Schlumberger

SWTC Flow loop

Operating Manual

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A INTRODUCTION

This operating manual contains the detailed procedures required to operate the SWTC flow loop during routine operations:

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Important notes:

Only trained and certified operators are allowed to run the flow loop. The abovementioned operating instructions may differ in terms of certification level requirement. The operator shall make sure he has got the necessary training certifications before starting a specific instruction.

This document only specifies the step-by-step instructions required for the flow loop operations. It is not meant to explain the detailed process of flow loop testing. A complete description of the SWTC Flow Loop is available in the *SWTC Flow Loop – General Description* **[4]** document.

The maintenance related activities are not captured in this document but specified in the *SWTC Flow Loop – Maintenance Procedures* **[3].**

Personal Protective Equipment (PPE)

PPE must be worn at all times when operating the flow loop.
Minimum PPE requirement: Safety boots, safety helmet, safety hand gloves, face shield/safety glass

B ACCRONYMS AND SYMBOLS

B-1 Acronyms

BMS	Building Management System
DAFC	Data Acquisition Flow Computer
DUT	Device Under Test
GLS	Gas Liquid Separator
MP	Multiphase
OWS	Oil Water Separator
SPG	Single Phase Gas
SPL	Single Phase Liquid

B-2 Symbols

The following symbols are used throughout the document:

◆	Quality	Critical to the quality of the job
✚	Safety	Critical to the safety of personnel and/or equipment
▢	Process Step	Job description
★	Technique	Best method known so far
●	Verify	Ensure that the process step is done correctly

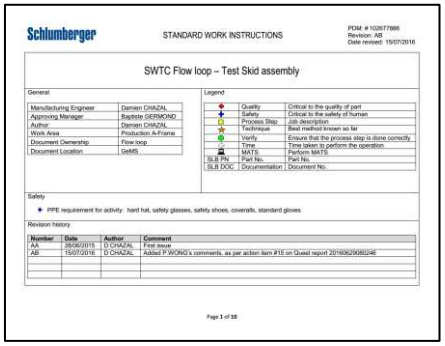
C OPERATING INSTRUCTIONS OVERVIEW

#	Title	Description	Location	Level
1	SKID ASSEMBLY / DISASSEMBLY	This step explains how to assemble a Vx Spectra meter on a standard flow loop skid, from the equipment and tools preparation up to the lifting and tightening operations. It also covers the skid disassembly.	Workshop, Crane area	2
2	SKID RIG-UP / RIG-DOWN	This step describes the connection of a standard test skid to one of the flow loop test stations, including the preparation of the test station, vacuum purging, nitrogen leak testing and DAFC configuration.	Flow loop, Test section	2
3	TEST LINE CONFIGURATION	This step explains how to configure the mixing manifold according to the test requirements (single phase liquid, single phase gas, multiphase, 3" or 6" test line). It also describes how to configure the test stations (isolation and bypass valves) either in parallel or series mode	Flow loop, Test section	2
4	STARTING THE CONTROL SYSTEM	This step explains how to initialize the control system, from the LabVIEW project configuration, operating mode selection and chillers start-up	Flow loop, Control room	2
5	STARTING THE GAS CIRCULATION	This step explains how to start the compressor while keeping the liquid lines closed in order to avoid any liquid back flow in the gas section. Once in running mode, it shows how to enable the control loops individually and start circulating gas.	Flow loop, Control room	1
6	STARTING THE LIQUID CIRCULATION	This step shows how to start the liquid pumps in closed loop (throttling valves closed and bypass valves open). Once in running mode, it shows how to enable the control loops individually and start circulating liquid.	Flow loop, Control room	1
7	SETTING NEW FLOW PERIOD	This step explains how to avoid oscillations and time delay to stabilise the flow in an efficient manner	Flow loop Control room	1
8	LOGGING OF FLOW PERIODS	This step explains how to record a new flow period. It also gives some quality assurance guidelines on the reference measurements consistency.	Flow loop, Control room	1
9	STOPPING THE LIQUID CIRCULATION	This step describes how to stop the liquid pumps while the compressor is still running to avoid any liquid back flow in the gas section.	Flow loop, Control room	1
10	STOPPING THE GAS CIRCULATION	This step explains how to flush the test line and eventually stop the gas compressor.	Flow loop, Control room	1

