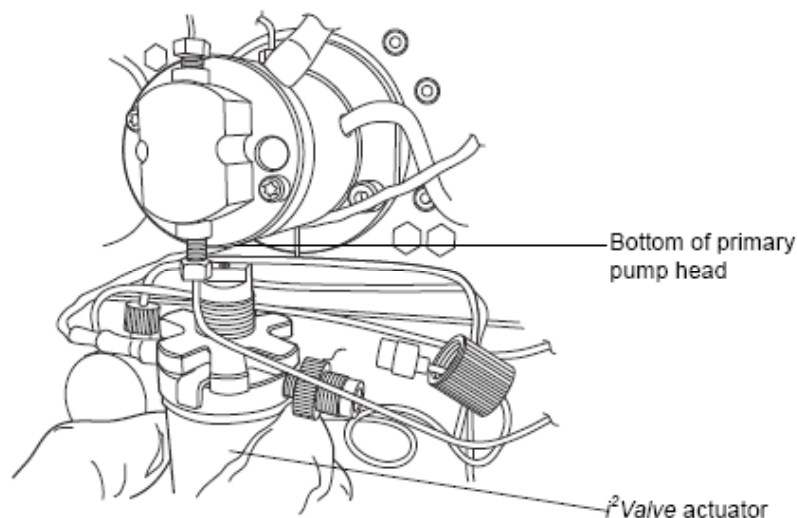
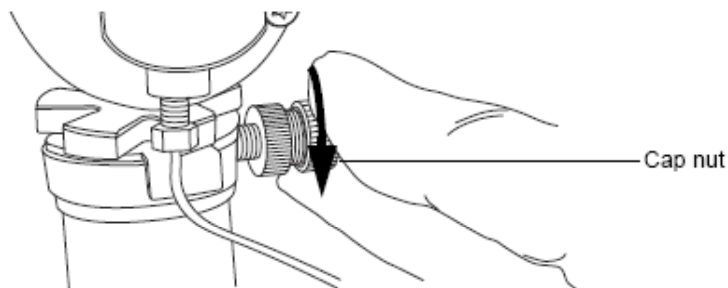
Note the presence of the gold gaskets rather than the normal peek gaskets. These help extend the working range of the check valves beyond 15K psi.

Primary Check Valve PM

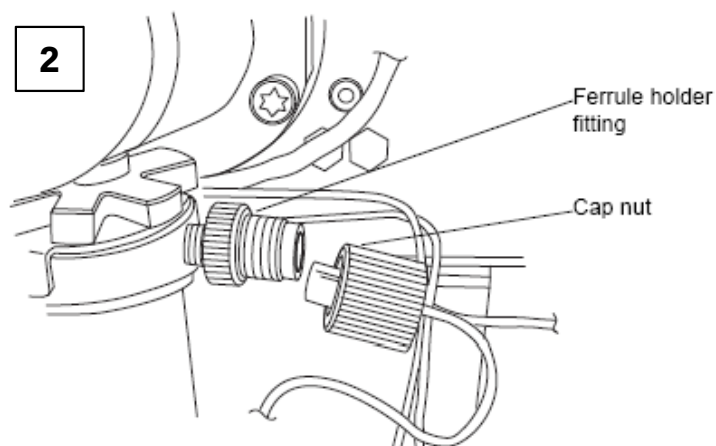
1

From the I-Class Operators Guide

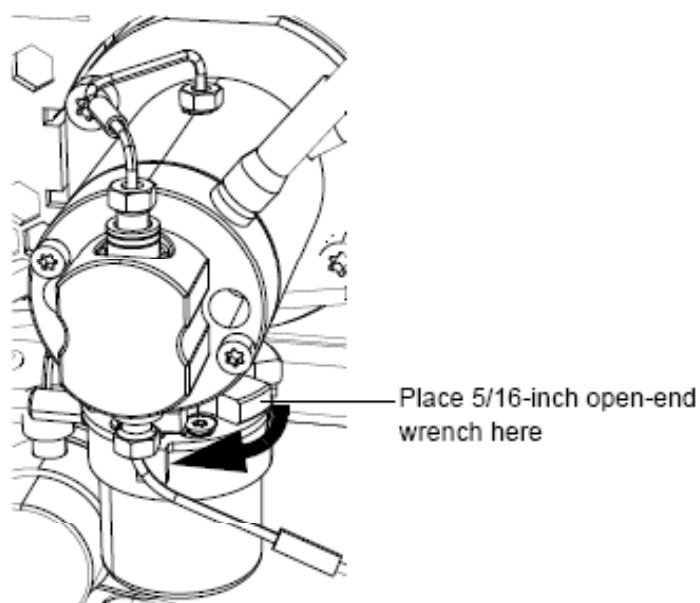
4



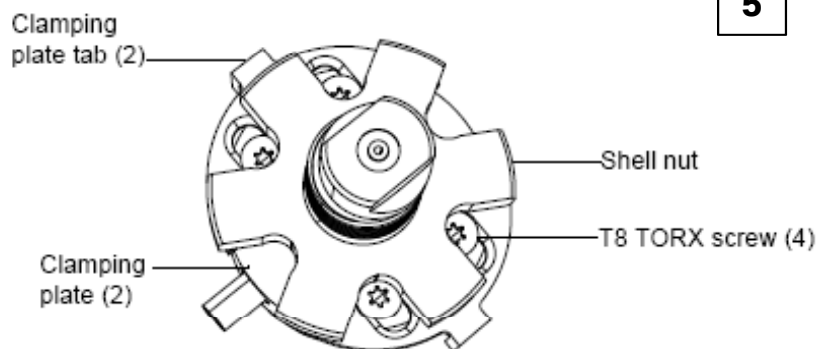
2



3



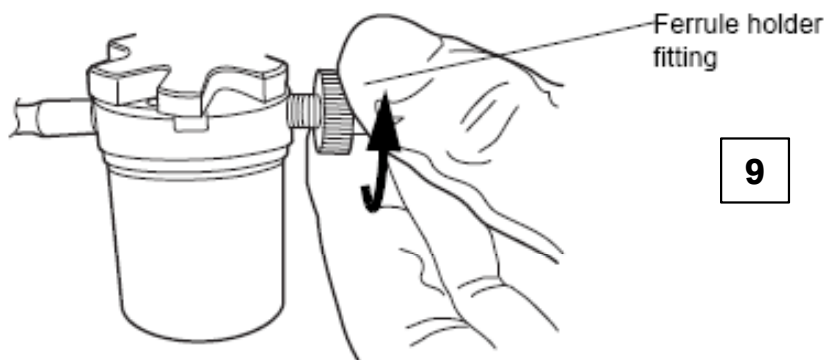
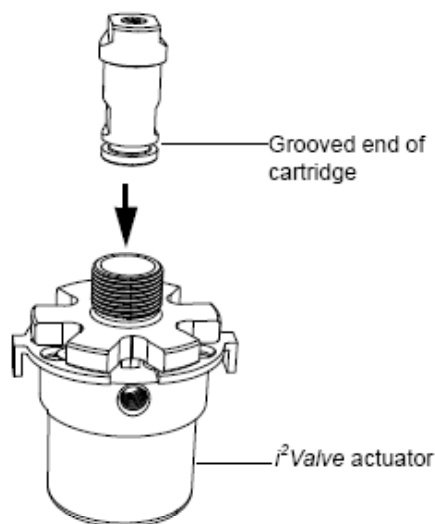
5



Primary Check Valve PM

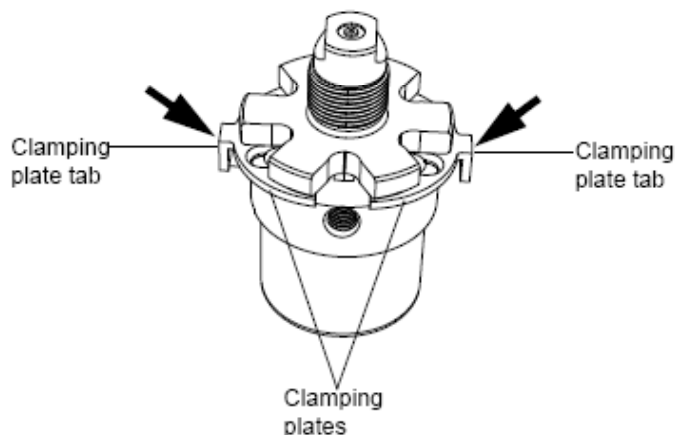
From the I-Class Operators Guide

6

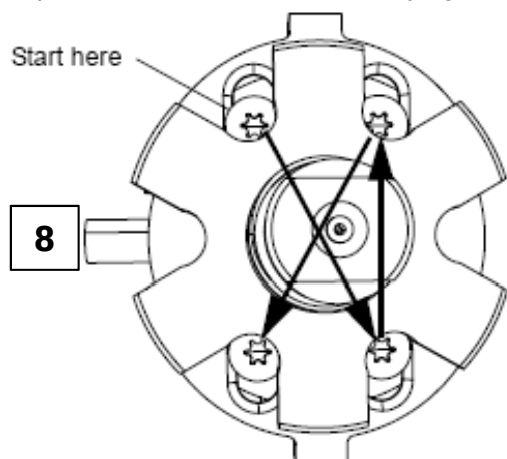


9

7

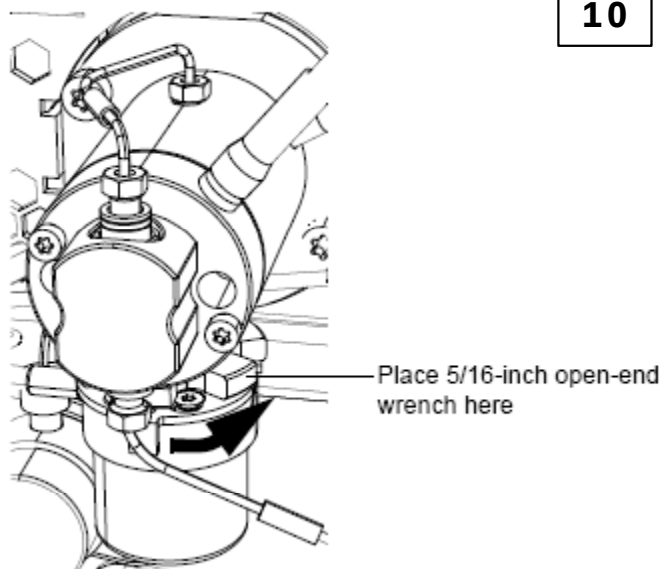


While squeezing the clamping plate tabs, use the T8 TORX driver to tighten the 4 screws that secure the plates, repeating the torquing pattern shown below at least 3 times and gradually increasing the torque until the screws are uniformly tight



8

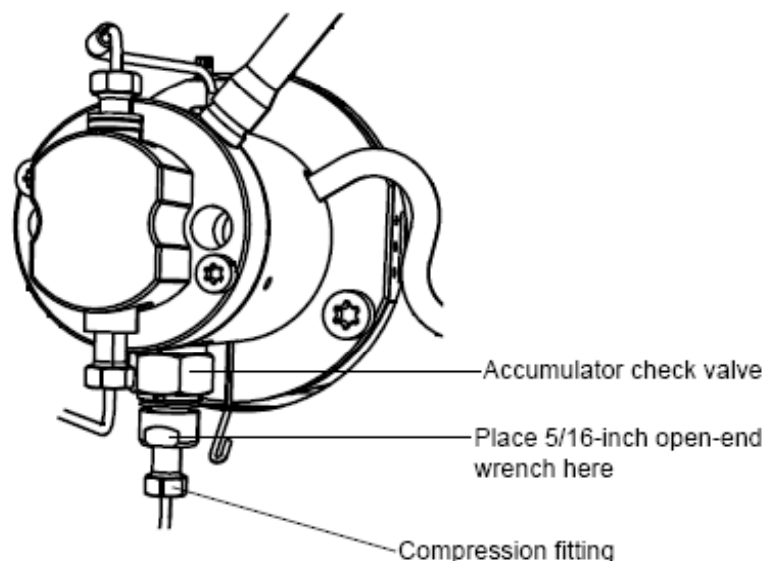
10



Accumulator Check Valve PM

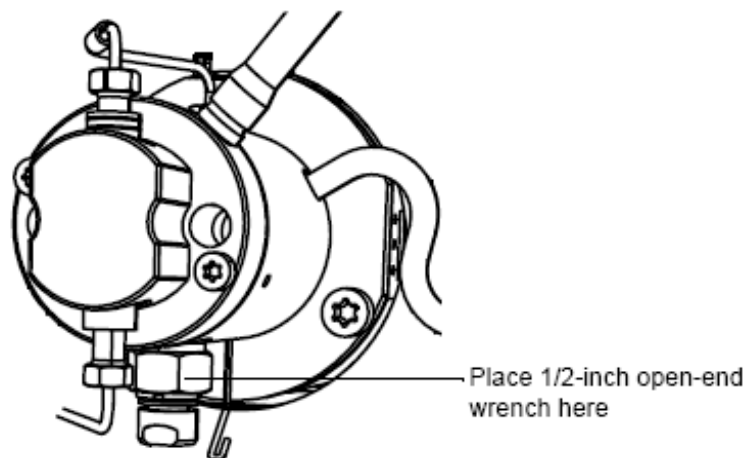
From the I-Class Operators Guide

4. Using the 5/16-inch open-end wrench to hold the check valve in place, disconnect the compression fitting by using the 1/4-inch open-end wrench.



Caution: To avoid leaks, ensure the Gold washer, which is normally on the top face of the accumulator check valve, does not remain in the head when you remove the valve assembly (see [page 71](#)).

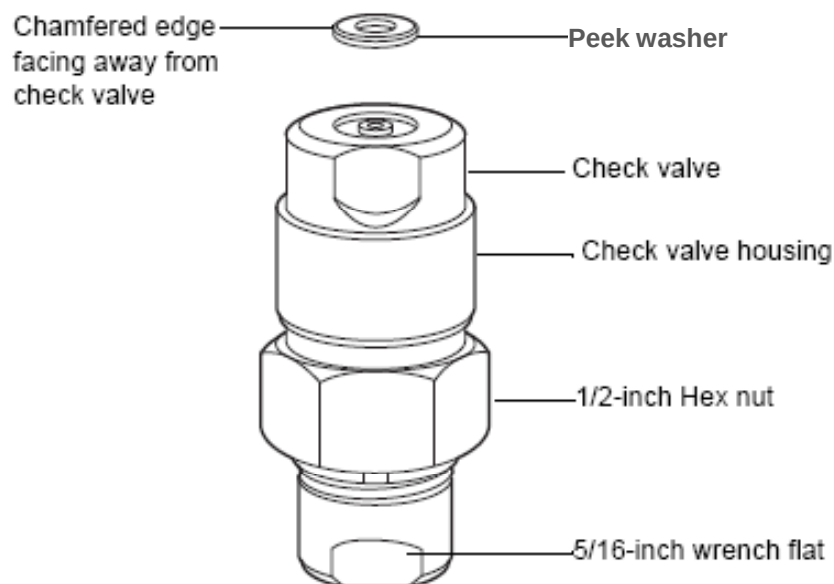
5. Use the 1/2-inch open-end wrench to loosen the check valve, and then remove the check-valve assembly from the head.



Accumulator Check Valve PM

From the I-Class Operators Guide

- ❑ Ensure the new Gold washer is inserted into the new check valve, its chamfered edge facing away from the check valve.
- ❑ Insert the check-valve assembly into the head, and use the 1/2-inch wrench to tighten the check-valve nut 1/8-turn beyond finger-tight.
- ❑ Finger-tighten the compression screw and ferrule, and then, using the 5/16-inch open-end wrench to hold the check valve in place, use the 1/4-inch wrench to tighten the compression screw up to 1/6-turn beyond finger-tight for an existing stainless steel tubing assembly, or 3/4-turn beyond finger-tight for a new stainless steel tubing assembly.



