

DOCUMENT TITLE: **ACQUITY QSM FINAL INSTRUMENT TEST**

SYSTEM/ASSEMBLY NAME: **ACQUITY QSM PUMP**

PART NUMBER AFFECTED **186015018, 800000297, 186015041, 800000309, N2971030,  
186015080, 800000484, 186015081, 800000485, 186015083,  
800000487, 186015084, 800000488**

TEST EQUIPMENT NAME: **ACQUITY SDS FINAL TEST STATION**

TEST EQUIPMENT NUMBER: **TE82943**

TEST SOFTWARE:



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## EQUIPMENT REQUIRED

| Quantity | Part Number  | Description                                                              |
|----------|--------------|--------------------------------------------------------------------------|
| 1        | TE82943      | AcQuity SDS Automated Test Station                                       |
| 1        | N/A          | 5/16 open ended wrench                                                   |
| 1        | N/A          | 5/8 open ended wrench                                                    |
| 1        | N/A          | 1/4 open ended wrench                                                    |
| 1        | Cat# 4701151 | Dispensette Bottle-Top dispenser or equivalent                           |
| 1        | 430001150    | Tube, 316L, SS, 1/16 OD X .020, 16 Roughness Avg. (roughly 36" required) |

## DISPOSABLES REQUIRED

| Quantity    | Part Number | Description                  |
|-------------|-------------|------------------------------|
| As Required | N/A         | 100% Virgin Methanol         |
| As Required | N/A         | 100% IPA                     |
| As Required | 700005319   | Production GPV Test Solution |

## REFERENCE DOCUMENTATION

| Document Number | Description                                                                       |
|-----------------|-----------------------------------------------------------------------------------|
| 730000710       | Creating and Maintaining Technical Files                                          |
| WAT000050MP     | Waters Record Retention Corporate Policy                                          |
| WAT046538       | GENERIC Electrical Safety Test PROC.                                              |
| 721009394       | Functional Specification for the QSM for ACQUITY GP, bioACQUITY, and ACQUITY PLUS |
| 735001953       | Fluidics Plumbing Diagram                                                         |
| 279001915       | ASSY PROC, ACQUITY UPLC BIO-QSM                                                   |
| N/A             | Seal Wash Testing for QSM Pumps Memo V00.doc                                      |
| N/A             | Prime Pump Testing for QSM Pumps Memo V00.doc                                     |
| N/A             | Dynamic Leak Specs for QSM.doc                                                    |
| N/A             | VV to Output Testing for QSM Pumps Memo V00.doc                                   |
| N/A             | High Pressure Testing for QSM Pumps Memo V00.doc                                  |

## DEFINITIONS AND ABBREVIATIONS

| Term   | Definition / Abbreviation                     |
|--------|-----------------------------------------------|
| AC     | Alternating Current                           |
| ASP    | Assembly Procedure                            |
| BioQSM | Biocompatible Quaternary Solvent Manager Pump |
| CM     | Contract Manufacturer                         |
| FSD    | Functional Specification Document             |
| GP     | General Purpose                               |
| IO     | Input Output                                  |
| IPA    | Isopropyl Alcohol                             |
| LED    | Light Emitting Diode                          |
| LSL    | Lower Specification Limit                     |
| MeOH   | Methanol                                      |
| N/A    | Not Applicable                                |
| PC     | Personal Computer                             |
| PCI    | Peripheral Component Interconnect             |
| PS     | Performance Specification                     |
| PSC    | Product Support Check                         |
| PSI    | Pound per square inch                         |
| QSM    | Quaternary Solvent Manager Pump               |
| SAP    | Systems Applications and Products             |
| SDS    | Solvent Delivery System                       |
| SN     | Serial Number                                 |
| SS     | Stainless Steel                               |
| Ti     | Titanium                                      |
| TSP    | Test and Specification Procedure              |
| USB    | Universal Serial Bus                          |
| USL    | Upper Specification Limit                     |
| UUT    | Unit Under Test                               |
| VV     | Vent Valve                                    |

**The QSM Final Test**

The QSM Final Test is performed consecutively on two separate test stations. The first test station provides the initial pretest power-up checks and electrical safety testing. The second station provides all of the remaining functional testing.

**I. The Pre-Test Power-up Electrical Safety Test Station**

The pretest power-up test station is used to perform an electrical safety test per Waters procedure WAT046538. All Test Units must pass this test in order to move to the Final Test Station.

**II. The QSM Automated Final Test Station**

The QSM Automated Final Test Station is designed to functionally test the Water's Corporation AcQuity (Bio) QSM Pump and the Altus QSM Pump. Tests include: Software Download, Rear Panel Tests, Prime Pump, Degasser Tests, Dynamic Leak, Flow Rate Accuracy, Static Leak Manifold to Filter Tubing, Compositional Accuracy, Fans, LEDs, IPA Fill and Drain.

The test strategy for this assembly is to test the functions that the unit as a whole must be able to provide.

The internal circuit boards, will have been through an In-Circuit and a Functional Test, prior to installing into this assembly. The Check Valves and Vent Valve Assembly will also have been tested and inspected.

The QSM Automated Testing will verify that these assemblies, boards and all other assemblies, when assembled together correctly, will produce the expected performance.

For clarity, please note the following information and equivalent descriptions.

| Part Number | QSM | Bio QSM | Description(s)  |
|-------------|-----|---------|-----------------|
| N2971030    | X   |         | Altus QSM       |
| 186015018   | X   |         | QSM             |
| 186015041   |     | X       | Bio QSM         |
| 186015080   | X   |         | QSM PLUS        |
| 186015081   |     | X       | Bio QSM PLUS    |
| 186015083   | X   |         | QSM XR PLUS     |
| 186015084   |     | X       | Bio QSM XR PLUS |

Prior to executing this test procedure on any QSM, the operator must check the Calibration Due label on the AnD Balance, and the Preventative Maintenance Due Labels on the TE82943 test box, and the TUV, to confirm these devices are within their valid date window.

**III. Functional Test System Features**

The system uses a PC with added serial ports to communicate with the QSM, the test box TE82943, the AnD balance, and the AcQuity TUV. An added Ethernet card to the PC, communicates with the QSM for faster firmware downloading.

TE82943 includes a USB digital IO and an analog input module for rear panel testing. A Valco valve controls the direction of the pump's output flow to either one of three restrictors or a dead end plug. The restrictors flow to the TUV-to-waste or to the AnD analytical balance, for flow rate testing. The QSM seal wash output can be connected to a vacuum pump for priming or diverted to the balance for flow rate testing. TE82943 front panel controls are under 'remote control' when the automated program is running.

The Test is controlled through an Operator Interface Test Program written in LabVIEW.

The Test Program has the following controls:

New Test – this button starts the testing on a newly assembled QSM.

Retest – this button will begin testing at a point determined appropriately close to where the last test run failure occurred.

Stop/Pause – this button, when active, will pause the program at the end of the current test step and prompt the operator with a choice to either stop or continue the testing.

Diagnostics – this button will launch the diagnostics page. In Diagnostics, the operator can select any test and verify the result.

Reprint Report – this button, when active, will send another hard copy of the test record to the printer.

The program will prompt the operator for information as required. Examples of inquiries include: QSM Serial Number, Factory Order Number, Operator Name, Part Number, etc... This will mainly occur during the initial launch of the test sequence.