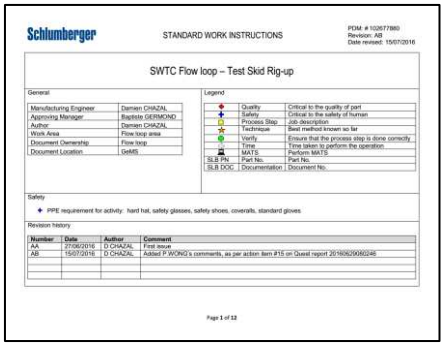
11	STOPPING THE CONTROL SYSTEM	Stopping the control system at the end of a flow loop test requires to check that all pumps are in IDLE state without any unresolved alarms and finally to stop the chillers.	Flow loop, Control room	1
12	RESETTING FROM ESTOP	This step shows the procedure to bring the Flow Loop back to normal state after Estop is pressed	Flow loop Control room, Electrical room	1
13	FILLING THE OIL-WATER SEPARATOR WITH WATER	This step explains how to fill-up the OWS with water. The transfer pump is operated until the desired level of water is reached in the OWS. The operator is supposed to be physically present at the Transfer manifold during the whole operation in order to operate the manual valves. Control and monitoring are done via the wireless tablet	Flow loop, Transfer manifold	3
14	FILLING THE OIL-WATER SEPARATOR WITH OIL	Same procedure as 11 except that the final liquid level is read on the GLS.	Flow loop, Transfer manifold	3
15	VACUUM PURGING OF THE FLOW LOOP	Before being pressurized, the flow loop needs to be vacuum purged. The operator is supposed to be physically present at the vacuum purging manifold during the whole operation. Control and monitoring are done via the wireless tablet.	Flow loop, Vacuum manifold	3
16	PRESSURIZING THE FLOW LOOP	This step describes how to pressurize the flow loop using the gas supply manifold and the Nitrogen pallets. Monitoring is done from the wireless tablet.	Flow loop, Gas manifold	3
17	DEPRESSURIZING THE FLOW LOOP	This step explains how to depressurize the flow loop by operating the vent valves on the vacuum purging manifold.	Flow loop, Vacuum manifold	3
18	DRAINING THE OIL PHASE OF THE OWS	This step describes how to transfer oil from the flow loop to one of the storage tanks. Only manual operations are involved except when the flow loop is not pressurized which implies running the oil pump. This operation shall be performed locally at the Transfer manifold with a continuous monitoring of the tanks levels from the tablet.	Flow loop, Transfer manifold	3
19	DRAINING THE WATER PHASE OF THE OWS	This activity is similar to 16 except that the water pump is eventually operated.	Flow loop, Transfer manifold	3

20	UNLOADING OF A TANKER TRUCK INTO A STORAGE TANK	Once the transfer manifold is configured, the transfer pump is started until the tank is filled or the truck empty. This operation shall be performed locally on the transfer manifold with a continuous monitoring of the tanks levels on the tablet.	Flow loop, Transfer manifold	3
21	DRAINING A STORAGE TANK INTO ATANKER TRUCK	Similar operation to 18 except that the content of a storage tank is transferred into a tanker truck for disposal	Flow loop, Transfer manifold	3
22	TRANSFERRING FROM ONE STORAGE TANK TO THE OTHER	The transfer manifold is configured in such a way that the outlet of the source tank is routed to the inlet of the destination tank. This operation shall be performed locally on the transfer manifold with a continuous monitoring of the tanks levels on the tablet	Flow loop, Transfer manifold	3

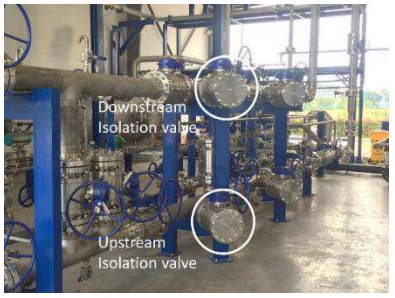
1 SKID ASSEMBLY / DISASSEMBLY

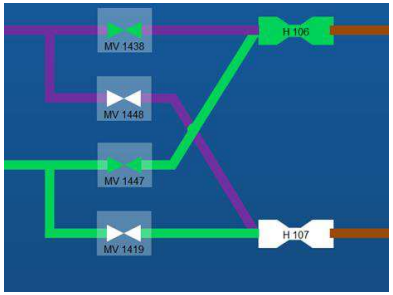
	Location: Workshop, crane area	Operator level: 2	Time required: 50 min
1.	☐ **Refer to the Skid assembly SWI [1].**		