Pump A Head Removal

Pump A Head Removal and Seal Inspection

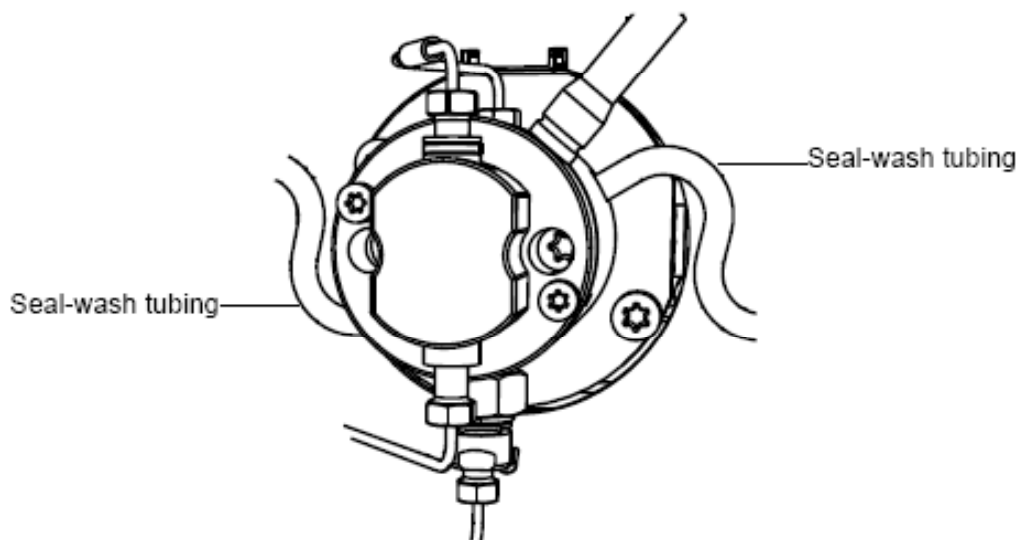
Important: Wear particulate-free, powder-free non-latex gloves when handling critical clean parts.

- Following the proper procedure from the Operators guide, remove the Accumulator Head from the A pump.

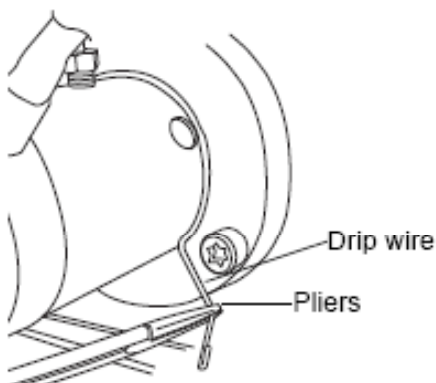
Note: It is necessary to remove the seals. Just observe the positioning of the new plunger seal at this time until spares are available.

From the I-Class Operators Guide

Remove the seal-wash tubing secured to the seal-wash housing by barbed fittings by using a tool or by pulling on the tubing as close to the head as possible.



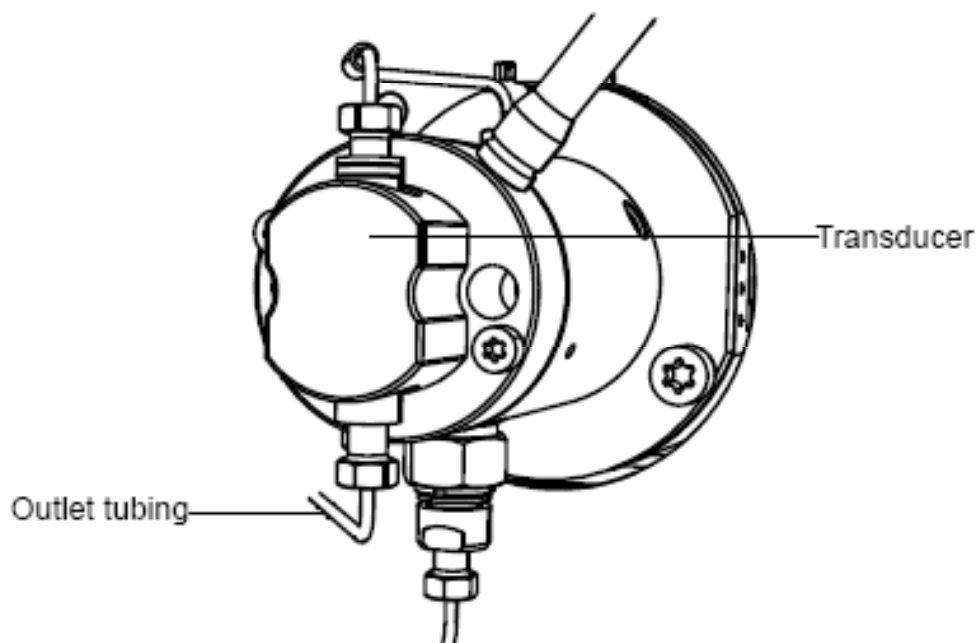
Using a pliers, remove the drip wire from the head assembly.



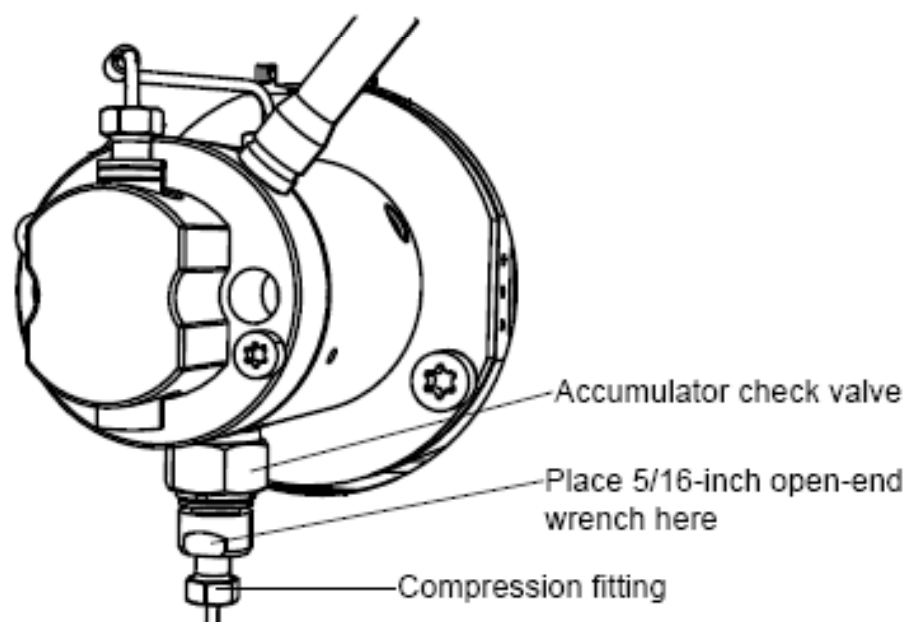
Pump A Head Removal

From the I-Class Operators Guide

Using the 1/4-inch open-end wrench, disconnect the outlet tubing from the transducer.

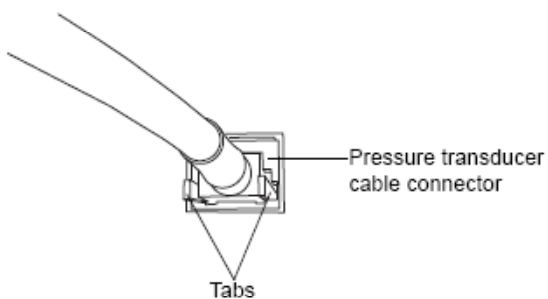


Using the 5/16-inch open-end wrench to hold the check-valve cartridge in place, disconnect the tubing connection from the check valve with the 1/4-inch open-end wrench.



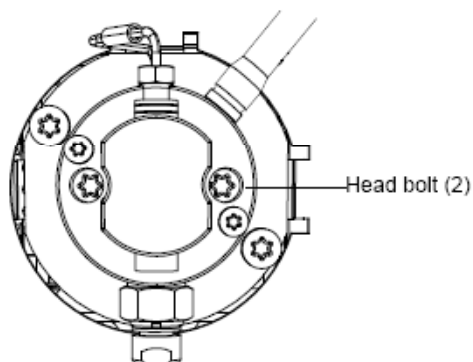
Pump A Head Removal

Disconnect the pressure transducer cable from the bulkhead by squeezing on the tabs and pulling gently.

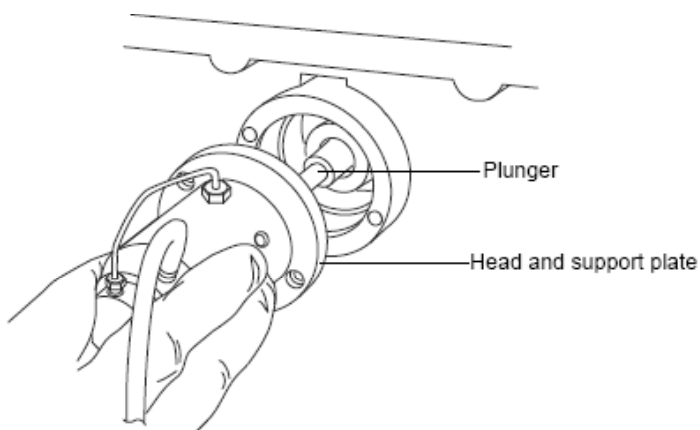
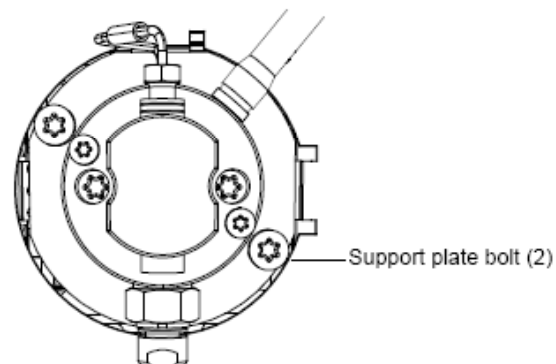


Using the T27 TORX driver, loosen the 2 head bolts 1/2-turn.

Tip: The bolts are accessible from the front of the pressure transducer.



Using the T27 TORX driver, loosen and remove the 2 support plate bolts, and then gently pull the head and support plate off the actuator housing, making sure not to tilt the head during the extraction.



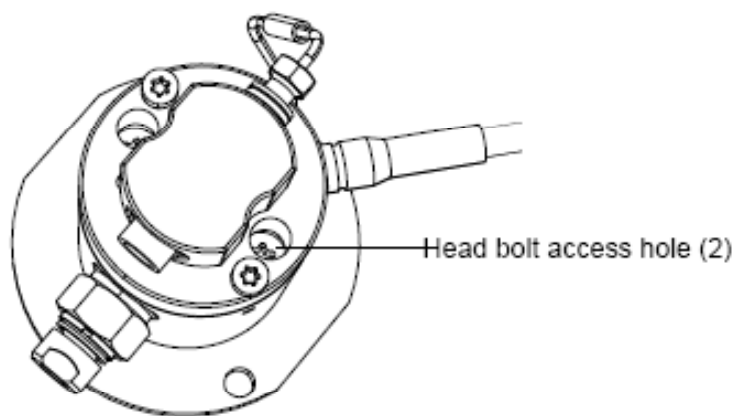
Pump A Head Removal

From the I-Class Operators Guide

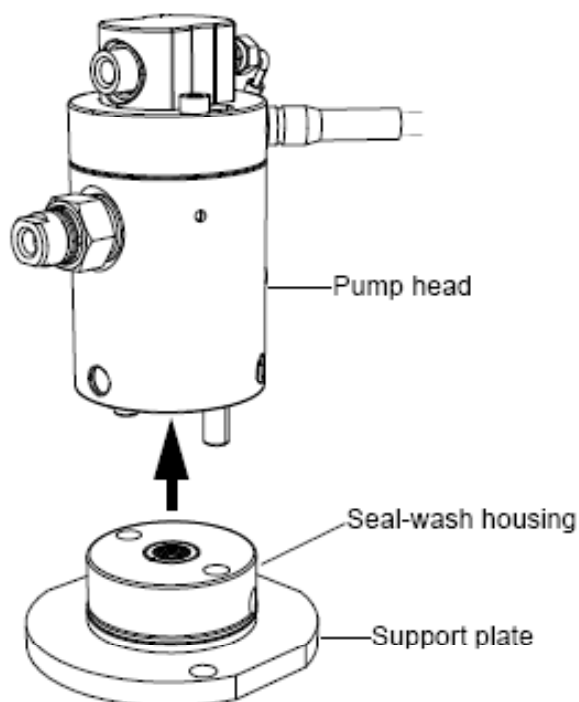
To remove the accumulator plunger seals:

1. Stand the head upright on a clean surface.
2. Using the T27 TORX driver, completely loosen the 2 head bolts to release the support plate from the pump head.

Requirement: If you remove the transducer and head bolts, be sure to reuse the head bolt washers when reassembling the pump head.



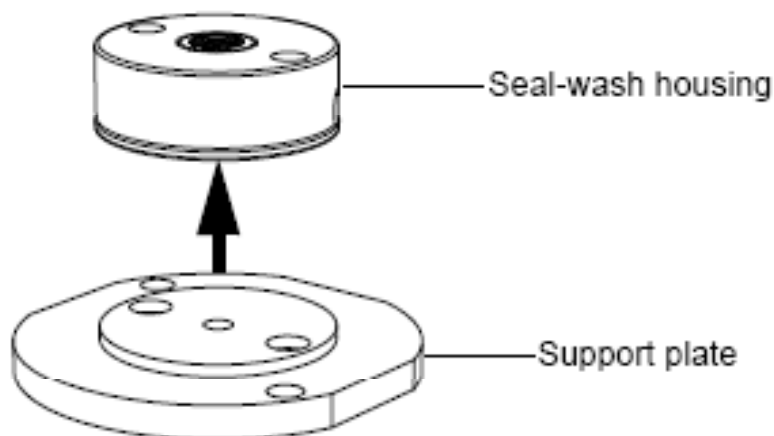
3. Lift the pump head from the support plate.



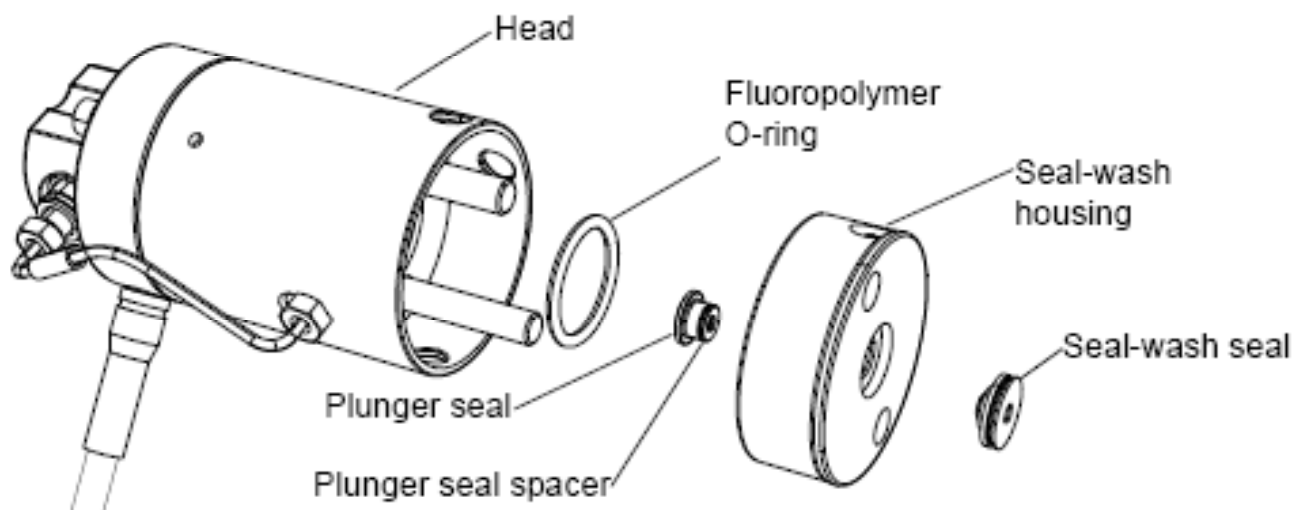
Pump A Head Detail

From the I-Class Operators Guide

Lift the seal-wash housing from the support plate.