Once the firmware has been loaded, the test runs without operator interaction, until it is time to pull lines from the MeOH and IPA bottles at the end of the test.

Operator Prompts can be easily identified from a distance by a yellow background popup window.

All data collected is sent to the SigmaQuest server.

#### **IV. Test Fixture Setup (Initial)**

Connect the monitor, keyboard, and mouse to the PC.

Connect the PC RS232 serial ports, USB, and Ethernet port (PCI card) to the proper locations as shown on the TE82943 test box schematic drawing diagram, Appendix 1.

Connect the PC "main board" Ethernet port to the Waters assigned facility network.

Connect TE82943 test box AC lines as shown on the schematic drawing. Refer to Appendix 1 Electrical Connections for details.

Connect the fluidic lines from TE82943 test box to the AnD scale and to waste as labeled on TE82943 rear panel. Refer to Appendix 2 Fluidic Connections for details.

Turn on TE82943 via the rear panel AC core module switch.

Turn on the AnD balance via the front panel power button.

Turn on the monitor and PC.

Enter the appropriate Login Name and Password.

Launch the Test Program by double clicking on the icon "TE82943 AcQuity QSM Final Functional Test.exe".

#### **V. MeOH with Caffeine Bottle Prep.**

The QSM Final Testing requires a bottle of MeOH with caffeine spike in order to perform the Compositional Accuracy testing. The desired concentration is 25mg/liter of caffeine.

Using the Dispensette Bottle-Top Dispenser (cat#4701151) attached to the 4 liter bottle of Production GPV Test Solution 700005319, draw out 10mL.

Inject the 10mL of GPV Test Solution into a 2 liter bottle of 100% Virgin Methanol.

Label the bottle as MeOH with 25mg/liter caffeine spike. Mix well.

Note: [(5mL/Liter = 25mg/Liter)].

## VI. Test Setup/Connections and Test Procedure with Automated Test Program

### 1. CONNECTIONS

- 1.1. Connect the “remote controlled” AC line from the rear panel of TE82943 to the rear of the QSM.
- 1.2. Verify that the AC power is off. (Press the QSM front panel switch to off if necessary).
- 1.3. Connect the Ethernet cable from the PC to the rear of the QSM.
- 1.4. Connect the RS232 serial cable from the PC to the QSM.
- 1.5. Connect the 6-pin green Phoenix cable to the rear of the QSM. (This is the added QSM extension cable that connects from the QSM to the Side II Phoenix connector that is cabled to the TE82943 test box).
- 1.6. Connect the extension cable with the 3-pin c-grid connector, from the TE82943 box to the QSM front panel Leak Detector connector. The QSM requires the added extension cable that contains the 82 ohm resistor. To prevent circuit damage, this extension cable is required for testing the QSM.
- 1.7. Connect the fluidic output from the mixer to the input filter port on the TE82943 front panel using the interface tube part number 430001150.
- 1.8. On the QSM, pull the Seal Wash output line from the drip tray's barbed fitting. Connect the line to the barbed fitting on the seal wash line input located on the front panel of TE82943.
- 1.9. Connect the large waste tubing to the QSM drip tray barb fitting, located just under the front of the QSM.
- 1.10. Place the QSM **A**, **B**, and **Seal Wash** Inlet tubes with sinkers into the MeOH bottle. Note: Bio QSMs must swap out their Ti sinker filters for SS sinker filters prior to Final Functional Test. Swap back to the original Ti sinker filters at the completion of testing.
- 1.11. Place the QSM **C** and **D** Inlet tubes with sinkers into the MeOH with Caffeine bottle. Note: Bio QSMs must swap out their Ti sinker filters for SS sinker filters prior to Final Functional Test. Swap back to the original Ti sinker filters at the completion of testing.

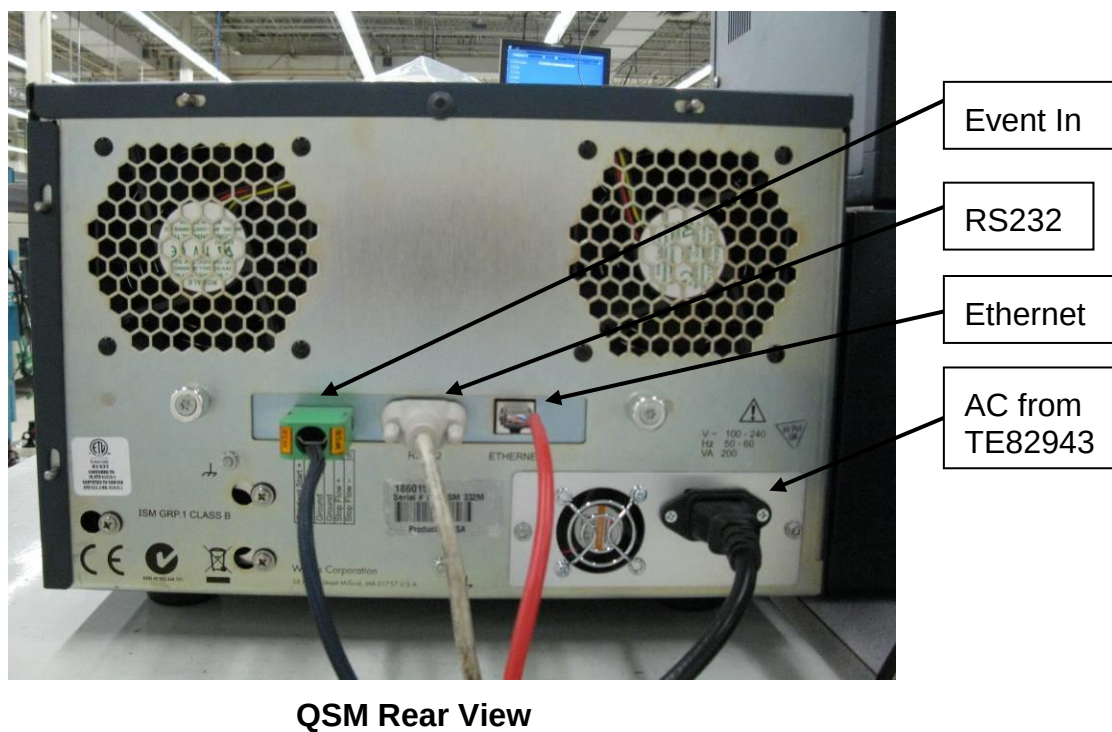
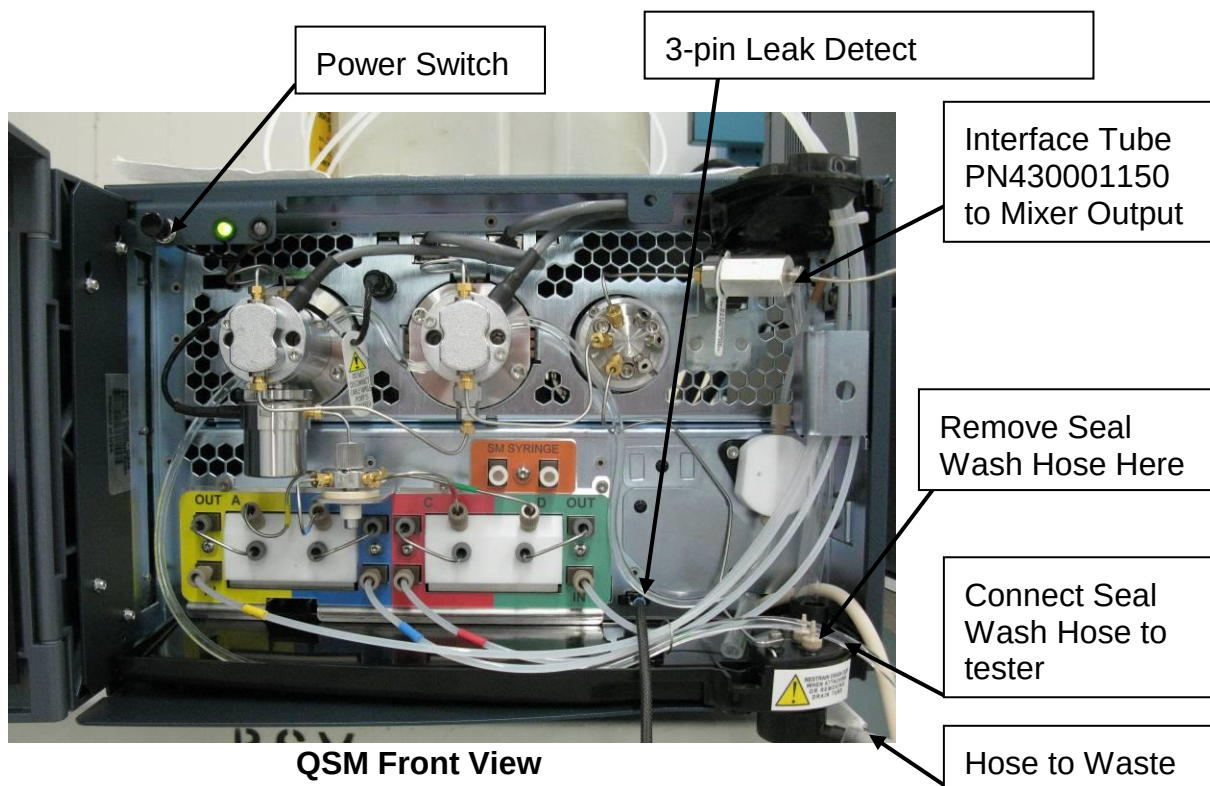
### 2. TEST PROGRAM