2 SKID RIG-UP / RIG-DOWN

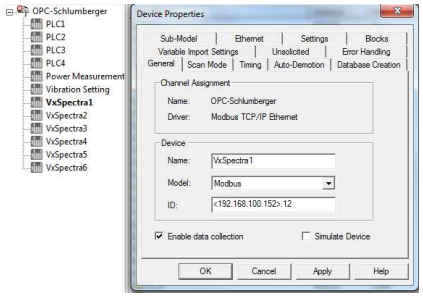
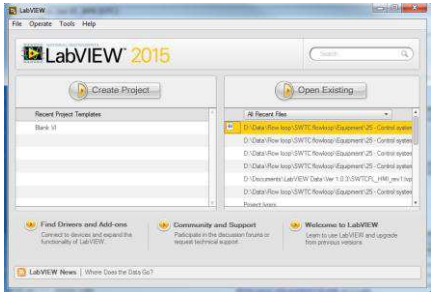
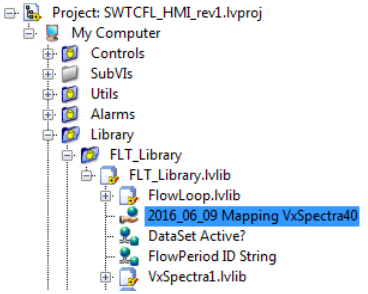
	Location: Flow loop, Test section	Operator level: 2	Time required: 135 min
1.	☐ **Refer to the Skid rig-up SWI [2].**		

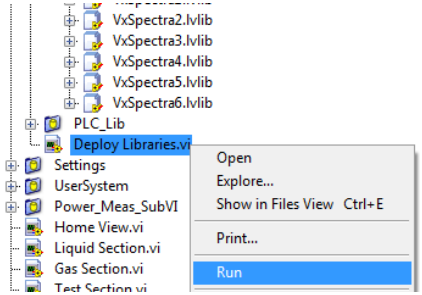
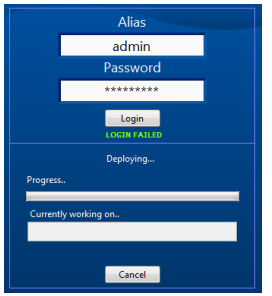
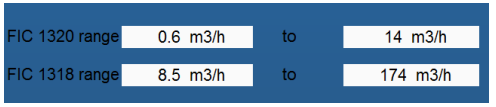
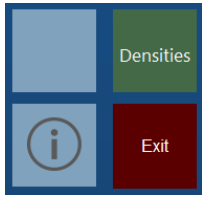
3 TEST LINE CONFIGURATION

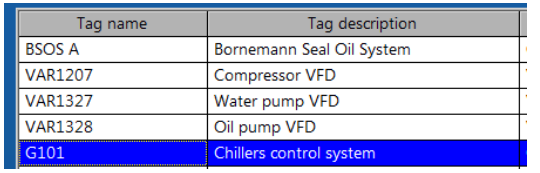
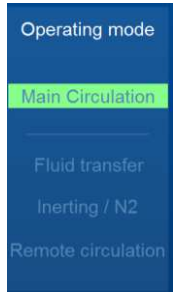
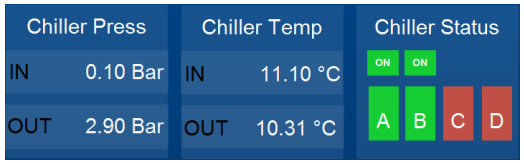
	Location: Flow loop, Test section	Operator level: 2	Time required: 30 min
1.	✚ Make sure that the test skid is pressurized up to the flow loop line pressure by looking at the pressure gauge mounted on the access port. The pressure difference shall not exceed 3bar ✚ Make sure that all pumps are in IDLE and that the start/stop key is off on the operator console		
2.	☐ **Close the upstream and downstream bypass valves of the selected test station:** (If planning for a test in series, the downstream bypass valve shall remain open) - Test station FM 1.1: MV 1410 and MV 1415 - Test station FM 1.2: MV 1404 and MV 1416 - Test station FM 1.3: MV 1450 (no downstream bypass) - Test station FM 2.1: MV 1425 and MV 1433 - Test station FM 2.2: MV 1429 and MV 1420 - Test station FM 2.3: MV 1422 (no downstream bypass)		
3.	☐ **Open the upstream and downstream isolation valves of the selected test station** (Note that the downstream isolation valve depends on the test configuration, either series or parallel) - Test station FM 1.1: MV 1409 and MV 1407 (or MV 1417 if mounted in series) - Test station FM 1.2: MV 1403 and MV 1401 (or MV 1449 if mounted in series) - Test station FM 1.3: MV 1418 and MV 1451 - Test station FM 2.1: MV 1424 and MV 1427 (or MV 1432 if mounted in series) - Test station FM 2.2: MV 1428 and MV 1431 (or MV 1435 if mounted in series) - Test station FM 2.3: MV 1434 and MV 1421		