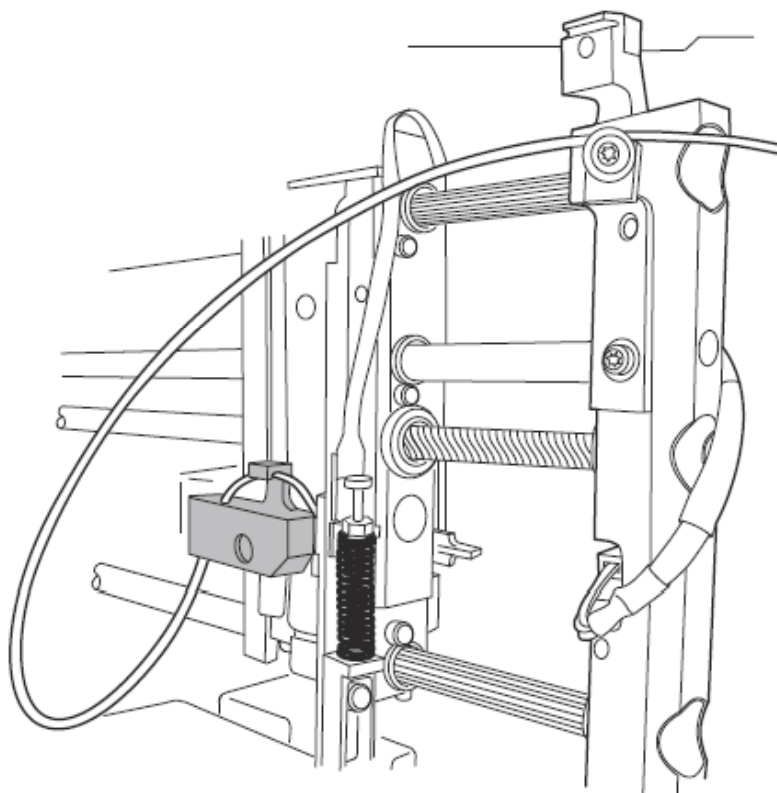
Plunger seals:



Note: Do not remove the seals at this time unless the instructor has indicated that spare seals are available.



Section 15 I-Class SM-FL PM Procedures



Performing the SM-FL PM

- ❑ Parts Replaced (only items in bold will be performed in this training as the others are the same as the SM)
 - ❑ **PEEK Sample Needle**
 - ❑ Injector Pod Assembly
 - ❑ Sample Metering Syringe
 - ❑ **Strong and Weak Wash Syringes**
 - ❑ **Inject Port O-Ring**
 - ❑ **Injector Loop**
 - ❑ Solvent Reservoir Filters
 - ❑ Air Filter

Replacing the Sample Needle

Important: Wear particulate-free, powder-free, non-latex gloves while handling the Stationary Side Seal, tubing and other critical clean parts.

- ❑ Following the proper procedure, remove and replace the Sample Needle. The same Sample Needle can be removed and replaced without damage.

To replace the sample needle:

1. In the ACQUITY UPLC Console, select Sample Manager-FL from the system tree.
2. Remove the sample plate, if a plate is loaded.
3. Click Maintain > Replace > Needle.

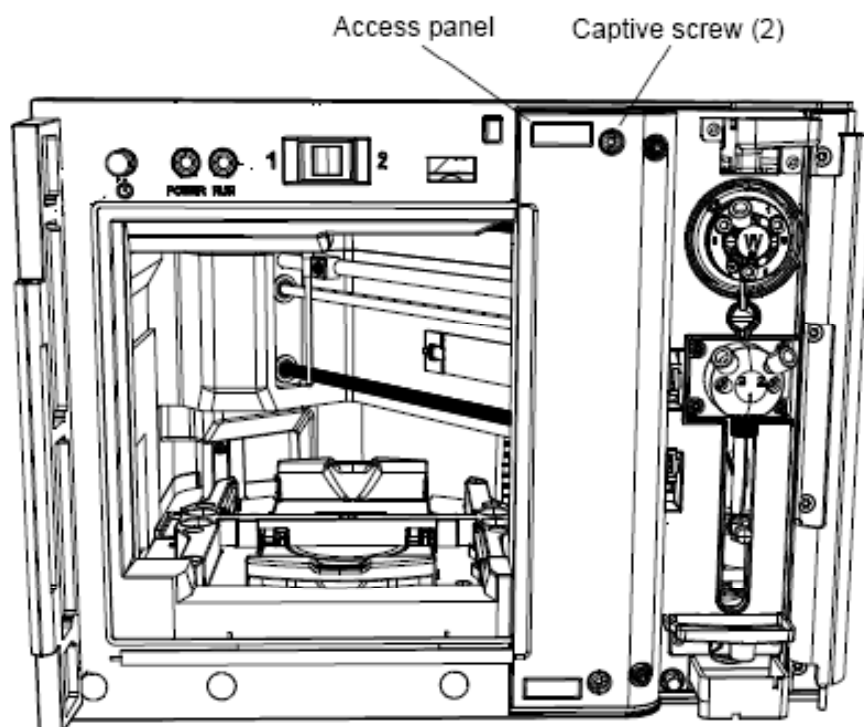
Result: Doing so invokes a wizard that moves the sample needle assembly to an accessible position.

4. Open the sample compartment and fluidics compartment doors.

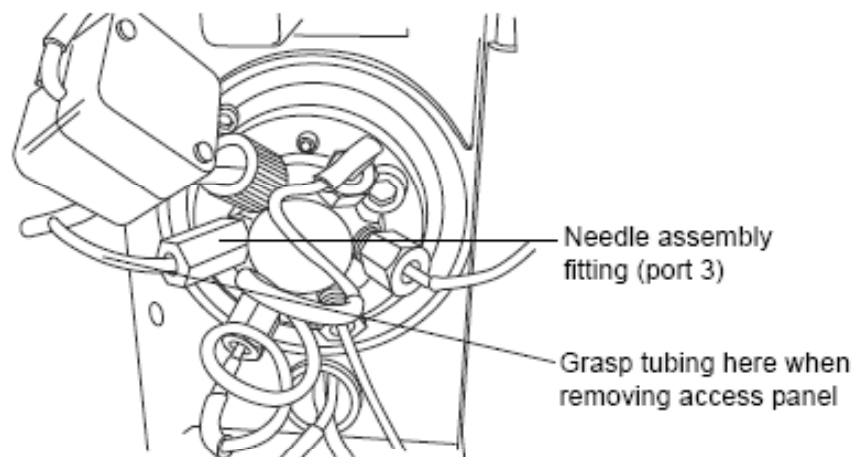
Sample Needle Replacement

From the I-Class Operators Guide

5. Using the T20 TORX driver, loosen the two captive screws that secure the access panel.



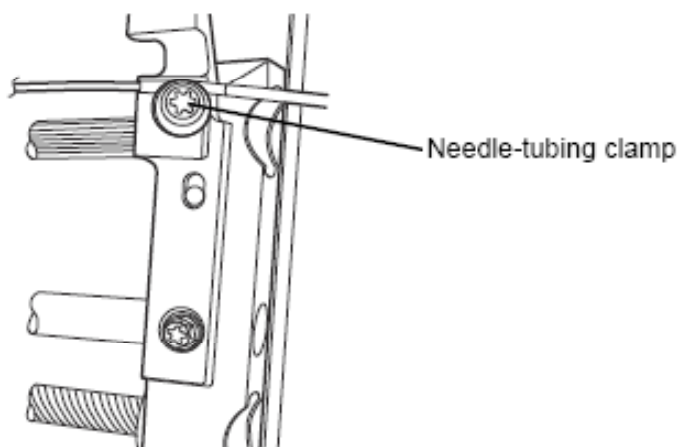
6. Carefully grasp the needle tubing, and hold it securely while you remove the panel.
7. Unscrew the needle assembly's fitting from injector port 3.



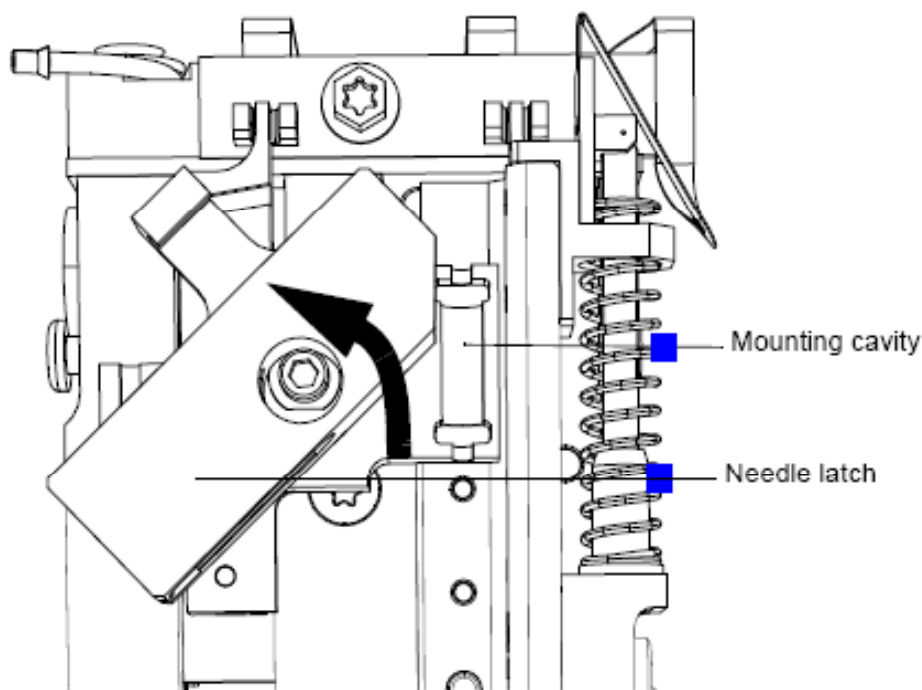
Sample Needle Replacement

From the I-Class Operators Guide

8. Hold the needle tubing, and use the TORX T10 driver to loosen the screw on the needle-tubing clamp.



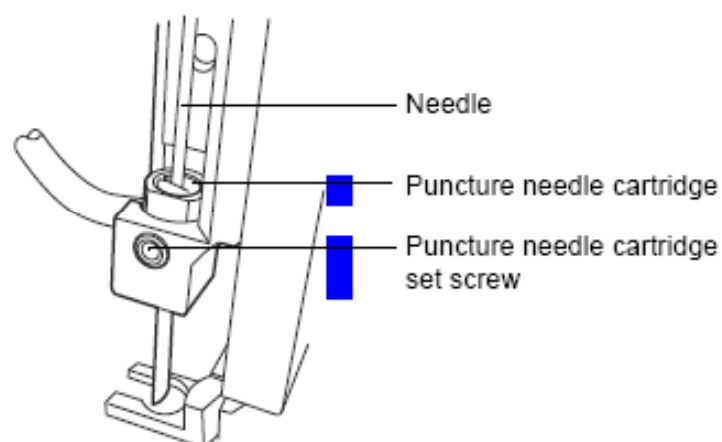
9. Remove the needle tubing from the slot in the clamp assembly.
10. Hold the fitting end of the needle tubing, and push the needle latch back, to release the needle mounting cylinder from its mounting cavity.



Sample Needle Replacement

From the I-Class Operators Guide

11. Lift the needle tip from the puncture needle cartridge at the bottom of the needle mechanism.



Warning: To avoid puncture wounds, do not press or otherwise touch the needle tip.



Caution: To avoid damaging the needle, do not press or otherwise touch its tip.



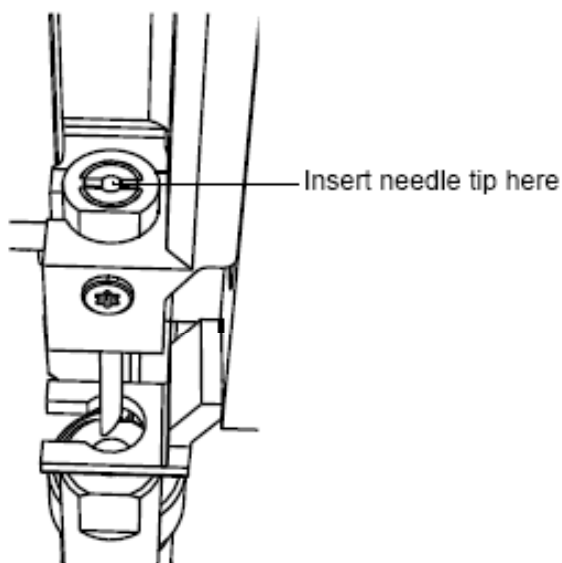
Caution: To avoid damaging the needle tubing, and to ensure the needle fits correctly in the device, do not bend or in any way deform the needle.

12. Using the T6 TORX driver, loosen the puncture needle cartridge set screw, and then remove the puncture needle cartridge.
13. Install the new puncture needle cartridge, and tighten the set screw.

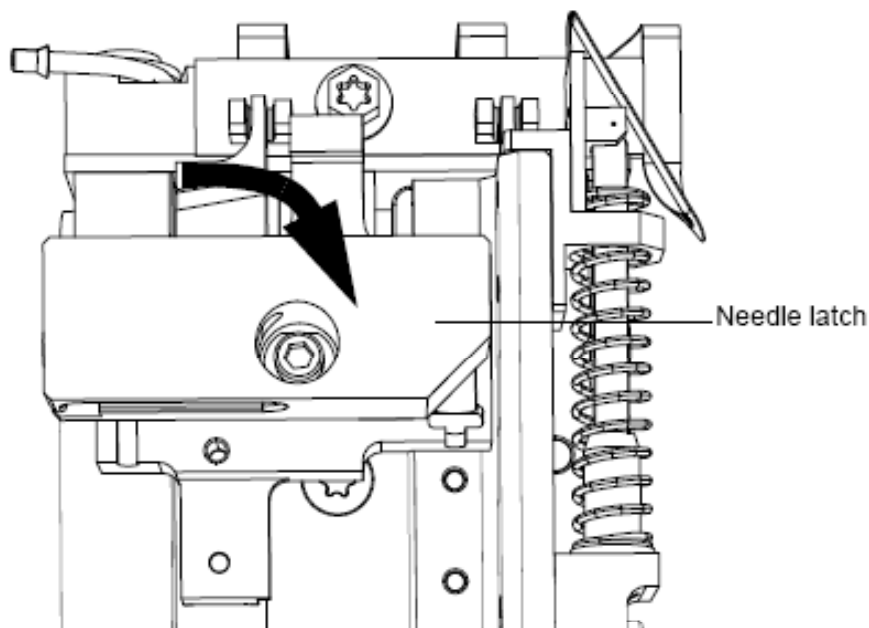
Sample Needle Replacement

From the I-Class Operators Guide

14. Holding the new needle assembly with both hands to control its position within the sample compartment, insert the needle's tip into the puncture needle cartridge at the bottom of the needle mechanism.



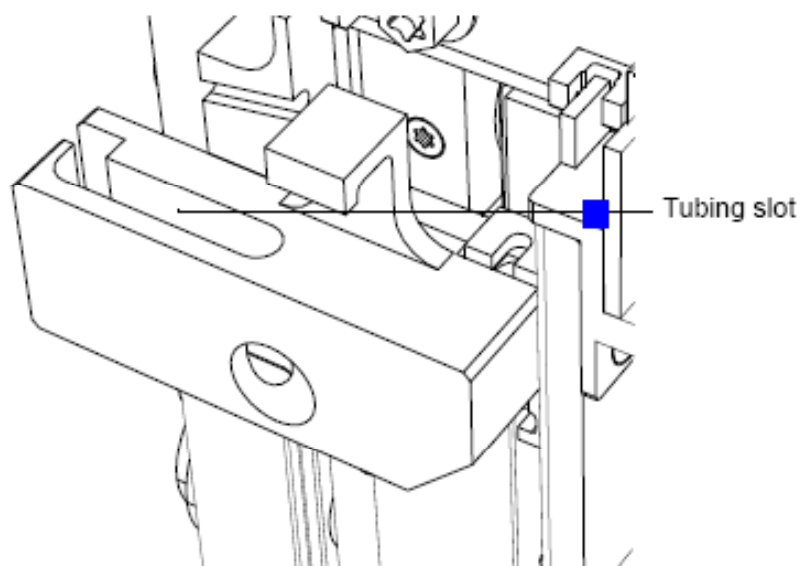
15. Insert the needle mounting cylinder into the mounting cavity on the carriage assembly.
16. Push the needle latch downward, to secure the needle assembly.