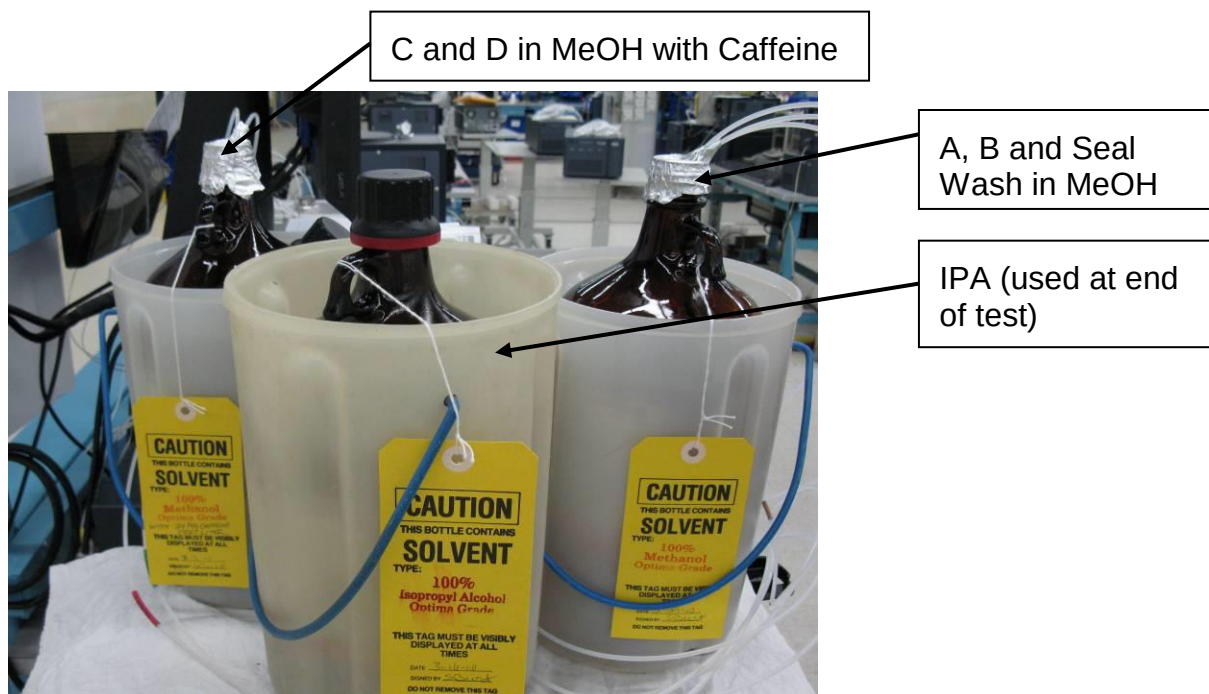
- 2.1. Prepare and install the QSM to the test system following the Test Setup procedure above.
- 2.2. Ensure the test program screen is shown on the PC.
- 2.3. On the Test Program, press the **New Test** button to start the test.

- 2.4. An Input Information window will appear. Enter in all the requested data. The bar code scanner may be used to expedite the data entry. The program will reject any data input that is considered invalid. Press the **OK** button at the end when all data has been entered.
- 2.5. **Note For Repairs Department:** Enter **REPAIR** for the **Operator Name**. This will provide a special option in the test program to allow any version of firmware to pass.
- 2.6. The Test Program will prompt the operator for data entry for the Electrical Safety test. Enter the response necessary.
- 2.7. Next, the Test Program will load the latest firmware. Depending on if the QSM has already been loaded or not, the program will prompt the operator to either **Continue** testing or to **Reload** the firmware. Enter the response necessary.
- 2.8. From this point until just before the IPA Prep., the testing can be run unattended.
- 2.9. Any failures can be observed by a yellow popup window prompting the operator for attention.
- 2.10. Enter the response necessary for the popup. (See 2.18 below for operator failure options from here).
- 2.11. The Test Program will prompt the operator for proper operations of the fans. Enter the response necessary.
- 2.12. The Test Program will prompt the operator for proper operations for the Front Panel LEDs. Enter the response necessary.
- 2.13. If the testing is successful, a popup window will now appear at the start of IPA Prep.
- 2.14. The operator will be requested to pull the A, B and Seal Wash lines from the MeOH bottle and to disconnect the interface tube from the mixer. The operator will also be requested to pull the C and D lines from the MeOH & Caffeine bottle and to put both lines into the IPA bottle. Press **OK** when complete.
- 2.15. The Test Program will continue on until the operator is prompted to pull the C and D lines from the IPA bottle. Press **OK** when complete.
- 2.16. Once the Test Program completes, a **PASS** window will appear. Press the **OK** button.
- 2.17. Disconnect all electrical and tubing connections from the QSM as referenced in the Test Setup/Connections section above. The test is complete. Retrieve the hard copy Instrument Final Test Record printout from the printer. Verify the information, add additional comments if necessary, sign and date, then place into the DHR folder.
- 2.18. In the case of a test failure, the operator has two choices, Diagnostics or Retest.
- 2.19. Diagnostics can be entered by pressing the **Diagnostics** button. The QSM will power up and then a pull down selection will be available to the operator.
- 2.20. This Diagnostic selection can be used as an aid to verify any test the operator chooses to run.
- 2.21. The Diagnostic routine can be exited, repairs made to the QSM, and re-entered again as many times as necessary.
- 2.22. It is recommended that the operator run the failed test in the diagnostics menu and verify a passing result before returning to the testing program.