4.	☐ **Configure the mixing manifold in SPG, SPL or MP on the 3” or 6” line:** - SPL 3”: Open MV 1438, close MV 1448 / MV 1419 / MV 1447 - SPG 3”: Open MV 1447, close MV 1438 / MV 1419 / MV 1448 - MP 3”: Open MV 1438 / MV 1447, close MV 1448 / MV 1419 - SPL 6”: Open MV 1448, close MV 1438 / MV 1419 / MV 1447 - SPG 6”: Open MV 1419, close MV 1438 / MV 1447 / MV 1448 - MP 6”: Open MV 1448 / MV 1419, close MV 1438 / MV 1447 ☆ The pumps will only start in one of these modes. If the test requires the use of the Venturi ejectors H106 and H107, the injection valves must be configured separately, once the pumps are running ● Check that all the valves are open on the flow path and the other valves closed	
5.	☐ **Lock-out all the test station valves** ☐ **Update the valves status on the control room white board**	
6.	● Check the configuration of the mixing manifold by looking at the status of the mixing manifold valves on the Test Section view	

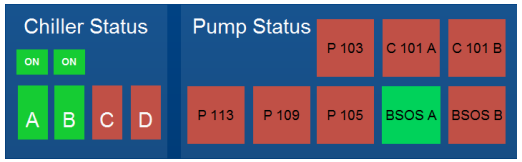
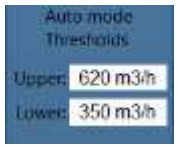
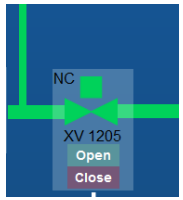
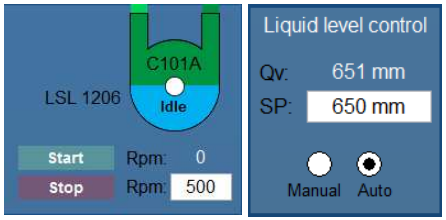
4 STARTING THE CONTROL SYSTEM

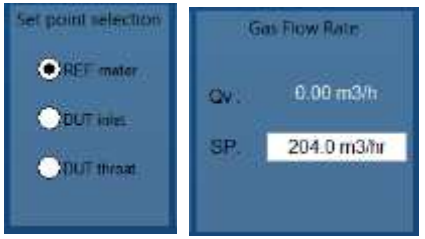
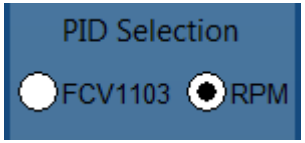
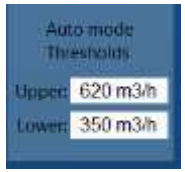
	Location: Flow loop, Control room — Operator level: 1	Time required: 15 min
1.	☐ **Open the NI OPC Servers** ☐ **Under the "General" tab,** ☐ Change the Vx Spectra meters IP addresses as per the addresses configured in their DAFCs ☐ Enable "Data collection" ☐ Disable "Simulate Device" ★ Unused Vx Spectra meters shall be set to "Simulate Device" to avoid communication failures	
2.	☐ **Start LabVIEW by clicking on 'Start > LabVIEW 2015 (32-bit)'** ☐ **Open the latest version of the 'SWTCFL_HMI_rev1' project** ★ All software revisions are tracked in the "*SWTC Flow loop software – Version control*" Quest report (20160607100133)	
3.	☐ **Expand the 'Library folder'** ☐ **Expand the 'FLT_Library' subfolder** ☐ **Expand the 'FLT_Library.lvlib' library** ☐ **Enter a new name for the "Data Set Marking I/O Server" by pressing F2** ★ Follow the Naming convention: "yyyy_mm_dd" "test description" "meter size"	

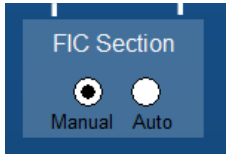
4.	☐ **Launch the "Deploy Libraries.vi" under the 'Library' sub-folder**	
5.	☐ **Enter your credentials** ☐ **Click on Login** ☐ **Wait for the shared variables deployment to be completed** ★ Deploying the shared variables can take around 1-2 minutes	
6.	◆ Verify that the correct Flow ranges have been entered in the "Gas - FIC selection", "Oil - FIC selection" and "Water - FIC selection" sub-processes under the settings panel. (Ask an Admin user to confirm if not allowed to access the settings panel) ★ The flow meters ranges are available in the *"SWTC Flow Loop – Reference Measurement and Calculations document"* **[5]**	
7.	◆ Verify that the correct sample densities and temperatures have been entered in the "Densities" panel accessible from the Home view.	