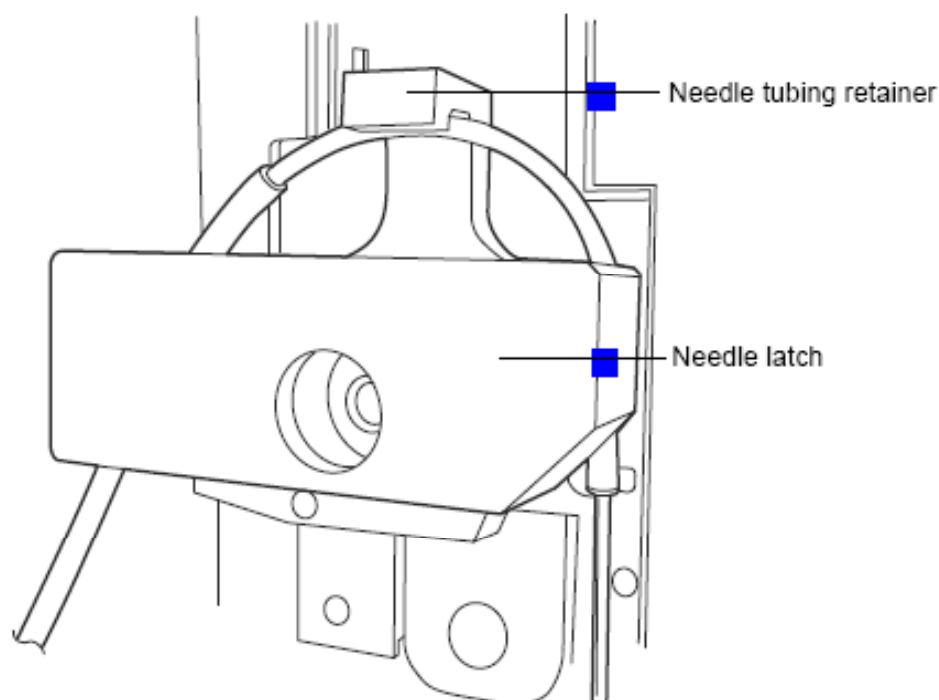
Sample Needle Replacement

From the I-Class Operators Guide

17. Route the needle tubing into the slot on the backside of the latch.



18. Carefully bend the needle tubing until it snaps into place underneath the retainer on the needle latch.



19. Bring the needle tubing up toward the slot in the clamp assembly.

Tip: The tubing bends, to accommodate the routing.

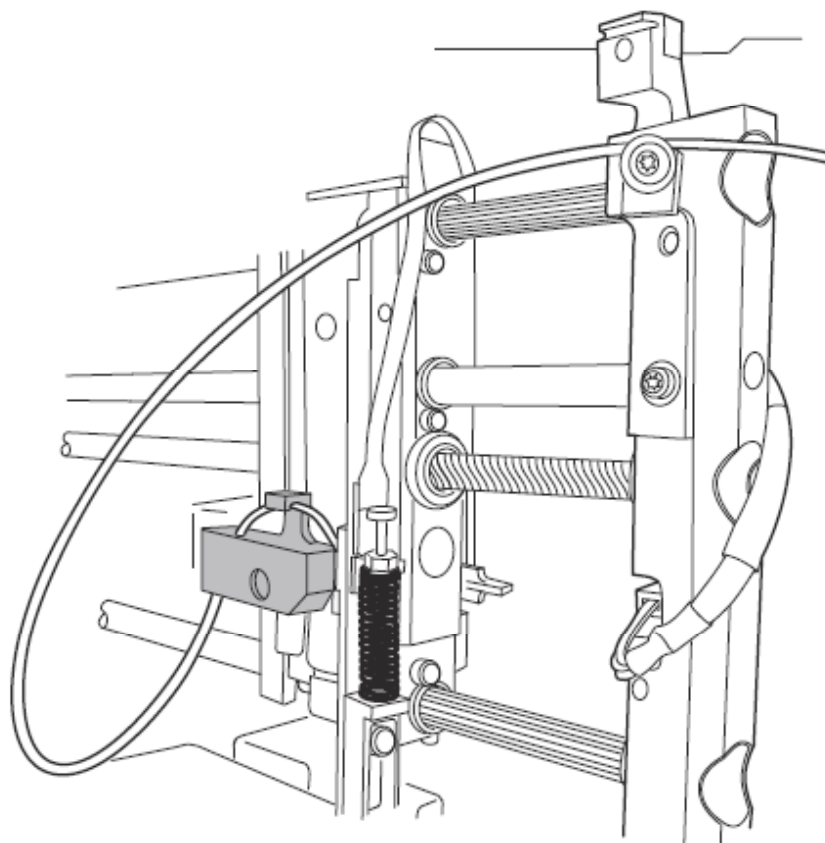
Sample Needle Replacement

From the I-Class Operators Guide

20. Ensure that the tubing is routed as pictured below.



Caution: To prevent damage to the needle tubing, do not force it into position.

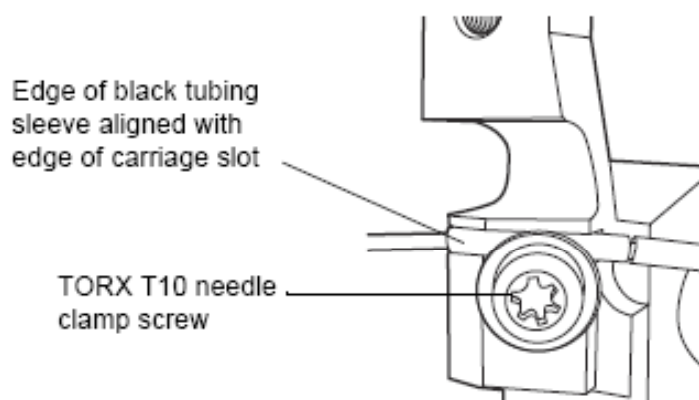


21. Route the needle tubing through the slot in the clamp assembly.



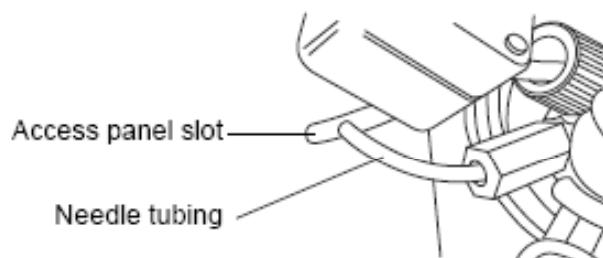
Sample Needle Replacement

22. Ensure that the edge of the black tubing sleeve aligns with the left edge of the slot, as shown below.



Caution: To avoid damage to the needle during operation, allow the needle to release any residual tension before you tighten the clamp.

23. Using the T10 TORX driver, tighten the screw on the needle-tubing clamp.
24. Insert the needle tubing fully into port 3 on the injection valve, with the two-piece ferrule assembly bottomed in the port, and then thread the fitting into the port.
25. Tightening the fitting by hand, and then add 1/4-turn using the wrench.
26. Reinstall the access panel, ensuring that the needle tubing is routed through the slot on the side of the access panel.
27. Use the T20 TORX driver to tighten the two screws that secure the access panel to the front of the unit.



28. Close the sample compartment and fluidics compartment doors.
29. Calibrate the needle's Z axis (see ["Calibrating the needle's z axis" on page 1-54](#)).
30. Characterize the needle seal (see the ACQUITY UPLC online Help).

Calibrating the Needle's Z-Axis

Calibrating the needle's z axis

You must calibrate the needle's z axis whenever you replace the sample needle. Failing to calibrate the needle can damage it. The calibration procedure is the same for all needles.

To calibrate the needle's z axis

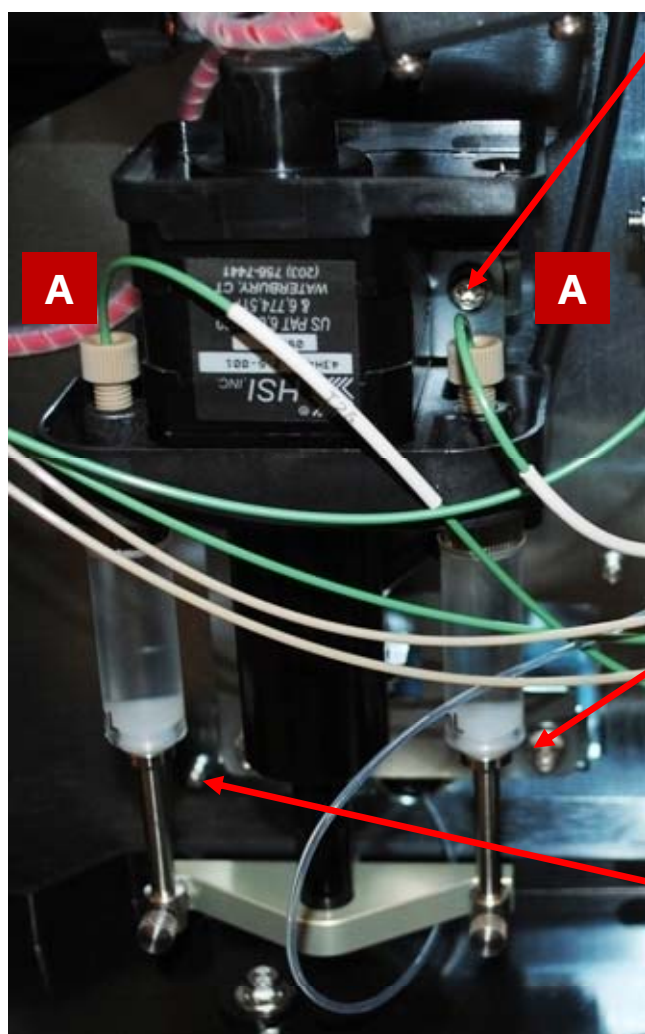
1. Open the sample manager door.
2. Remove the plates from the trays.
3. In the console, select Sample Manager > Control > Reset SM.
Result: The mechanism moves to the home position, with the needle above the wash station.
4. Click Maintain > Calibrate needle Z axis.
5. Click Start, and then click OK in the confirmation window.
Tip: To easily and efficiently achieve the correct needle setting, slide a business card under the needle.
6. Select 1.0 mm for displacement per keystroke.
7. Use the +Z button (Page Down key) to drive the needle down to within 1 millimeter of the tray surface.
8. Switch the displacement increment to 0.1 millimeter, and lower the needle until it is almost touching the surface of the business card.
9. Click Save > Yes, and then click Close.
10. Remove the card.
11. Specify the sample needle and syringe volumes, if they changed.
12. Characterize the needle seal (see the ACQUITY UPLC online Help).

Removing the Wash Syringe Drive

Removing the Wash Syringe Drive Assembly

- ❑ Remove the Wash Syringe drive assembly by disconnecting the peek tubing **A** and removing the 3 T20 torx screws.
- ❑ Reinstall the assembly and then practice replacing the strong and weak wash syringes (detailed on the next 3 pages).

Screw Locations



Replacing the Wash Syringes

Replacing the Strong and Weak Wash Syringes

- Using the procedure that follows, remove and replace the Strong and Weak Wash Syringes. The same syringes can be removed and replaced without damage.

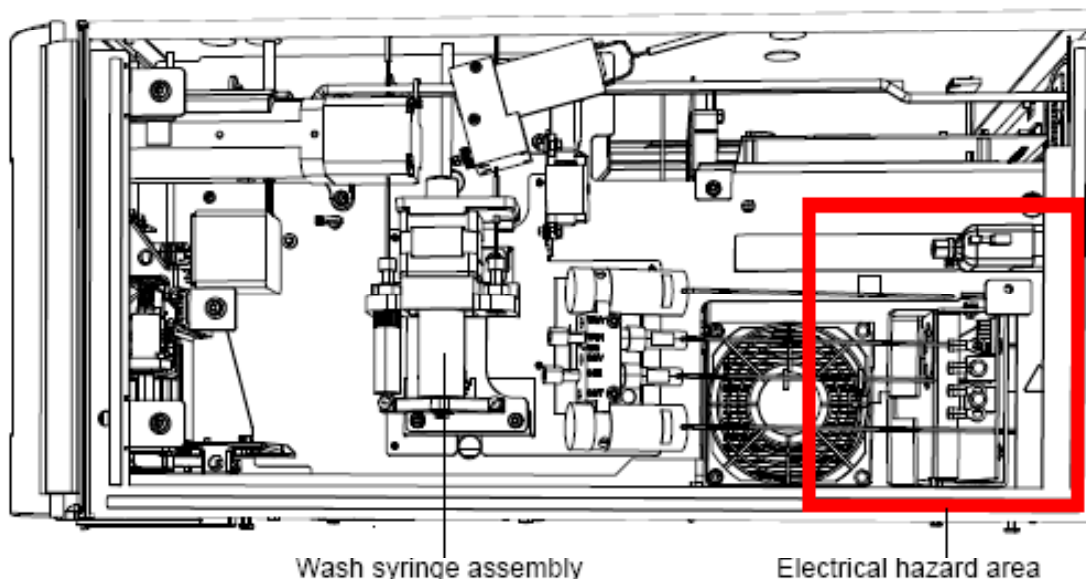
from the I-Class Operators Guide

To replace the wash syringes:

1. Remove the wash solvent lines from the solvent bottles.
2. Remove the two TORX T20 screws that fasten the instrument's side panel.
3. Slide the side panel back about 2.5 cm, tilt the bottom of the panel to disengage the top lip from the instrument chassis, and then remove the panel.

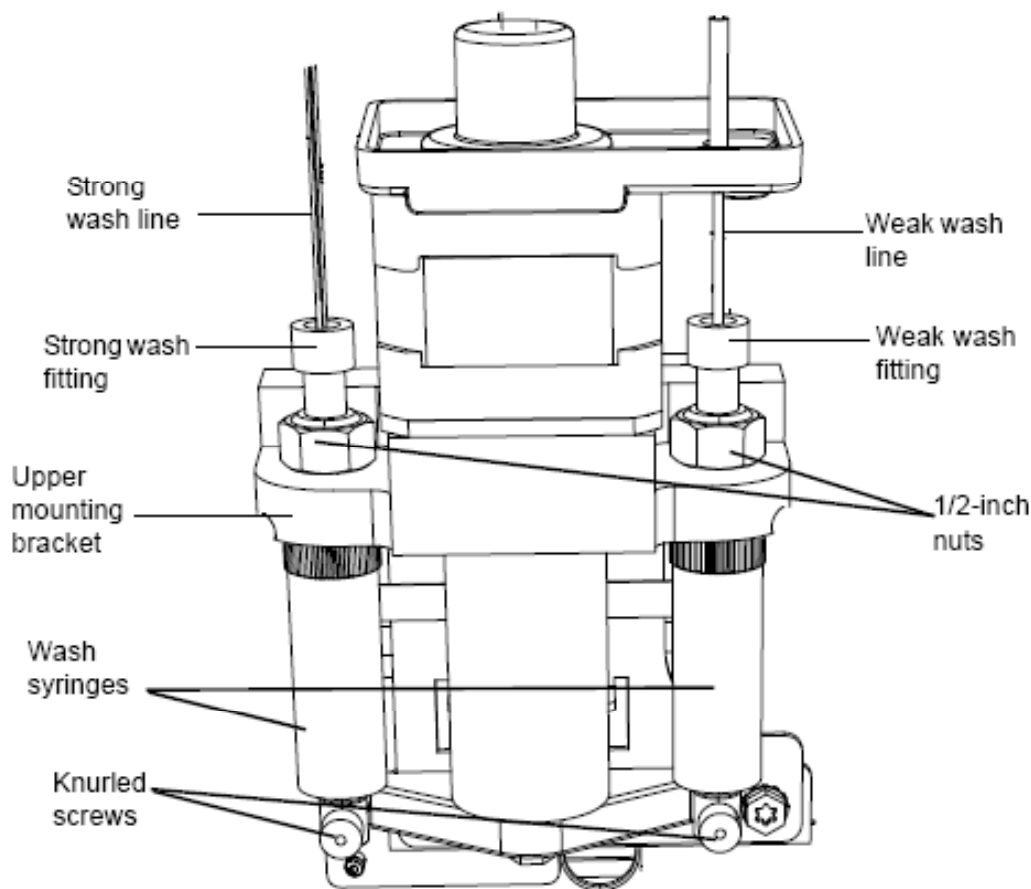


Warning: To avoid injury from electric shock, do not contact any of the components in the electrical hazard area shown below.



Replacing the Wash Syringes

4. Unscrew the weak and strong wash fittings, and then move the wash lines away from the seal wash assembly.



5. Using the 1/2-inch open-end wrench, remove the nuts that secure the wash syringes to the upper mounting bracket.
6. Loosen the knurled screws that secure the wash syringe plungers to the wash syringe mounting bracket.
7. Unscrew each syringe until it separates from the mounting bracket.

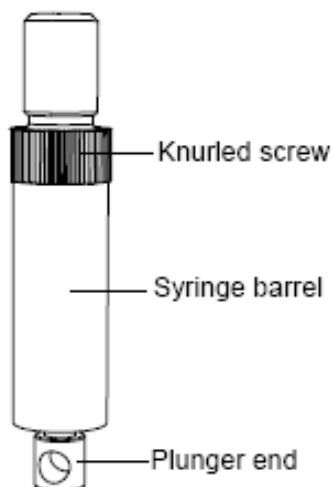


Caution: To avoid breaking the syringe, do not hold it by its glass barrel. Instead, hold the syringe by its knurled collar.