- 2.23. Note that some repairs, fluidic assembly replacements for example, may require re-priming the QSM before rerunning the failed test. All tests and actions are available in the Diagnostic routine to accommodate the operator's needs.
- 2.24. Once the operator feels the QSM will pass the failed test, the QSM can now be retested. Press the **Retest** button.
- 2.25. The Test Program will power-up the QSM. A popup window will prompt the operator for failure information. From the pull down, select the fail note that most closely corresponds with the repair made to the QSM to correct the failure. Press **OK** to continue.
- 2.26. The Test Program will now pickup in the test sequence at a point appropriate to the place of the last failure. It is usually at the same test, but in some cases may be at a point just before the failure.
- 2.27. Other Test Program features:
- 2.28. If necessary, the Final Test Record that prints at the end of a passing QSM, can be reprinted by pressing the **Reprint Report** button. This button is only active until another QSM is started.
- 2.29. The **Stop/Pause** button on the main Test Program window, when active, can be used to pause the testing at the end of the current test. The operator then has the option to **Continue** with the test or to **Stop** testing.
- 2.30. During some tests, a new window will be present with buttons providing the options of **Abort** or **Stop/Pause at end of test**.
- 2.31. In this case, the **Abort** button will Stop the testing as quickly as it can.
- 2.32. The **Stop/Pause at end of test** button will finish testing the particular test, and then pause. The operator then has the option to **Continue** with the test or to **Stop** testing.
- 2.33. The **Exit** button will exit out of the Test Program.

## Figures





**QSM Input Lines in MeOH and MeOH with Caffeine Bottles**  
**(The IPA Bottle is used at the end of testing)**

**Note: 4 liter bottles shown just for fluidic reference**

### VII. Test Specifications & Traceability Matrix

| Test #    |                |         | Description of Test                                            | Test     |                        | Acceptance Criteria |     |     |      | Reference                                  |
|-----------|----------------|---------|----------------------------------------------------------------|----------|------------------------|---------------------|-----|-----|------|--------------------------------------------|
| Procedure | Report         |         |                                                                | Operator | Automated Test Fixture | PASS / FAIL         | LSL | USL | Unit | FSD, ASP, PS, PSCs, schematics, SAP, etc.. |
|           | QSM & N2971030 | Bio QSM |                                                                |          |                        |                     |     |     |      |                                            |
|           |                |         | Test Fixture Calibrated and Preventative Maintenance Performed | X        |                        | X                   |     |     |      | TSP 735002155 sec.III                      |
| 1         | 1              | 1       | Test Electrical Safety                                         |          | X                      | X                   |     |     |      | PSC – Note 1<br>FSD 721009394 sec. 5.7     |
| 2         | 2              | 2       | Test Loader Download                                           |          | X                      | X                   |     |     |      | PSC – Note 1                               |
| 3         | 3              | 3       | Test Reboot Firmware                                           |          | X                      | X                   |     |     |      | PSC – Note 1                               |
| 4         | 4              | 4       | Test Firmware Version                                          |          | X                      | X                   |     |     |      | PSC – Note 1<br>SAP (CS03)                 |
| 5         | 5              | 5       | Test Instrument Type                                           |          | X                      | X                   |     |     |      | PSC – Note 3<br>ASP 279001915 p.37         |
| 6         | 6              | 6       | Test Serial Number                                             |          | X                      | X                   |     |     |      | PSC – Notes 1 & 2                          |
| 7         | 7              | 7       | Test Alarms at Bootup                                          |          | X                      | X                   |     |     |      | PSC – Note 3<br>FSD 721009394 sec. 6.12    |
| 8         | 8              | 8       | Test Gradient Start Input SHORT                                |          | X                      | X                   |     |     |      | PSC – Note 3<br>FSD 721009394 sec.5.2.2.3  |
| 9         | 9              | 9       | Test Gradient Start Input OPEN                                 |          | X                      | X                   |     |     |      | PSC – Note 3<br>FSD 721009394 sec.5.2.2.3  |
| 10        | 10             | 10      | Test Stop Flow Input SHORT                                     |          | X                      | X                   |     |     |      | PSC – Note 3<br>FSD 721009394 sec.5.2.2.3  |

|    |    |    |                                      |  |   |   |        |         |        |                                                              |
|----|----|----|--------------------------------------|--|---|---|--------|---------|--------|--------------------------------------------------------------|
| 11 | 11 | 11 | Test Stop Flow Input OPEN            |  | X | X |        |         |        | PSC – Note 3<br>FSD 721009394<br>sec.5.2.2.3                 |
| 12 | 12 | 12 | Test Leak Detect Connected           |  | X | X |        |         |        | PSC – Note 3<br>PS 810000345<br>sec.2.10.5,<br>710000345 p.9 |
| 13 | 13 | 13 | Test Leak Detect Disconnected        |  | X | X |        |         |        | PSC – Note 3<br>PS 810000345<br>sec.2.10.5,<br>710000345 p.9 |
| 14 | 14 | 14 | Test Leak Detect Leak                |  | X | X |        |         |        | PSC – Note 3<br>PS 810000345<br>sec.2.10.5,<br>710000345 p.9 |
| 15 | 15 | 15 | Test Alarms Recheck                  |  | X | X |        |         |        | PSC – Note 3<br>FSD 721009394<br>sec. 6.12                   |
| 16 | 16 | 16 | Test Seal Wash Pump Prime/Flow       |  | X | X | 2.000  | 5.000   | ml/min | PSC – Note 4<br>FSD 721009394<br>sec. 5.3.9                  |
| 17 | 17 | 17 | Test Input D Prime with MeOH         |  | X | X | 10.000 | 85.000  | PSI    | PSC – Note 5<br>FSD 721009394<br>sec. 5.3.2                  |
| 18 | 18 | 18 | Test Input C Prime with MeOH         |  | X | X | 10.000 | 85.000  | PSI    | PSC – Note 5<br>FSD 721009394<br>sec. 5.3.2                  |
| 19 | 19 | 19 | Test Input B Prime with MeOH         |  | X | X | 10.000 | 85.000  | PSI    | PSC – Note 5<br>FSD 721009394<br>sec. 5.3.2                  |
| 20 | 20 | 20 | Test Input A Prime with MeOH         |  | X | X | 10.000 | 85.000  | PSI    | PSC – Note 5<br>FSD 721009394<br>sec. 5.3.2                  |
| 21 | 21 | 21 | Test Degasser Pressure               |  | X | X | 0.000  | 1.547   | PSI    | PSC – Note 2<br>FSD 721009394<br>sec. 5.14.11                |
| 23 | 22 | 22 | Test Dynamic Leak - Accum. Leak Rate |  | X | X | 5.000  | 149.900 | nL/min | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.12                |