8. Pull down the syringe barrel to clear the upper mounting bracket, and remove the syringe.
9. Unpack each replacement wash syringe.

Replacing the Wash Syringes

Wash syringe



10. Partially fill each new wash syringe (by hand) with weak or strong wash solvent (to help remove air bubbles and to lubricate the syringe plunger).
11. Slide the plunger end of the new wash syringe over the threaded post on the syringe guide mounting bracket.
12. If necessary, depress the syringe barrel to clear the upper mounting bracket, and then screw each new wash syringe into the mounting bracket.
Tip: You sometimes must pull upward on the syringe barrel as you screw the wash syringe into the mounting bracket.
13. Using the 1/2-inch open-end wrench, install the nut that secures the wash syringe to the upper mounting bracket.
14. Install and finger tighten the knurled screw that holds each wash syringe barrel to the mounting bracket.
15. If plugs are fitted in the wash syringe tips, remove them.
16. Reattach the weak-wash and strong-wash lines, connecting the fittings finger-tight.
17. Prime the system until no bubbles appear in the syringes.
18. Grip the device's side panel by its bottom edges.
19. Position the side panel so that it extends approximately 2.5 cm beyond the rear of the device, with the top edge of the panel beneath the device's top cover.

Replacing the Sample Loop

from the I-Class Operators Guide

20. Tilt the bottom of the side panel inward, and slide the side panel forward until it meets the front of the device.

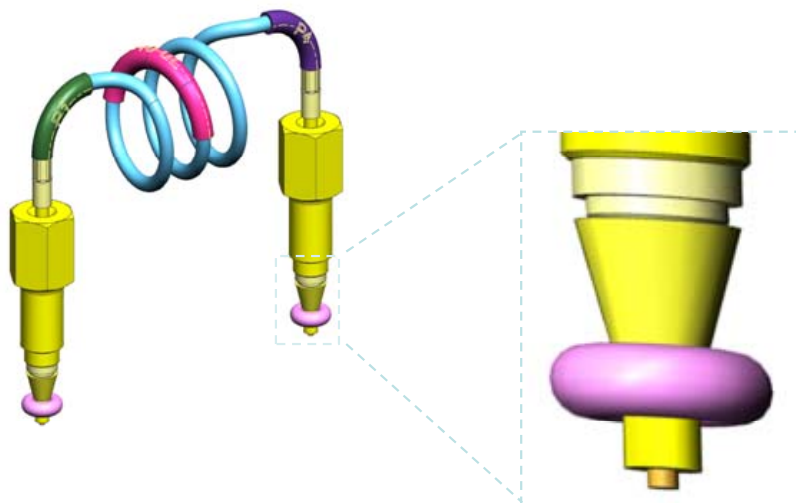
Tip: The holes in the panel align with the screw holes in the chassis.

21. Secure the side panel using the two TORX T20 screws.

I-Class Sample Loops

The Sample Loops for the I-Class have been redesigned to:

- ☐ Improve Volume Accuracy
 - ☐ Hypodermic style tubing
 - ☐ 0.025" OD
- ☐ Improve Dispersion
 - ☐ Protruded end
 - ☐ Positive contact point
- ☐ Coil style is flexible
 - ☐ User friendly easy to install



Replacing the Sample Loop

- ❑ Following the proper procedure, remove and replace the Sample Loop. The same Sample Loop can be removed and replaced without damage.

Replacing the sample loop

Replace the sample loop when it clogs or when its capacity is inappropriate for your chromatographic need.



Caution:

- To prevent bandspreading or excessive carryover, be sure to reinstall a previously installed sample loop in exactly the same way that it was installed before, so that the same end goes into the same port.
- To avoid leaks, remove the O-rings prior to installing the sample loop. The O-rings on the new sample loop hold the seals in place during shipping.

Required materials

- 1/4-inch open-end wrench
- ACQUITY UPLC sample loop

To replace the sample loop

1. Open the fluidics compartment door.

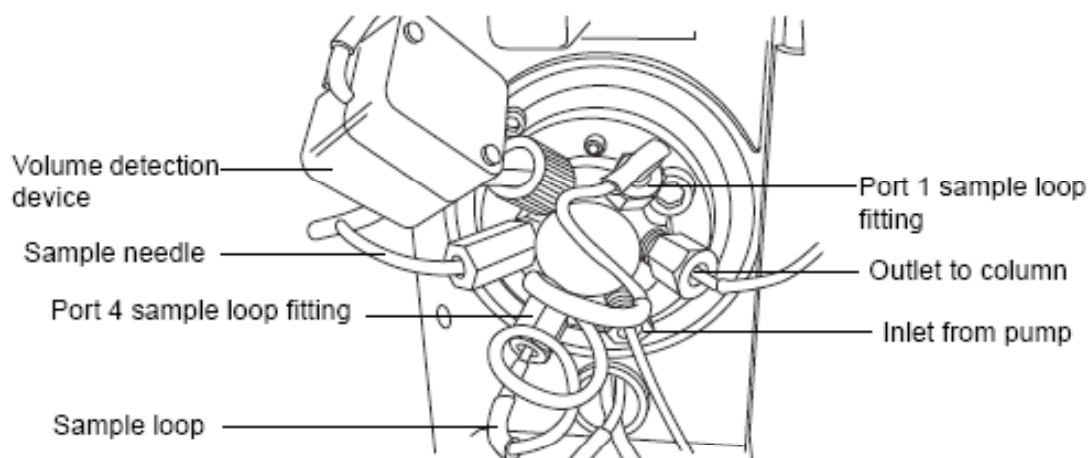


Caution: To avoid kinks, do not pull on the volume detection device (port 2) or sample needle (port 3) tubing.

2. Use the wrench to remove the fittings on ports 1 and 4 of the injection valve.

Replacing the Sample Loop

Sample loop fittings on the injection valve



3. Remove the sample loop and its fittings.
4. If you are going to reuse the sample loop, label each end with the port it was connected to.

Tip: If you replaced the injection valve cartridge, do not install previously used sample loops on the new cartridge.

5. Place the sample loop and its fittings in a contamination-free bag.
6. Unpack the replacement sample loop and fittings.



Caution: To avoid leaks, remove the O-rings prior to installing the sample loop. The O-rings on the new sample loop are used to hold the seals in place during shipping.

7. Remove the O-rings from the sample loop.



Caution:

- To prevent dead volume in the system, ensure that the ends of the loop are fully inserted into the ports of the injection valve before swaging the ferrules.
- Use only Waters approved ACQUITY UPLC loops with ACQUITY UPLC fittings. Each loop must be fitted to its injector.

Replacing the Sample Loop

8. Ensure the 2-piece ferrule is in place on one end of the sample loop. If not, slide a 2-piece ferrule and compression screw onto one end of the sample loop, and then seat the end into injection valve port 1.
9. Finger-tighten the fitting and then add 3/4-turn using the wrench.
See also: [“Installation recommendations for fittings” on page 15.](#)
10. Remove the fitting and inspect the ferrule to ensure it has not moved.
11. Repeat step 8 through step 10 for the other end of the sample loop and for injection valve port 4.
12. Reinstall the sample loop fitting into valve ports 1 and 4.



Caution:

- To avoid kinks, do not push on the volume detection device (port 2) or sample needle (port 3) tubing.
- To prevent bandspreading or excessive carryover, be sure to reinstall the sample loop in exactly the same way that it was installed before, so that the same end goes into the same port.

13. Close the fluidics compartment door.



Caution: Be careful not to crush the loop or volume detection device line.

14. Ensure the sample compartment door is closed.
15. In the ACQUITY UPLC Console, select Sample Manager from the system tree.
16. Click Maintain > Calibrate System Volume to characterize the new system volumes.

Note: You can wait until the Post Service Diagnostic Tests section to Characterize the Needle and Loop volume.

Replacing the Inject Valve

- Following the proper procedure, remove and replace the Inject Valve. Note: You can leave the Sample loop on the Inject Valve while removing and reinstalling it.

Replacing the injection valve cartridge



Warning: To avoid personal contamination with biologically hazardous or toxic materials, wear clean, chemical-resistant, powder-free gloves when performing this procedure.

Requirement: When you replace the injection valve, you must also replace the sample loop.

Required materials

- 2-mm Allen wrench
- Gloves: clean, powder-free, chemical-resistant
- Injection valve cartridge

To replace the injection valve cartridge:

1. In the ACQUITY UPLC Console, select Sample Manager FL from the system tree.
2. In the SM-FL information window, click Maintain > Park needle and inject valve > Yes.

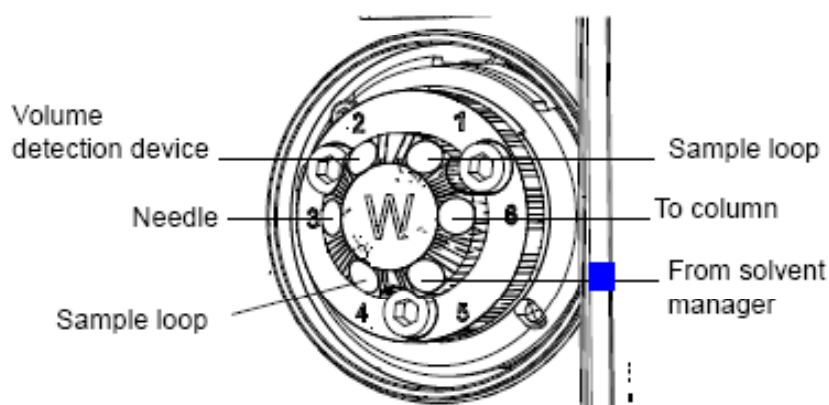


Caution: To avoid damaging electrical parts, never disconnect an electrical assembly while power is applied to an instrument. To completely interrupt power, set the power switch to Off, and then unplug the power cord from the AC source. Wait 10 seconds thereafter before you disconnect an assembly.

3. Power-off the SM-FL.
4. Open the fluidics compartment door.

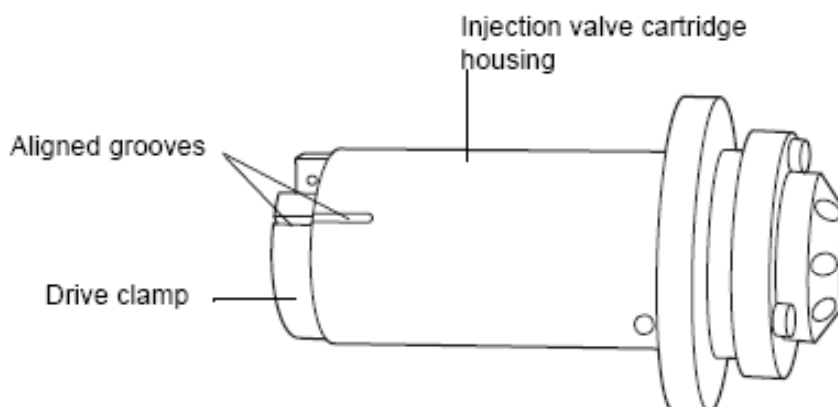
Replacing the Inject Valve

5. Remove the fittings attached to the injection valve cartridge.



6. Use the 2-mm Allen wrench to remove the screw at the 10 o'clock position on the injection valve cartridge.
7. Remove the injection valve cartridge from the injection valve assembly.
8. Carefully unpack the replacement injection valve cartridge.
9. Ensure that the groove in the cartridge housing and the groove on the drive clamp align.

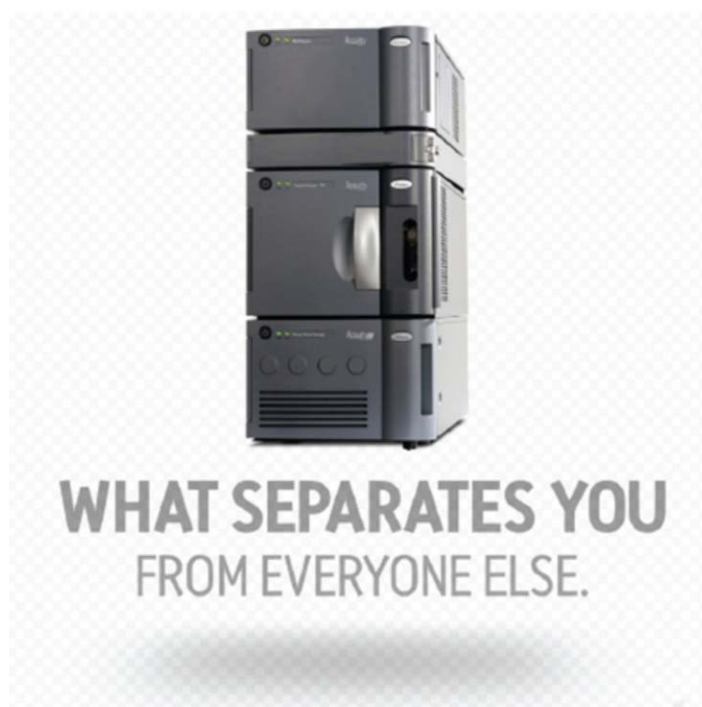
Tip: If they do not align, turn the drive clamp until the grooves line up.



10. Insert the new injection valve cartridge into the injection valve assembly.
- Note:** If the injection valve cartridge does not slide fully into the injection valve assembly, contact your Waters service representative.
11. Insert the 2-mm Allen screw at the 10 o'clock position on the injection valve cartridge, and tighten it.
 12. Reattach all fittings, ensuring the tubes bottom in their fitting holes.
 13. Close the fluidics compartment door.
 14. Power-on the SM-FL.

Section 16

I-Class Post Service Diagnostic Tests



Post Service Diagnostic Tests-

Post Service Diagnostic Tests

- ❑ Following the “ACQUITY I-Class System Installation Manual” (located online and on the workstation), put the modules back together.
- ❑ Make sure you closely follow the instructions on how to plumb the system together and route the tubing up the side.
- ❑ Make sure all solvent lines back in there proper solvents for the verification tests.
- ❑ Prime all lines for 2 minutes if they still contain solvent otherwise prime for 3 minutes.
- ❑ Start a flow rate of 0.5ml/min with 50% A and 50% B and allow the pressure to stabilize for at least 2 minutes. Record the current pressure and delta pressure ripple in the table below.

Solvent Line	System Pressure	Pressure Ripple	Pass / Fail
A-B			

The Delta pressure ripple should be below 1% of the system pressure for a passed test result.

Post Service Diagnostic Tests

- ☐ Perform a dynamic leak test using the solvent line in which you replaced the filter to a pressure of 9000 psi.
- ☐ Record the results in the fields below.

Leak Test					
Parameters		Status		Results	
	Accumulator				Primary
Result:					
Leak Rate:		nL/min			nL/min
Maximum Pressure:		psi			psi
Percent of Stroke:		%			%
Compressed Volume:		uL			uL
Compression Attempts:					
Test Attempts:					
					Print
					Start Close

BSM Diagnostic Tests Overall Results (Pass/Fail)_____

Initials_____

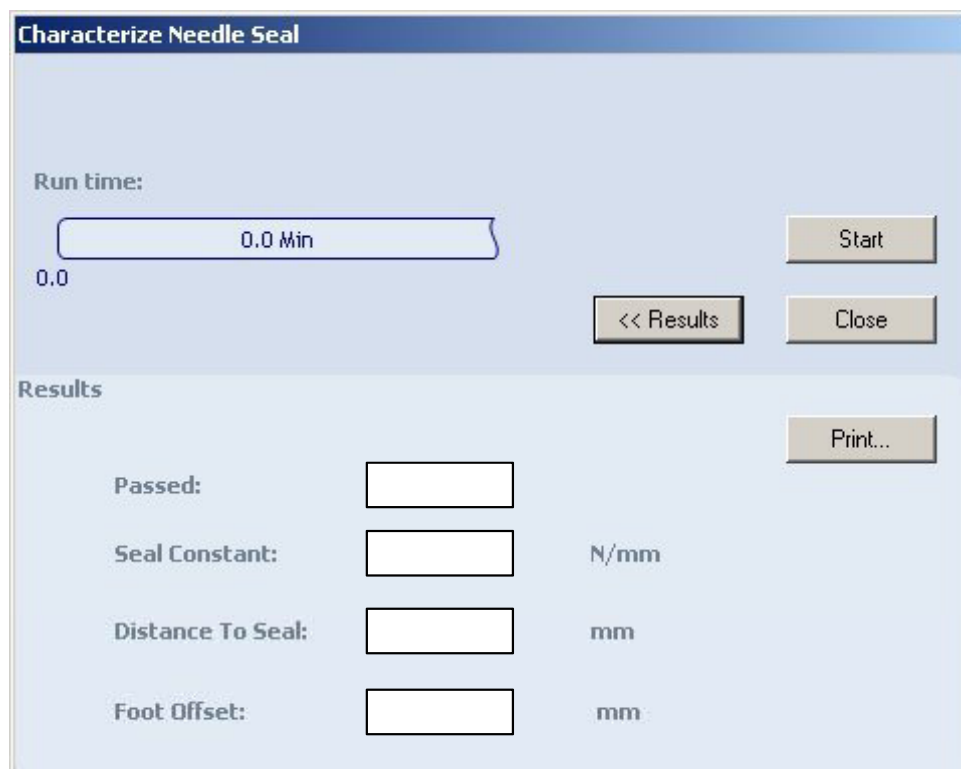
Date_____

Post Service Diagnostic Tests

Post Service Diagnostic Tests-SM-FTN

This section deals with the SM-FTN. If your system has an SM-FL then proceed to the Post Service Diagnostic Tests-SM-FL section.