|    |    |    |                                                   |  |   |   |           |           |         |                                               |
|----|----|----|---------------------------------------------------|--|---|---|-----------|-----------|---------|-----------------------------------------------|
| 24 | 23 | 23 | Test Dynamic Leak - Accum. Percent of Stroke      |  | X | X | 1.000     | 30.000    | %       | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.13 |
| 25 | 24 | 24 | Test Dynamic Leak - Accum. Compressed Volume      |  | X | X | 1.000     | 50.000    | uL      | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.14 |
| 26 | 25 | 25 | Test Dynamic Leak - Accum. Maximum Pressure       |  | X | X | 14000.000 | 15000.000 | PSI     | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.15 |
| 27 | 26 | 26 | Test Dynamic Leak - Primary Leak Rate             |  | X | X | 5.000     | 149.900   | nL/min  | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.16 |
| 28 | 27 | 27 | Test Dynamic Leak - Primary Percent of Stroke     |  | X | X | 1.000     | 50.000    | %       | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.17 |
| 29 | 28 | 28 | Test Dynamic Leak - Primary Compressed Volume     |  | X | X | 1.000     | 50.000    | uL      | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.18 |
| 30 | 29 | 29 | Test Dynamic Leak - Primary Maximum Pressure      |  | X | X | 12000.000 | 13000.000 | PSI     | PSC – Note 6<br>FSD 721009394<br>sec. 5.14.19 |
| 31 | 30 | 30 | Test Flow Rate Accuracy 2.0ml/min                 |  | X | X | 1.980     | 2.020     | ml/min  | FSD 721009394<br>sec. 5.14.1                  |
| 32 | 31 | 31 | Test Pressure Ripple                              |  | X | X | 0.000     | 15.000    | PSI     | PSC – Note 3<br>FSD 721009394<br>sec. 5.14.10 |
| 33 | 32 | 32 | Test Flow Rate Accuracy 0.5ml/min                 |  | X | X | 0.495     | 0.505     | ml/min  | FSD 721009394<br>sec. 5.14.1                  |
| 34 | 33 | 33 | Test Static Leak Decay Vent Valve to Filter/Mixer |  | X | X | 1.000     | 250.000   | PSI/min | PSC – Note 7                                  |
| 35 | 34 | 34 | Test High Pressure                                |  | X | X | 9000.000  | 14000.000 | PSI     | PSC – Note 8<br>FSD 721009394<br>sec. 5.3.10  |
| 36 | 35 | 35 | Test Compositional Accuracy – AC90%AU             |  | X | X | 89.500    | 90.500    | %       | FSD 721009394<br>sec. 5.14.3                  |
| 37 | 36 | 36 | Test Compositional Accuracy – BD90%AU             |  | X | X | 89.500    | 90.500    | %       | FSD 721009394<br>sec. 5.14.3                  |
| 38 | 37 | 37 | Test Compositional Accuracy – BD10%AU             |  | X | X | 9.500     | 10.500    | %       | FSD 721009394<br>sec. 5.14.3                  |

|    |    |    |                                       |   |   |   |       |        |   |                                             |
|----|----|----|---------------------------------------|---|---|---|-------|--------|---|---------------------------------------------|
| 39 | 38 | 38 | Test Compositional Accuracy – AC10%AU |   | X | X | 9.500 | 10.500 | % | FSD 721009394<br>sec. 5.14.3                |
| 40 | 39 | 39 | Test Serial Number Re-verification    |   | X | X |       |        |   | PSC – Notes 1 & 2                           |
| 41 | 40 | 40 | Test Fans                             | X | X | X |       |        |   | PSC – Note 3<br>FSD 721009394<br>sec. 5.2.1 |
| 42 | 41 | 41 | Test LEDs                             | X | X | X |       |        |   | PSC – Note 3<br>FSD 721009394<br>sec. 5.2.3 |
|    | 42 | 42 | Acquity QSM Final Test Overall Result |   | X | X |       |        |   |                                             |

### PSC Notes:

1. Pre-test condition.
2. Internal function of instrument firmware.
3. Verify invalidated assembly process.
4. Reference *Seal Wash Testing for QSM Pumps Memo V00.doc* for system test limit calculations.
5. Reference *Prime Pump Testing for QSM Pumps Memo V00.doc* for system test limit calculations.
6. Reference *Dynamic Leak Specs for QSM.doc* for system test limit calculations
7. Reference *VV to Output Testing for QSM Pumps Memo V00.doc* for system test limit calculations
8. Reference *High Pressure Testing for QSM Pumps Memo V00.doc* for system test limit calculations.

## 1. ELECTRICAL SAFETY

The operator is prompted to enter the Electrical Safety Test result.

## 2. LOADER DOWNLOAD

The QSM is powered up. During this time, the serial communications is being monitored. It is then determined what version firmware, if any, is loaded on the QSM. If there is no firmware previously loaded, the test program will load the latest version of firmware. Otherwise it will prompt the operator to continue on testing or reload the latest version.

The “Loader” program is called from the test program to load the firmware via the QSM’s Ethernet port. Once loaded, the QSM is rebooted.

## 3. REBOOT FIRMWARE

The QSM is powered up. During this time, the serial communications is being monitored. It is then determined if the QSM firmware boots up as expected.

## 4. FIRMWARE VERSION

The serial command **version** is sent to the QSM. The pump response is compared against the latest version name located in the file *TestStringsFile.txt*.

## 5. TEST INSTRUMENT TYPE

The serial command **jumpers** is sent to the UUT. The jumper configuration is returned. Electrical jumper number 6 (pins 11 & 12) on J2 of the UUT personality board, is used to tell the firmware the instrument type. No jumper is for the QSM. Added jumper is for the Bio QSM.

## 6. SERIAL NUMBER

The scanned serial number from the Input Information Window is loaded into the QSM via the serial command **setserial serialnumber**. The serial number is then read back out of the QSM via the command **showserial**. The response is then compared back to the scanned serial number. The QSM is then rebooted to clear Alarms associated with the serial number update.

## 7. ALARMS AT BOOTUP

Once the QSM reboots, the serial command **printalarm** is sent to the QSM. Any alarms present will be displayed to the operator and the testing will be halted.

## 8. GRADIENT START INPUT SHORT

The QSM rear panel input pins labeled **Gradient Start** are shorted together. The QSM is then sent the serial command **peek 0x500038**. The expected serial response is **01**.

## 9. GRADIENT START INPUT OPEN

The QSM rear panel input pins labeled **Gradient Start** are left open. The QSM is then sent the serial command **peek 0x500038**. The expected serial response is **00**.

#### 10. STOP FLOW INPUT SHORT

The QSM rear panel input pins labeled **Stop Flow** are shorted together. The QSM is then sent the serial command **peek 0x500038**. The expected serial response is **02**.

#### 11. STOP FLOW INPUT OPEN

The QSM rear panel input pins labeled **Stop Flow** are left open. The QSM is then sent the serial command **peek 0x500038**. The expected serial response is **00**.

#### 12. LEAK DETECT CONNECTED

The QSM front panel Leak Detect input pins 1-2 are connected together with an 82 ohm resistor. This provides a 3.2 vdc input to pin 1 of the Personality board. There is also a 1K ohm resistor from pins 2-3. The QSM is then sent the serial command **peek 0x50003b**. The expected serial response is **02**.