- ☐ Reset the SM-FTN from the console menu.
- ☐ Prime the Wash Solvent for 1 minute and the Purge Solvent for 10 cycles.
- ☐ Calibrate the Needle Z-axis and enter the result below.
Needle Z-axis Offset: _____ mm.
- ☐ Check the plot properties menu in the SM-FTN top level console and make sure the Seal Force plot is enabled.
- ☐ Characterize the Needle Seal and enter the result below.



The image shows a software dialog box titled "Characterize Needle Seal". It has a light blue background and a dark blue title bar. The dialog is divided into two main sections. The top section, labeled "Run time:", contains a text input field showing "0.0 Min" and a "Start" button. Below the input field is a "0.0" label. To the right of the input field are two buttons: "<< Results" and "Close". The bottom section, labeled "Results", contains four rows of labels and input fields: "Passed:" with a checkbox, "Seal Constant:" with a text input field and the unit "N/mm" to its right, "Distance To Seal:" with a text input field and the unit "mm" to its right, and "Foot Offset:" with a text input field and the unit "mm" to its right. A "Print..." button is located to the right of the "Results" section.

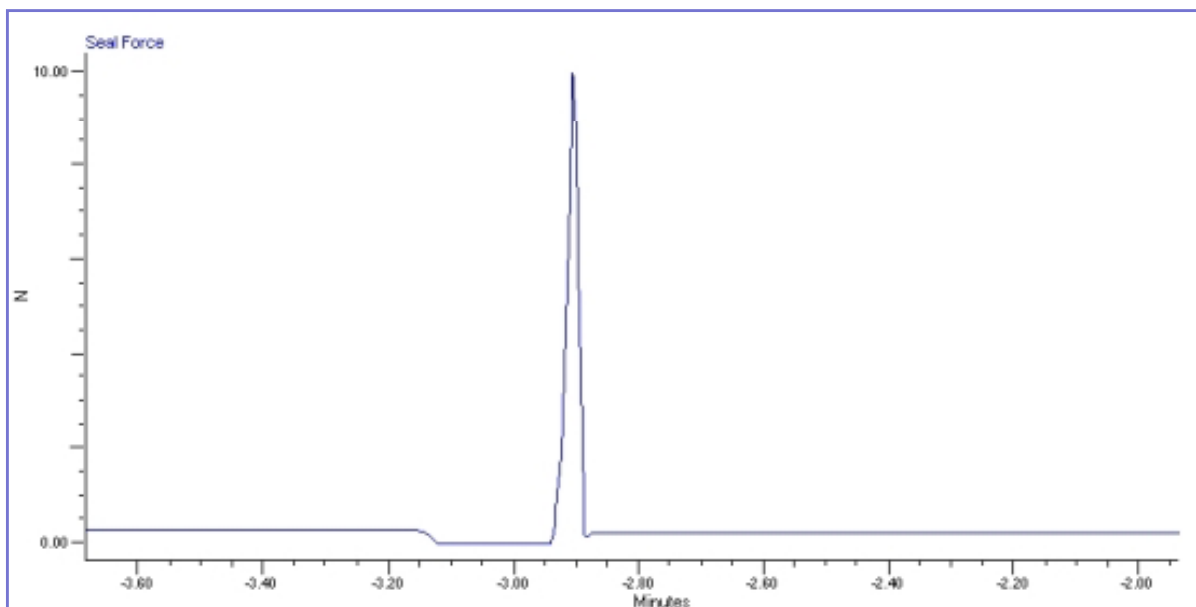
Run time:	
0.0 Min	Start
0.0	<< Results Close

Results	
Passed:	☐
Seal Constant:	N/mm
Distance To Seal:	mm
Foot Offset:	mm

Print...

Post Service Diagnostic Tests

- Examine the Seal Force plot after the Characterize Needle Seal function is completed. It should look similar to the below plot.



- Start a flow rate of 0.6ml/min with 90% A 10%B and allow the pressure to stabilize.
- Run the Needle Seal Readiness test and enter the result below.

Results		
Passed:		
Pressure Difference:		psi
Flow:		ml/min

Post Service Diagnostic Tests

Running the BSM / SM Dynamic Leak Test

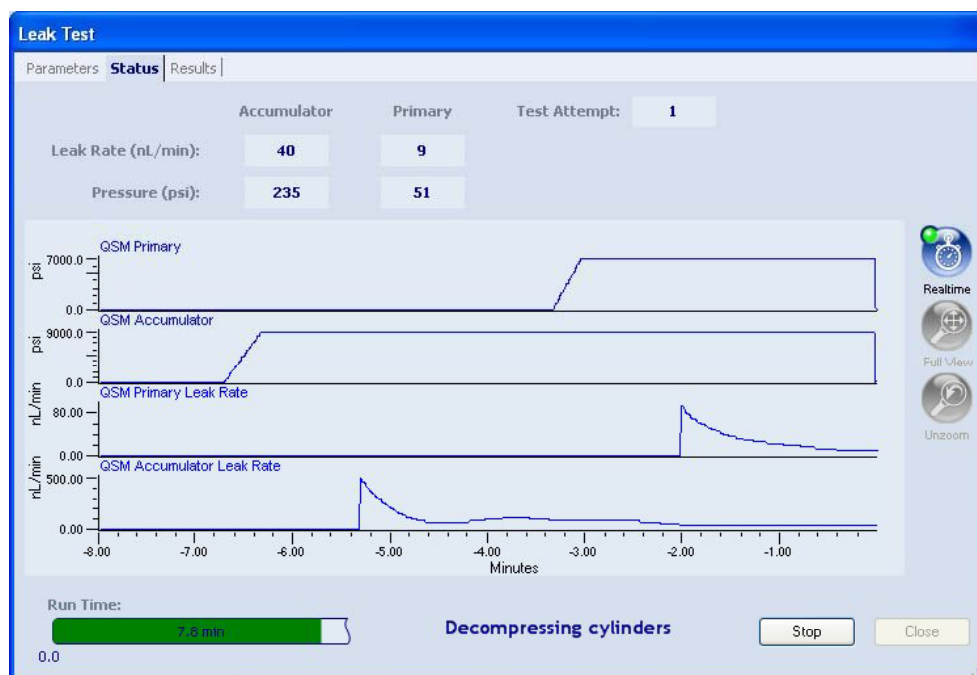
- ☐ Stop the flow and disconnect the column inlet line from the column.
- ☐ Connect the fitting plug (or union and plug, located in the solvent bottle tray front compartment) to the column inlet line to plug the line.
- ☐ Run the Dynamic Leak Test from the BSM menu.
 - ☐ Use the A Pump
 - ☐ Set the pressure 17000 PSI.
 - ☐ Choose Column as the end point.
 - ☐ Record the results below.

The screenshot shows a software window titled "Leak Test" with three tabs: "Parameters", "Status", and "Results". The "Results" tab is active. It displays two columns of data entry fields, labeled "Accumulator" and "Primary".

	Accumulator	Primary
Result:		
Leak Rate:	nL/min	nL/min
Maximum Pressure:	psi	psi
Percent of Stroke:	%	%
Compressed Volume:	uL	uL
Compression Attempts:		
Test Attempts:		

At the bottom right of the window are three buttons: "Print", "Start", and "Close".

Post Service Diagnostic Tests



Do the results correlate well with the BSM leak tests?

This test should give a good level of confidence that the Stationary Side Seal, tubing and fittings are holding pressure and functioning correctly.

- ☐ If the test failed, recheck all fittings and try the test again. Troubleshoot the problem by changing the location of the pin plug if necessary.
- ☐ Once the test has passed, disconnect the plug and reconnect the column to the inlet line.
- ☐ Fill in the fields below and initial and date it.
- ☐ Proceed to the System Performance Tests Section

SM-FTN Diagnostic Tests Overall Results
(Pass/Fail) _____

Initials _____

Date _____

Post Service Diagnostic Tests

Post Service Diagnostic Tests-SM-FL

This section deals with the SM-FL If your system has an SM-FTN then go to the previous section; Post Service Diagnostic Tests-SM-FTN.

- ☐ If needed, reset the SM-FTN from the console menu.
- ☐ Prime the Sample and Wash Syringes for 3 cycles.
- ☐ Characterize the Needle Z-axis and enter the result.
Needle Z-axis Offset: _____mm.
- ☐ Characterize the Needle Seal and enter the result.
Needle Seal- (Pass/Fail & Offset): _____mm
- ☐ Calibrate the Air Sensor and enter the result.
Air Sensor - (Pass/Fail & Volume): _____ul
- ☐ Characterize the Needle and Loop Volumes and enter the results below.

Characterize Needle and Loop Volumes

Nominal Configuration

Loop size: **10.0** µL
Needle size: **10** µL
Sample syringe size: **100.0** µL

Run time:

0.0 Min
0.0

Start
<< Results
Close

Results

Print...

Measured volume

System volume with loop:	µL
System volume without loop:	µL
Loop:	µL
Needle:	µL

Post Service Diagnostic Tests

- ❑ Run the Sample Syringe Leak Test and record the results in the blank fields below.

Results		Leak Test	
Passed:			
Test pressure:			psi
Compressed volume:			µL
Decompressed volume:			µL
Start pressure:			psi
End pressure:			psi
Pressure change:			psi
Average pressure leak:			psi/sec

- ❑ Run the Wash Syringe Leak Test and record the results in the blank fields below.

Weak Wash Leak Test

Results		Leak Test	
Passed:			
Test pressure:			psi
Compressed volume:			µL
Decompressed volume:			µL
Start pressure:			psi
End pressure:			psi
Pressure change:			psi
Average pressure leak:			psi/sec

Strong Wash Leak Test

Results		Leak Test	
Passed:			
Test pressure:			psi
Compressed volume:			µL
Decompressed volume:			µL
Start pressure:			psi
End pressure:			psi
Pressure change:			psi
Average pressure leak:			psi/sec

- ❑ Run the Needle Seal static leak test and record the results in the blank fields below.

Results		Leak Test	
Passed:			
Test pressure:			psi
Compressed volume:			µL
Decompressed volume:			µL
Start pressure:			psi
End pressure:			psi
Pressure change:			psi
Average pressure leak:			psi/sec

Post Service Diagnostic Tests

- ❑ Run the Back Pressure Regulator test and record the results in the blank fields below.

The screenshot shows a software window titled "Back Pressure Regulator Test". It contains a "Run time:" label with a text input field showing "0.0 Min" and a "0.0" value below it. To the right are "Start", "<< Results", and "Close" buttons. Below this is a "Test Results" section with a "Print" button. The results are listed as follows:

Passed:	
Start pressure:	psi
End pressure:	psi
Average pressure:	psi
Standard deviation:	psi

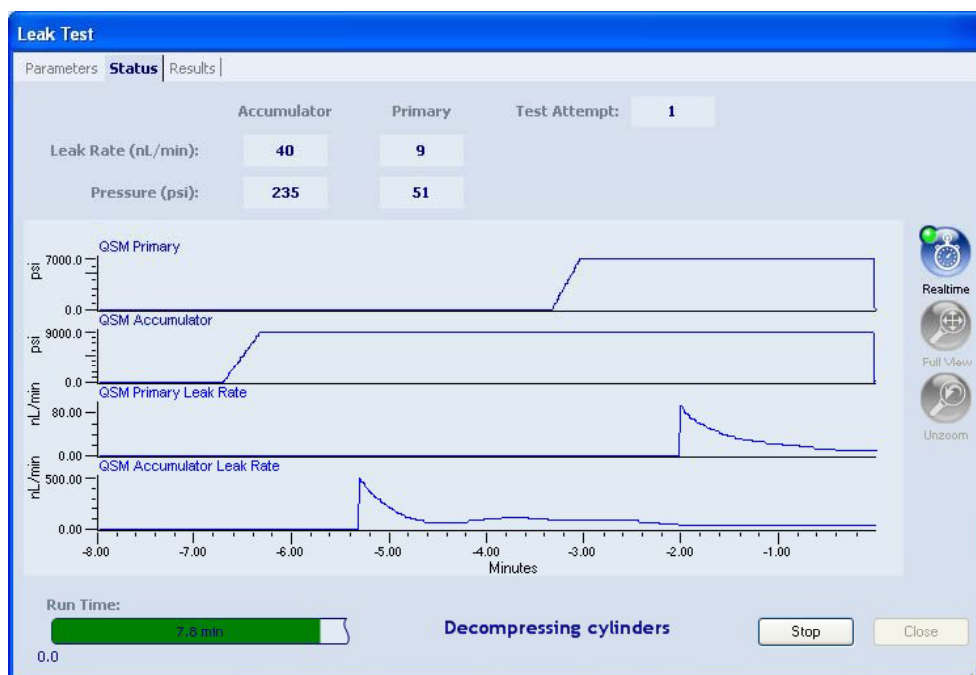
Running the BSM / SM Dynamic Leak Test

- ❑ Stop the flow and disconnect the column inlet line from the column.
- ❑ Connect the fitting plug (or union and plug, located in the solvent bottle tray front compartment) to the column inlet line to plug the line.
- ❑ Run the Dynamic Leak Test from the BSM menu.
 - ❑ Use the A Pump
 - ❑ Set the pressure 17000 PSI.
 - ❑ Choose Column as the end point.
 - ❑ Record the results below.

The screenshot shows a software window titled "Leak Test" with tabs for "Parameters", "Status", and "Results". The "Results" tab is active. It displays two columns of data: "Accumulator" and "Primary". Each column has a "Result:" label and a text input field. Below these are labels for "Leak Rate:", "Maximum Pressure:", "Percent of Stroke:", "Compressed Volume:", "Compression Attempts:", and "Test Attempts:", each followed by a text input field and a unit. At the bottom right are "Print", "Start", and "Close" buttons.

	Accumulator	Primary
Result:		
Leak Rate:	nl/min	nl/min
Maximum Pressure:	psi	psi
Percent of Stroke:	%	%
Compressed Volume:	ul	ul
Compression Attempts:		
Test Attempts:		

Post Service Diagnostic Tests



Do the results correlate well with the BSM leak tests?

This test should give a good level of confidence that the Stationary Side Seal, tubing and fittings are holding pressure and functioning correctly.

- ☐ If the test failed, recheck all fittings and try the test again. Troubleshoot the problem by changing the location of the pin plug if necessary.
- ☐ Once the test has passed, disconnect the plug and reconnect the column to the inlet line.
- ☐ Fill in the fields below and initial and date it.

SM-FL Diagnostic Tests Overall Results (Pass/Fail) _____

Initials _____

Date _____

System Performance Tests

- ☐ Run the system performance tests as detailed in the I-Class Installation procedure to check the system as a whole.
- ☐ Record the precision results below.

Note- The before and after service results for the system are a key part of the certification exam.

Caffeine Area and Height Results Table

	Area %RSD Specification	Area %RSD	Area %RSD Pass Fail	Height %RSD Specification	Height %RSD	Height %RSD Pass Fail
1	%RSD < or = 0.5			%RSD < or = 1.1		

Caffeine Retention Time (RTsec) Results Table

	Retention time (sec) Standard Deviation Specification	Retention time (sec) Standard Deviation	Retention time (sec) Standard Deviation Pass Fail
1	SD RT < or = 1.0sec		

Precision Tests Overall Results (Pass/Fail)_____

Initials_____

Date_____

Gradient Test Results

- ☐ Record the Gradient test results below.

Note- The peak retention times must be converted from minutes to seconds before doing the statistics in order to properly determine the standard deviation in seconds.

Retention Time Reproducibility

	Name	Retention Time (Seconds) Standard Deviation Specification	Retention Time (Seconds) Standard Deviation	Retention Time (Seconds) Standard Deviation Pass Fail
1	2-acetylfuran	SD RT < or = 1.0sec		
2	acetanilide	SD RT < or = 1.0sec		
3	acetophenone	SD RT < or = 1.0sec		
4	propiophenone	SD RT < or = 1.0sec		
5	butylparaben	SD RT < or = 1.0sec		
6	benzophenone	SD RT < or = 1.0sec		
7	valerophenone	SD RT < or = 1.0sec		

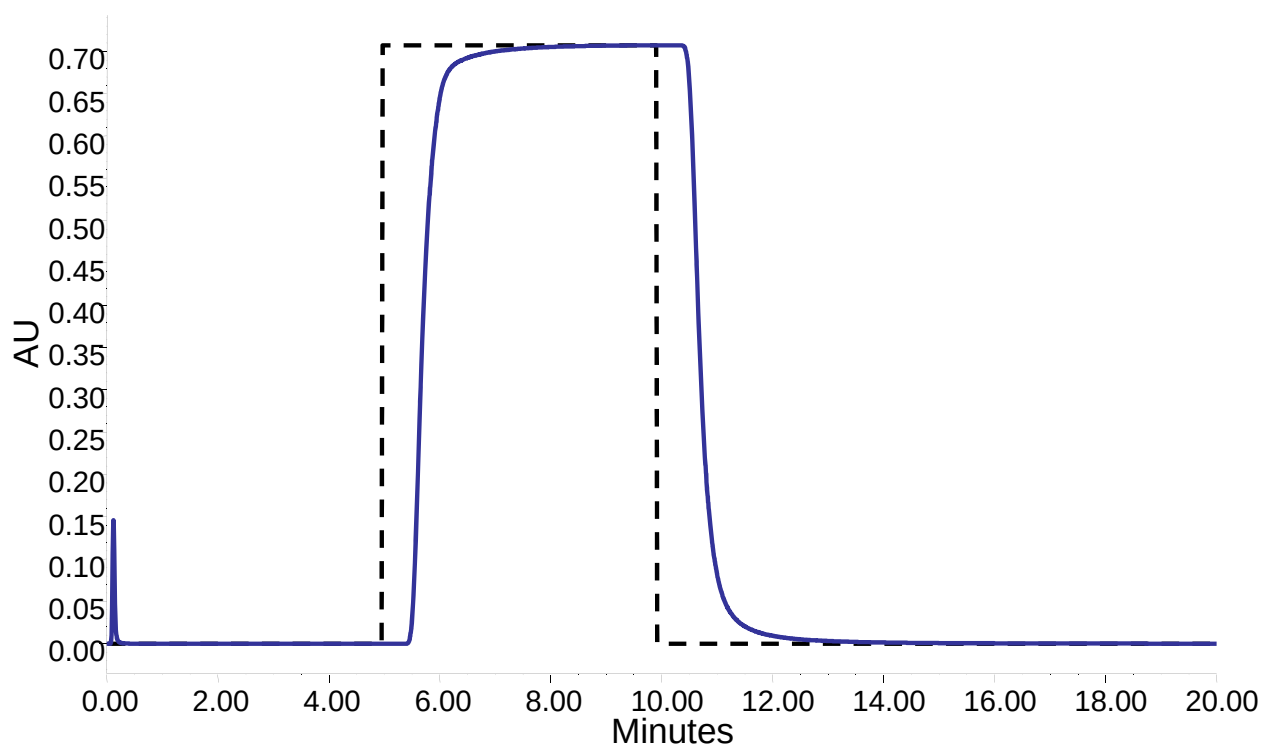
Gradient Tests Overall Results (Pass/Fail)_____

Initials_____

Date_____

Section 17

Determining I-Class System Volumes



Extra-Column Volume

The extra-column volume comprises the volume of the system from the point of the injection to the point of detection.

A more accurate determination would include all parts of the column (the connectors and frits) minus the packing material. However this is quite difficult to measure without sophisticated equipment.

- ☐ Modify the Precision (Caffeine) method to the following parameters and then save it as System Bandspreading.
 - ☐ Switch the flow in the Gradient table to isocratic using 90% A 10%B at 0.5 ml/min.
 - ☐ Switch the TUV method sampling rate to 40 pts/sec and the filter to none.
- ☐ Use the Caffeine sample from the system precision test.
- ☐ Run 3 replicate **1ul** injections of the test with a Run Time of 30 seconds.
- ☐ Calculate the extra-column volume in ul, using the following formula:

$$X = Rt * F * 1000 \text{ (ul / ml)}$$

Rt= Retention time of the peak

F= flow rate in ml/min

I-Class Extra-column Volume= _____ul

Bandspreading

Bandspreading is the broadening of the peaks as they flow through the extra-column volume of the system. It is an important measure of the system impact on the efficiency of the chromatography.

- ❑ Calculate the system bandspreading volume in ul, using the following formula:

$$B = W * F * 1000 \text{ (ul/ml)}$$

W= Width of the peak at 4.4% height

F= flow rate in ml/min

- ❑ If you are using a system with the SM-FL, find out the values for the SM-FTN from another group and visa-versa.

I-Class SM-FL Bandspreading = _____ul

I-Class SM-FTN Bandspreading = _____ul

- ❑ Return the system to its normal configuration and reinstall the ACQUITY column.

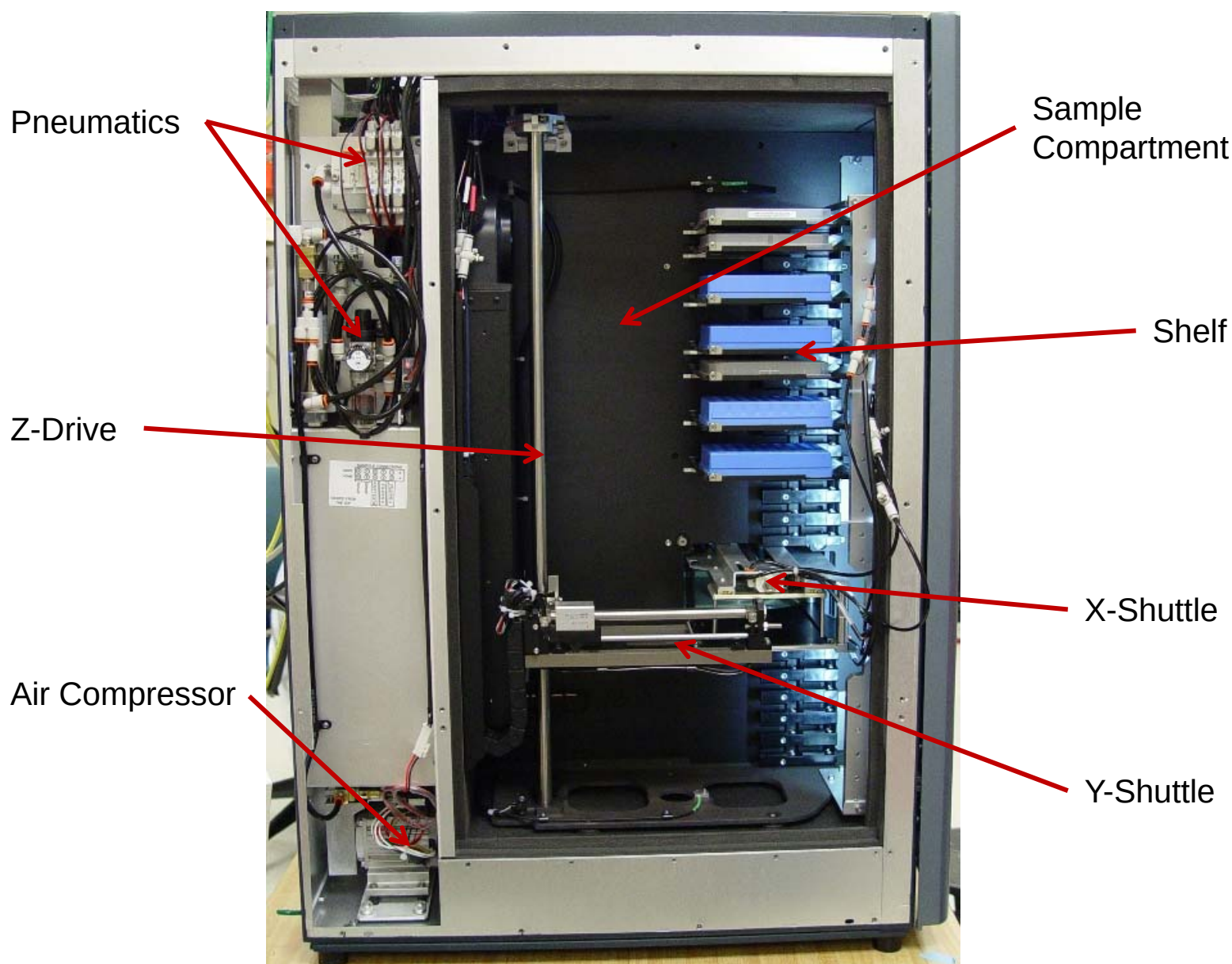
Section 18 Sample Organizer



Sample Organizer Subassemblies

Reviewing the Sample Organizer Subassemblies

- While in front of the unit, remove the left panel of the and review the major subassemblies of the Sample Organizer as detailed in the diagram below.



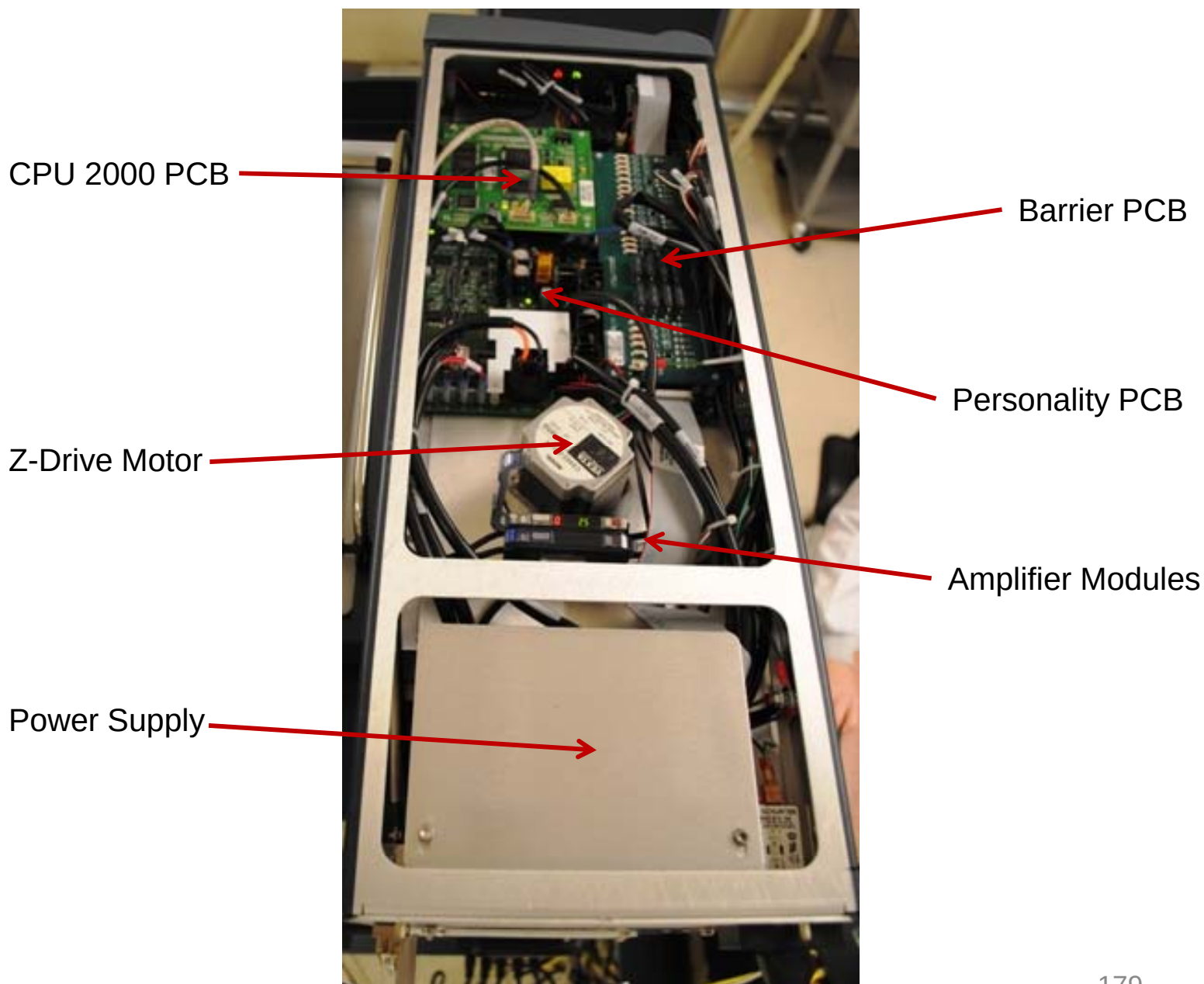
Sample Organizer Subassemblies

Electronic Subassemblies

- ❑ Remove the top panel of the unit and review the major electrical and control subassemblies of the Sample Organizer as detailed in the diagram below.



Warning- Beware of live AC and DC voltages when troubleshooting and servicing with side or top panels removed. Always remove the power cord from the Sample Organizer before touching any of the electronics.



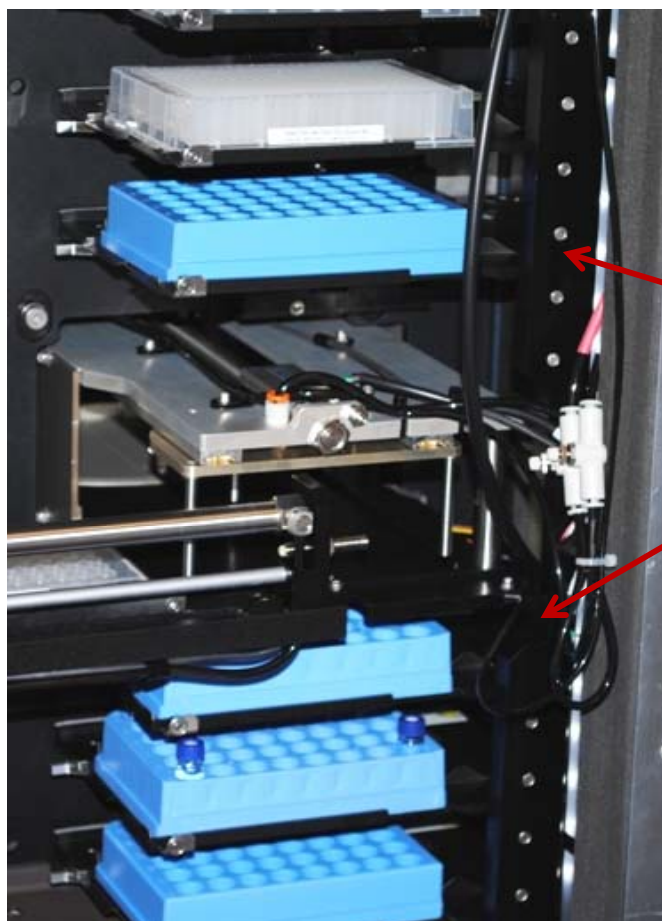
Sample Organizer New Features

Shelf Stability Bracket and New Wider Shelves

Note the location and details of the Shelf Stability Bracket. It was added, along with the new wider shelves to prevent shelf sag. The new trays are not compatible with the old Sample Organizer.