#### 13. LEAK DETECT DISCONNECTED

The QSM front panel Leak Detect input pins 1-2 are left open. There is a 1K ohm resistor from pins 2-3. The QSM is then sent the serial command **peek 0x50003b**. The expected serial response is **00**.

#### 14. LEAK DETECT LEAK

The QSM front panel Leak Detect input pin 3 is shorted to GND. There is also a 1K ohm resistor from pins 2-3. The QSM is then sent the serial command **peek 0x50003b**. The expected serial response is **01**.

#### 15. ALARMS RECHECK

The serial command **printalarm** is sent to the QSM. Any alarms present will be displayed to the operator and the testing will be halted.

#### 16. SEAL WASH PUMP PRIME/FLOW

The serial command **swpprime** is sent to the QSM to start the seal wash pump. The QSM's seal wash pump can be heard running by a clicking sound. The vacuum pump located inside TE82943 is activated. The vacuum pump helps the seal wash pump prime by pulling MeOH through the seal wash line. After enough time has elapsed to draw the MeOH through the system, the test program then switches from Priming to Establishing Flow. The test waits for a period of time to allow the MeOH to be pumped by the seal wash pump through TE82943 and out into the AnD balance. Next, the Flow Rate Testing begins.

The AnD scale is monitored for 2 minutes. Balance readings are taken at the beginning and end of this time. The measured flow rate is then calculated.

## 17.INPUT D PRIME WITH MEOH

The serial command **gpvsetvalve d** is sent to the QSM to activate the QSM's GPV valve D. The serial command **setflow 4 p** is sent to the QSM to start the pump priming MeOH to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals. The priming will run for 210 seconds to allow enough time to draw MeOH through the system. The last 60 seconds of accumulator pressure data readings are collected and averaged to provide a test measurement. Also, a counter is set to count any number of accumulator pressure readings during the last 60 seconds that fall outside of the test limits. Greater than one reading outside the limit range constitutes a failure.

## 18.INPUT C PRIME WITH MEOH

The serial command **gpvsetvalve c** is sent to the QSM to activate the QSM's GPV valve C. The serial command **setflow 4 p** is sent to the QSM to start the pump priming MeOH to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals. The priming will run for 210 seconds to allow enough time to draw MeOH through the system. The last 60 seconds of accumulator pressure data readings are collected and averaged to provide a test measurement. Also, a counter is set to count any number of accumulator pressure readings during the last 60 seconds that fall outside of the test limits. Greater than one reading outside the limit range constitutes a failure.

## 19.INPUT B PRIME WITH MEOH

The serial command **gpvsetvalve b** is sent to the QSM to activate the QSM's GPV valve B. The serial command **setflow 4 p** is sent to the QSM to start the pump priming MeOH to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals. The priming will run for 210 seconds to allow enough time to draw MeOH through the system. The last 60 seconds of accumulator pressure data readings are collected and averaged to provide a test measurement. Also, a counter is set to count any number of accumulator pressure readings during the last 60 seconds that fall outside of the test limits. Greater than one reading outside the limit range constitutes a failure.

## 20.INPUT A PRIME WITH MEOH

The serial command **gpvsetvalve a** is sent to the QSM to activate the QSM's GPV valve A. The serial command **setflow 4 p** is sent to the QSM to start the pump priming MeOH to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals. The priming will run for 210 seconds to allow enough time to draw MeOH through the system. The last 60 seconds of accumulator pressure data readings are collected and averaged to provide a test measurement. Also, a counter is set to count any number of accumulator pressure readings during the last 60 seconds that fall outside of the test limits. Greater than one reading outside the limit range constitutes a failure.

## 21. DEGASSER PRESSURE

The serial command **wdegasserstatus** is sent to the QSM. The QSM's degasser pressure reading is returned in response.

## 22. VALVE CONDITIONING ACTION STEP

This routine is used to run-in the pump seals at pressure. This will allow the valve seals to seat. The file *SealConditioningFile.txt* is used to control this action. Parameters for time, pump flow rate, and restrictor number are stored. The routine will set up the specified restrictor. Then a serial command will send the **setflow x** command, where **x** is the desired flow rate. The pressure is displayed and the routine will run for the specified time. Test Engineering will determine the parameters to use for this action based on seal reliability data. Parameters used at this time are 180 sec., 1.0 ml/min, restrictor 1.

## 23. DYNAMIC LEAK – ACCUMULATOR LEAK RATE

The serial command **leaktest 14000 A 0 0 0 0** is sent to the QSM. This launches a QSM internal test which does the following:

The QSM will fill and empty the Accumulator and Primary cylinders several times to obtain a good solvent intake. The vent valve is set to a mid point state between the vent and system outputs. This closes off the output of the pump. The Accumulator is pressured to 14K PSI. The Accumulator pressure is monitored and the Accumulator motor is stepped 'dynamically' to maintain the set pressure. The Leak Rate is then calculated. Next the Primary is pressured to 12K PSI. The Primary pressure is monitored and the Primary motor is stepped 'dynamically' to maintain the set pressure. The Leak Rate is then calculated.

The results are available for display at the completion of the test.

Consistent failures are an indication of a fitting leak, bad seals, faulty check valve, etc..

Clues to the exact failure can be derived from the data results. Diagnosis information is sometimes given by the internal test. This will be displayed to the operator when available.

## 24. DYNAMIC LEAK – ACCUMULATOR PERCENT OF STROKE

Refer above for test description.

## 25. DYNAMIC LEAK – ACCUMULATOR COMPRESSED VOLUME

Refer above for test description.

## 26. DYNAMIC LEAK – ACCUMULATOR MAXIMUM PRESSURE

Refer above for test description.

## 27. DYNAMIC LEAK – PRIMARY LEAK RATE

Refer above for test description.

## 28. DYNAMIC LEAK – PRIMARY PERCENT OF STROKE

Refer above for test description.

## 29. DYNAMIC LEAK – PRIMARY COMPRESSED VOLUME

Refer above for test description.

## 30. DYNAMIC LEAK – PRIMARY MAXIMUM PRESSURE

Refer above for test description.

## 31. FLOW RATE ACCURACY 2.0ML/MIN

The serial command **setflow 2 n** is sent to the QSM. The output of the pump is routed through a restrictor inside TE82943 which will provide approximately 1000 PSI pressure. The flow is then routed out to the AnD Balance. The pump will run for 90 seconds to initialize the flow to the balance. Then the Flow Rate Testing will begin and run for 60 seconds. Readings are taken from the balance at the beginning and end of this time. The measured flow rate is then calculated.

## 32. FLOW RATE PRESSURE RIPPLE

During the above 2.0ml/min flow rate accuracy testing, the pressure ripple is being recorded. The serial command **getp** is sent to the QSM to retrieve the results.

## 33. FLOW RATE ACCURACY 0.5ML/MIN

The serial command **setflow .5 n** is sent to the QSM. The output of the pump is routed through a restrictor inside TE82943 which will provide approximately 2000 PSI pressure. The flow is then routed out to the AnD Balance. The pump will run for 90 seconds to initialize the flow to the balance. Then the Flow Rate Testing will begin and run for 300 seconds. Readings are taken from the balance at the beginning and end of this time. The measured flow rate is then calculated.