New wider Shelf



Shelf Stability Bracket

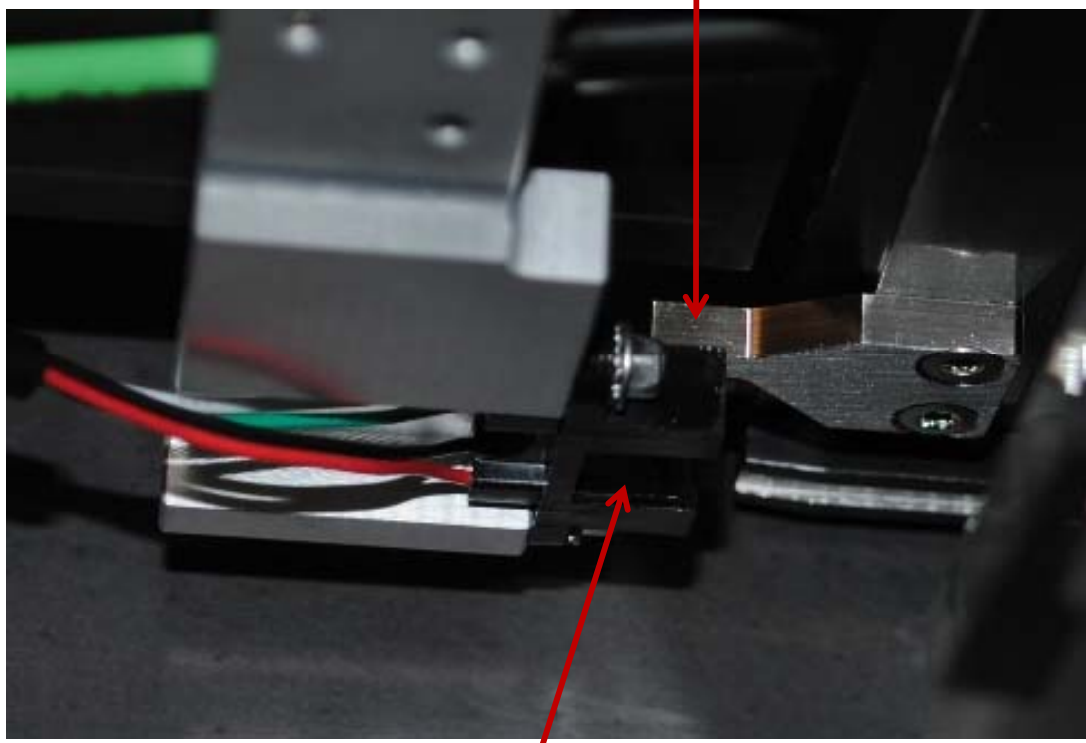
Sample Organizer New Features

Shelf Sensor and Sensor Flag

The new shelf sensor flag (along with the shelf sensor) greatly improves the detection of shelves in the new Sample Organizer. Find the shelf sensor on the bottom of the YTS.



Shelf Sensor Flag



Shelf Sensor

Sample Organizer New Features

X-Transfer Shuttle

The X-Transfer Shuttle was modified to accommodate the transfer of plates from the SO to a modified rotary tray in the SM-FTN or SM-FL. This required the transfer pneumatics to be situated on top to facilitate the sliding of the plate into the rotary with the use of 3 prongs.

X-Shuttle Transfer Pneumatics

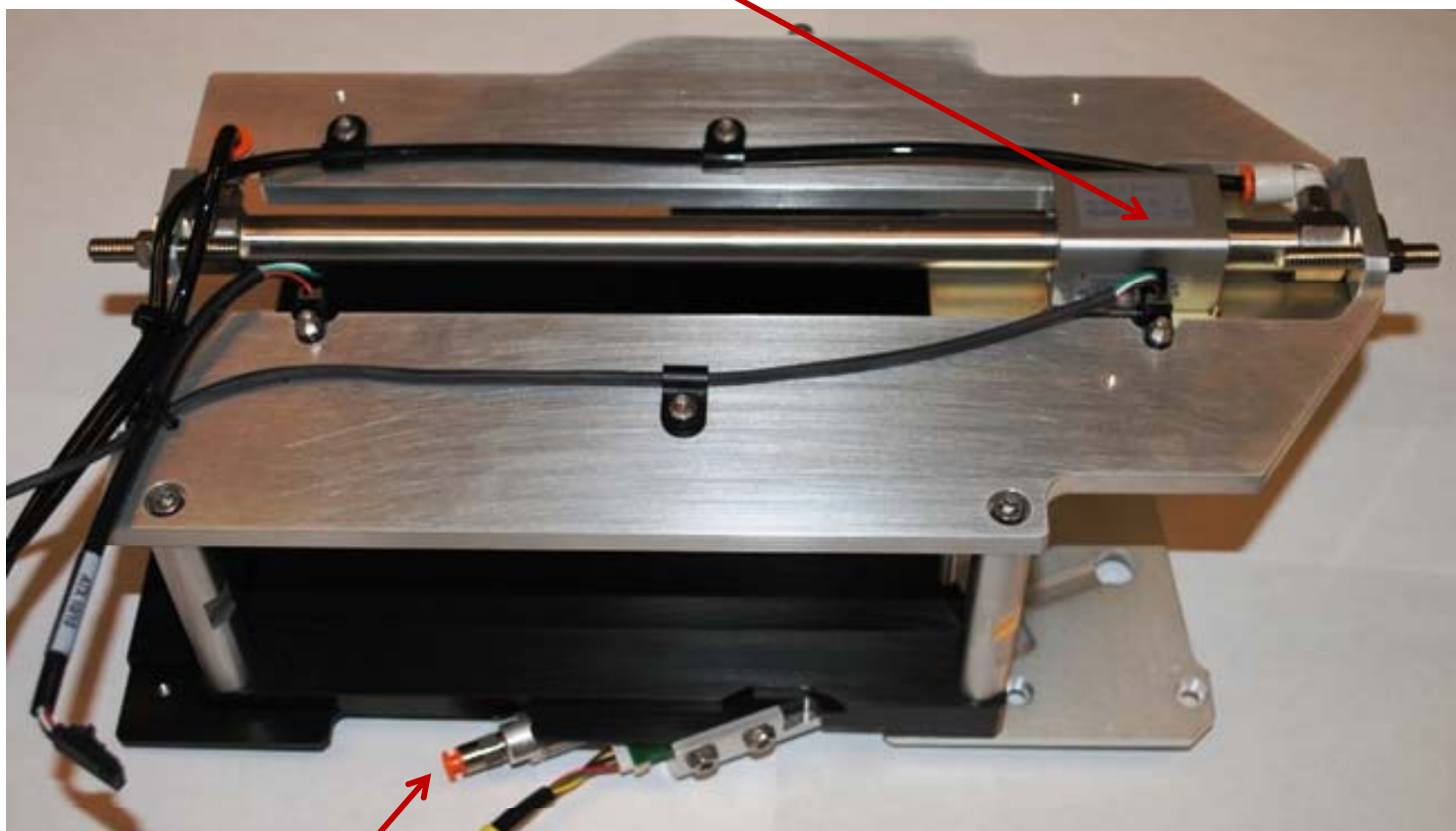
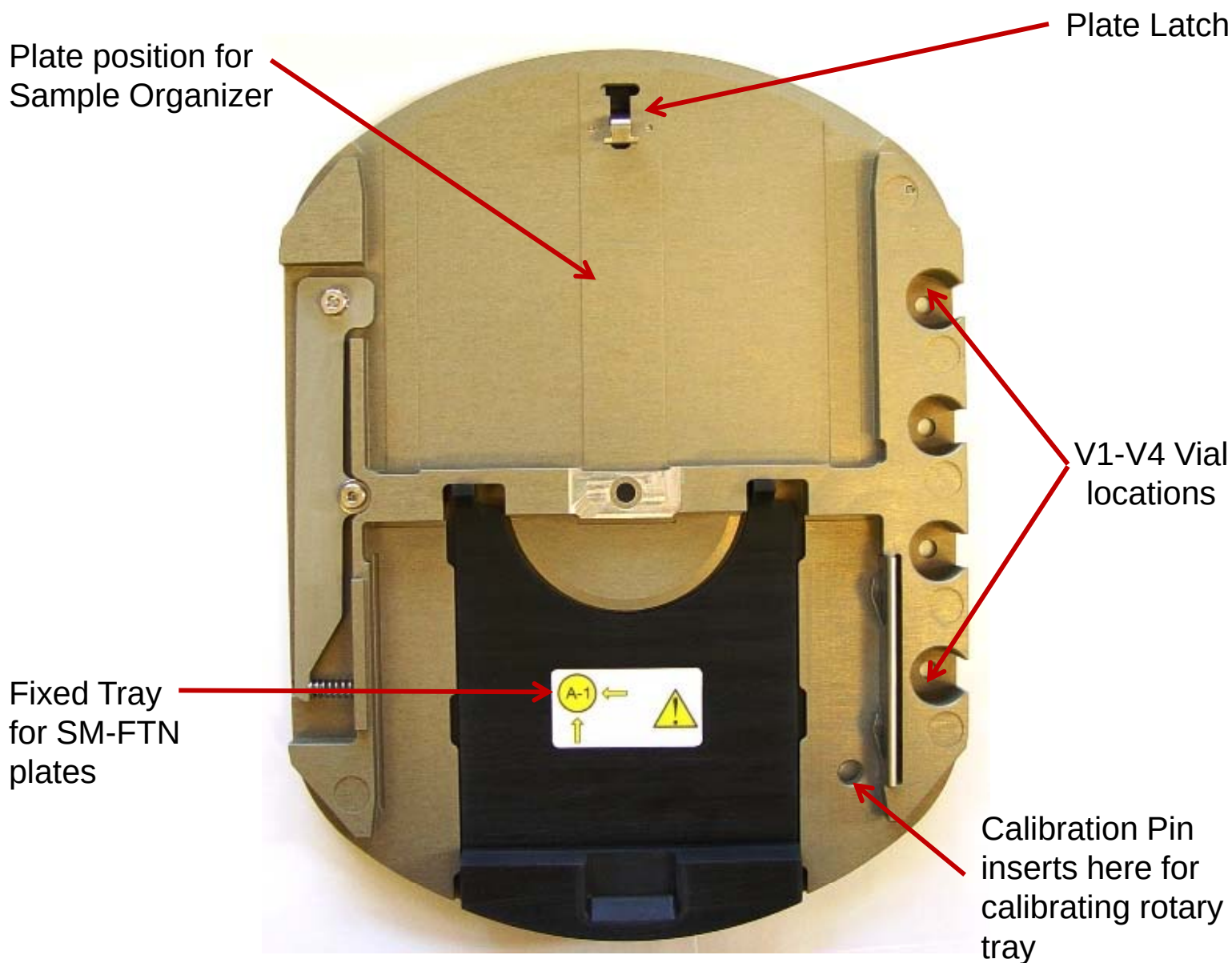


Plate Latch Pneumatic Actuator

Sample Organizer New Features

Sample Organizer Rotary Tray

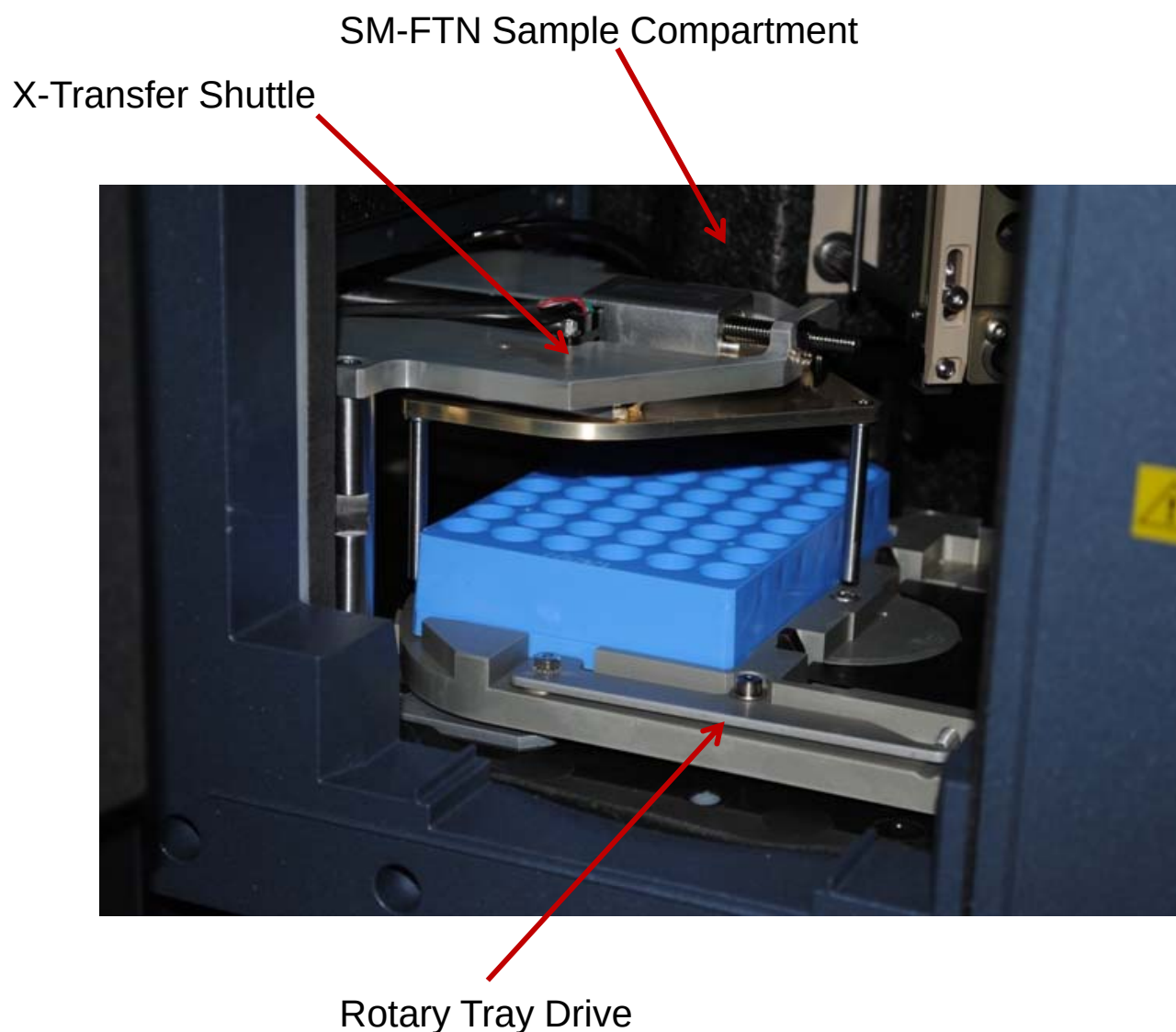
The rotary tray shipped with the SO has been modified to handle the insertion of plates from the SO. This tray is installed into the SM in place of the stock rotary tray. It has a spring-loaded latch to hold the plate from the SO in place. It has a fixed tray location for plates as well as 4 locations for up to 4ml vials (V1-V4).



Sample Organizer New Features

X-Transfer Shuttle and Rotary Tray Installed

The X-Transfer Shuttle installed in the SM_FTN along with the modified rotary tray. Two of the 3 prongs used in the transfer of the plate can be seen in the below photo.



Sample Organizer Installation

Reviewing the Sample Organizer Installation Procedure

- ❑ While in front of the unit, review the procedure for assembling the ACQUITY UPLC System Sample Organizer (715002991). Perform all operations that are in bold below. The procedure consists of 13 subtasks:
 - ❑ Disassembling the ACQUITY stack (if necessary)
 - ❑ Unpacking and opening the sample organizer
 - ❑ Attaching the outboard leg and sample manager shelf
 - ❑ Docking the sample manager
 - ❑ **Installing the X-axis transfer shuttle (XTS)**
 - ❑ *Note: For this exercise, remove first then reinstall both the XTS and the rotary tray.*
 - ❑ **XTS Pre-alignment**
 - ❑ **Making electrical and pneumatic connections**
 - ❑ **Configuring the sample organizer**
 - ❑ *Remove the SO from the SM configuration then reconfigure it.*
 - ❑ **Checking the pressure**
 - ❑ **Checking the flow controls**
 - ❑ **Verifying / adjusting the hard stops using the calibration block**
 - ❑ **Installing the sample organizer shelves**
 - ❑ **Testing the sample organizer shelves**

Sample Organizer Diagnostics

Running the Sample Organizer Diagnostics

- ☐ Once you have the unit operational again, go to the Sample Organizer menu in the console. Perform all operations listed below:
 - ☐ Scan and Store (from the Configure menu).
 - ☐ Put several plates in to check for proper detection.
 - ☐ Troubleshoot> Plate Transfer
 - ☐ Run 3 cycles of the transfer.
 - ☐ Switch the unit to interactive control.
 - ☐ Run the following functions:
 - ☐ X Shuttle- Home and Away
 - ☐ Y Shuttle- Home and Away
 - ☐ Z-Axis- Home and Away
- ☐ Record the shuttle transfer times in the table below.
- ☐ Switch the Sample Organizer back to non- interactive control.
- ☐ Return the unit back to the condition you found it .

Shuttle	Home to Away	Away to Home
X-Shuttle		
Y-Shuttle		
Plate Latch		