## 34. STATIC LEAK DECAY VENT VALVE TO FILTER/MIXER

The serial command **setflow flowrate** is sent to the QSM. Where *flowrate* is a variable that is dependent on measured pressure. The output of the pump is dead ended inside TE82943. The test begins by ramping the pressure to a set point of 10000 PSI. Once at 10000 PSI, the flow rate is reduced to zero and the pressure allowed to stabilize. The last 60 seconds of this test is used to capture the pressure decay.

Note : This test is intended to test the connections from the vent valve to the filter/mixer. It includes the front connection of TE82943, since the dead end plug is located inside the tester. Any tester leaks, have been attributed to a worn out QSM interface tubing assembly. Replace the interface tubing assembly part number 430001150 if necessary.

## 35. HIGH PRESSURE FLOW

During the compositional accuracy test below, the high pressure test is conducted. The serial command **setflow 1 n** is sent to the QSM. The output of the pump is routed through a restrictor inside TE82943 which will provide approximately 12000 PSI pressure. The flow is then routed out to

the AcQuity TUV and then to waste. The pump will run for 420 seconds and the high pressure reading is verified at the end.

### 36.COMPOSITIONAL ACCURACY – AC90%AU

The compositional accuracy test is designed to verify the ability of the GPV (4 gradient proportioning valves) to operate properly and provide the correct flow. This is accomplished by adding a spiked solution of MeOH to two of the input lines and mixing, or proportioning the spiked solution with the non-spiked MeOH lines and measuring the output composition. An AcQuity TUV detector is used to measure the absorbance of caffeine to provide this function. (Inputs A,B in MeOH ; Inputs C,D in MeOH with caffeine).

The test starts by running a clean MeOH solution through GPV 50%A and 50%B for 420 seconds. This provides a zero reference for the TUV absorbance. The TUV is then sent an autozero. GPV 50%C and 50%D are selected and a spiked solution of MeOH is run for 510 seconds. This provides a full scale reference for the TUV absorbance.

A 90% spike and 10% clean solution will be mixed using GPV 10%A and 90%C and run for 300 seconds.

### 37.COMPOSITIONAL ACCURACY – BD90%AU

Refer above for test description.

A 90% spike and 10% clean solution will be mixed using GPV 10%B and 90%D and run for 220 seconds.

### 38.COMPOSITIONAL ACCURACY – BD10%AU

Refer above for test description.

A 10% spike and 90% clean solution will be mixed using GPV 90%B and 10%D and run for 370 seconds.

### 39.COMPOSITIONAL ACCURACY – AC10%AU

Refer above for test description.

A 10% spike and 90% clean solution will be mixed using GPV 90%A and 10%C and run for 170 seconds.

### 40.SERIAL NUMBER RE-VERIFICATION

The serial number is read back out of the QSM via the command **showserial**. The response is then compared back to the scanned serial number from the beginning of the test.

### 41.FANS

The operator is prompted to verify that both fans are on and blowing outward.

### 42.LEDS

The operator is prompted to verify that the Front Panel Power and Flow LEDs are working properly. The Power LED will be lit Green. Using a serial **poke address** command, the Flow LED will be verified in the Off, Green, and Red states.

#### **VIII. Test Program IPA Prep. Action Descriptions**

The following list describes the actions performed for the IPA preparation before the QSM can ship. During the test program run, this procedure must be completed in order for the QSM to be considered a passing unit. The final test record is generated at the end of this process.

#### **43. PURGE LINE A OF MEOH**

The operator is instructed to pull the A, B and Seal Wash input lines out of the MeOH bottle and to disconnect the output interface tubing from the mixer. Lines C and D are to be pulled out of the MeOH and caffeine bottle and placed into the IPA bottle.

The serial commands **gpvsetvalve a** is sent to the QSM to activate the QSM's GPV valve A. Input line A is selected. The serial command **setflow 4 p** is sent to the QSM to start priming the residual internal MeOH to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals.

The priming will run for 110 seconds to allow enough time to purge the MeOH throughout the system. The operator may observe the transducer pressures dropping to near zero when the last of the MeOH is purged.

#### **44. PURGE LINE B OF MEOH**

The serial commands **gpvsetvalve b** is sent to the QSM to activate the QSM's GPV valve B. Input line B is selected. The serial command **setflow 4 p** is sent to the QSM to start priming the residual internal MeOH to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals.

The priming will run for 110 seconds to allow enough time to purge the MeOH throughout the system. The operator may observe the transducer pressures dropping to near zero when the last of the MeOH is purged.

#### **45. PRIME LINE C WITH IPA**

The serial commands **gpvsetvalve c** is sent to the QSM to activate the QSM's GPV valve C. Input line C is selected. The serial command **setflow 4 p** is sent to the QSM to start priming the IPA to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals.

The priming will run for 120 seconds to allow enough time to prime the IPA throughout the system. The IPA prime also provides the function of flushing any caffeine residue.

#### **46. PRIME LINE D WITH IPA**

The serial commands **gpvsetvalve d** is sent to the QSM to activate the QSM's GPV valve D. Input line D is selected. The serial command **setflow 4 p** is sent to the QSM to start priming the IPA to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals.

The priming will run for 120 seconds to allow enough time to prime the IPA throughout the system. The IPA prime also provides the function of flushing any caffeine residue.

#### 47. FLOW LINE D WITH IPA FOR 45 SEC.

The serial command **setflow 1 n** is sent to the QSM to start flowing the IPA through the vent valve and out the mixer port. The priming will run for 45 seconds to allow enough time to flow the IPA through the output.

#### 48. PURGE LINE C OF IPA

The operator is instructed to pull the C and D input lines out of the IPA bottle.

The serial commands **gpvsetvalve c** is sent to the QSM to activate the QSM's GPV valve C. Input line C is selected. The serial command **setflow 4 p** is sent to the QSM to start priming the IPA to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals.

The priming will run for 100 seconds to allow enough time to purge the IPA throughout the system. The operator may observe the transducer pressures dropping to near zero when the last of the IPA is purged.

#### 49. PURGE LINE D AND SEAL WASH

The serial commands **gpvsetvalve d** is sent to the QSM to activate the QSM's GPV valve D. Input line D is selected. The serial command **setflow 4 p** is sent to the QSM to start priming the IPA to waste. The two pressure transducers are monitored and displayed at approximately 1 second intervals.

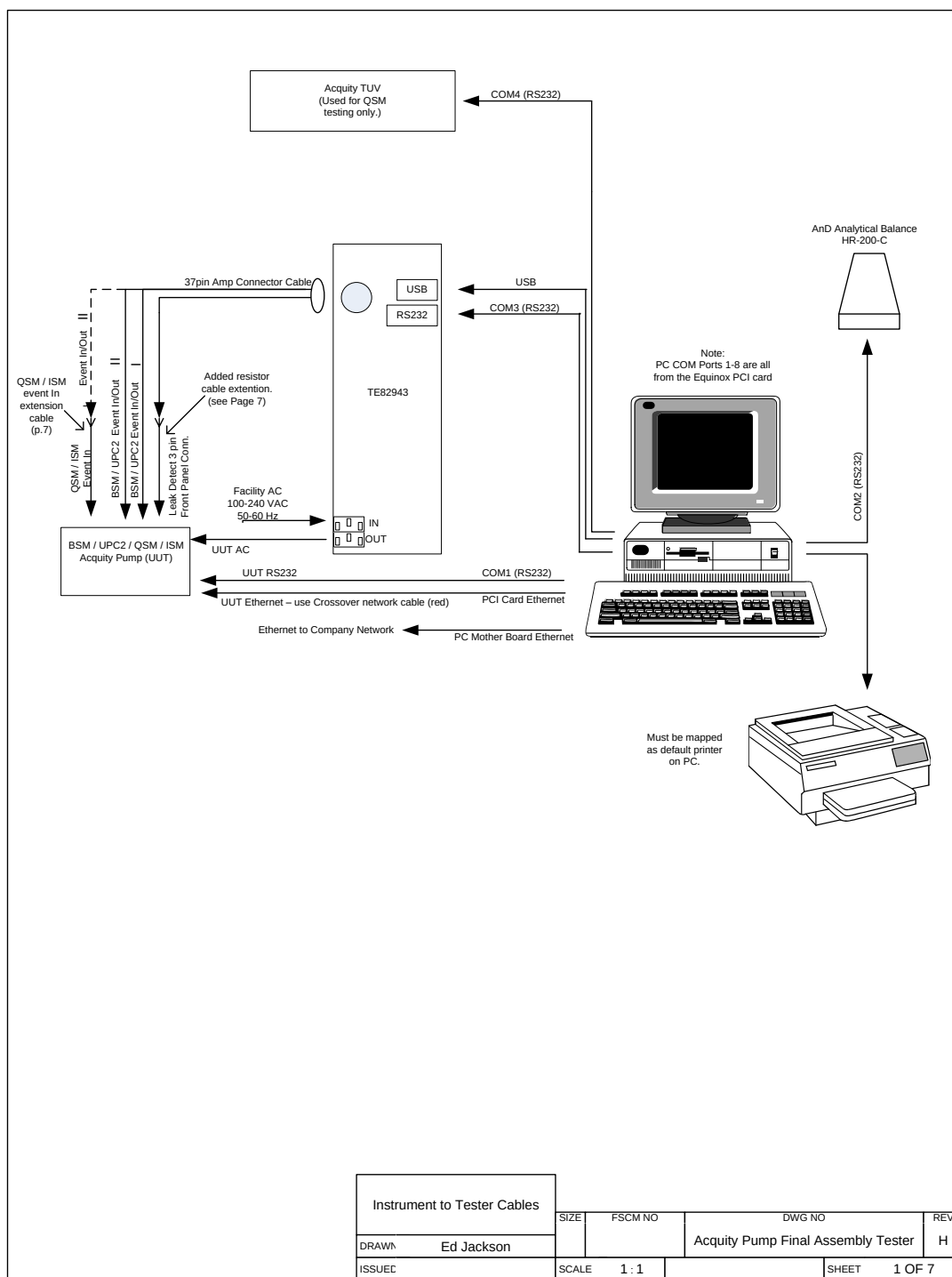
The priming will run for 100 seconds to allow enough time to purge the IPA throughout the system. The operator may observe the transducer pressures dropping to near zero when the last of the IPA is purged. The seal wash pump is activated and the test box vacuum pump is activated to purge the seal wash line during this time.

**186015041 Only Note:** Upon completion, the Operator is prompted to replace all the inlet line SS Filters with the original Ti Filters.

#### 50. MANUAL POWER OFF THE QSM

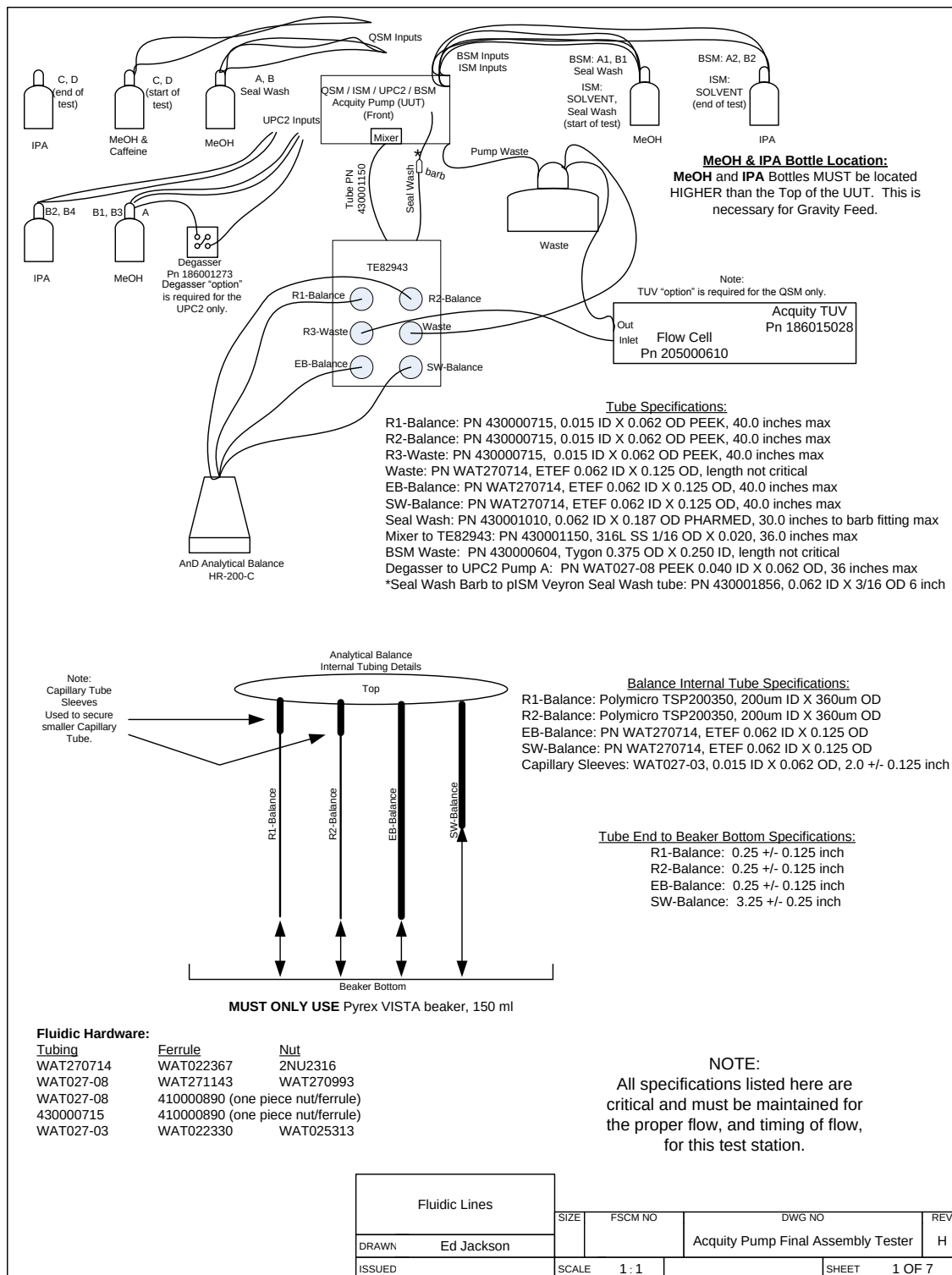
The operator is instructed to press the QSM front panel power switch to power off the UUT. The power state of the QSM is monitored by the test program. The test program will continue to the end of testing when power off is detected.

## IX. Appendix 1



## Electrical Connections

### X. Appendix 2



### Fluidic Connections