8.	☐ **Click on the "Settings panel" and on "G101" under the Equipment tab** ● Verify that the chillers BMS is ON ● Check that a 10°C set point has been entered for the chilled water temperature	
9.	☐ **Switch on the Start/Stop key on the local console** ● Verify that the ON light turns on ● Verify that the FAULT light is off ☐ **In case of fault, identify the issue by looking at the alarms summary** ☐ **Once the issue is resolved, press the ACKNOWLEDGE button**	
10.	☐ **Select the "Main Circulation" mode on the Home view** ● Verify that the controller has switched to the "Main circulation" mode. It should be highlighted with light green	
11.	☐ **Start the chillers G101A and G101B by clicking on their respective ON/OFF button** ★ Running 1 chiller only may be sufficient for low flow and low dP tests. ● Check that the status of the chillers turns green ★ The chillers periodically switch-off once the chilled water temperature has reached the set point. ★ Once running, the chilled water pressure (OUT) will naturally increase by a few bar	

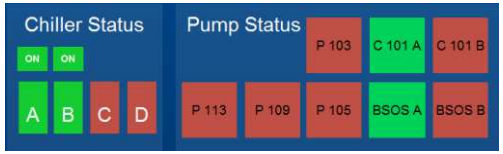
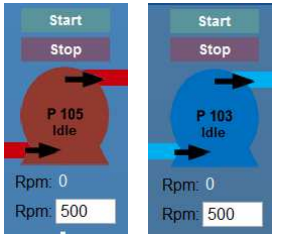
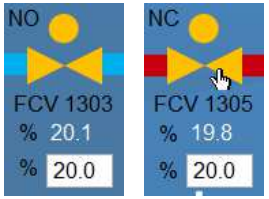
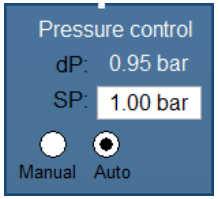
5 STARTING THE GAS CIRCULATION

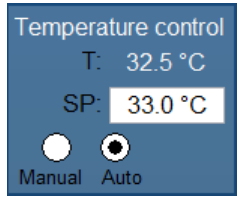
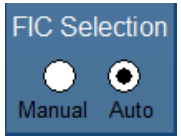
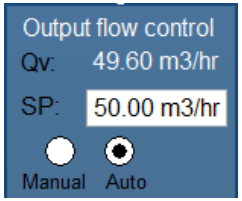
	Location: Flow loop, Control room **Operator level: 1**	**Time required: 10 min**
1.	◆ One gas compressor shall always be started first when in MP mode ◆ Check that the chiller(s) status is ON ◆ The flow loop shall be set in “Main circulation mode” ◆ Verify that there are no unresolved alarms in the alarms summary table ◆ Check that the compressors are in IDLE state ◆ Check Auto Mode Threshold limits are set at 350 m3/hr and 620 m3/hr for lower value and higher value respectively.	 
2.	◆ Check that the large flow line selection valve (XV 1205) is open on the “Gas section view”	
3.	■ **Start the C101A or C101B gas compressor by clicking on the ‘Start’ button** ★ The compressor start up sequence lasts about 1 minute ● Verify that the compressor enters the RUN state ● Verify that the ‘Liquid level’ control block is in AUTO and that its SP is within 300 to 700mm ★ The ‘Liquid level’ controller is enabled by default and should never be disabled except for troubleshooting or maintenance by Level 3 & 4 operators.	

4.	☐ **Select the location where the gas output flow shall be calculated** (“REF meter”, “DUT inlet” or “DUT throat”) ◆ Do not select “DUT inlet” or “DUT throat” when there are no Vx Spectra connected to the flow loop since the DUT line pressure will not be available ☐ **Enter the gas output flow set point** ★ It is recommended to increase gradually the gas output flow by 50m3/h increments	
5.	☐ **Enable the bypass valve controller (left) or pump speed controller (right) by selecting ‘AUTO’** ★ The bypass valve controller shall be used for low to moderate flow rates (5 to 150 m3/h) ★ The pump speed controller shall be used for moderate to high flow rates (150 m3/h and above)	
6.	☐ **If gas flow SP is more than Upper threshold, second compressor will start automatically in Auto Mode and if SP is less than lower threshold, second compressor will stop** ◆ Make sure XV1205 is Open to prevent pressure build up on gas line	
7.	☐ **Semi Auto mode can be selected if automatic starting stopping of compressor is not required** ★ Both compressors keep running in semi auto with Main Compressor running at manually entered RPM and other compressor controlled by PID ★ FCV1103 needs to be controlled manually to achieve SP flowrate	

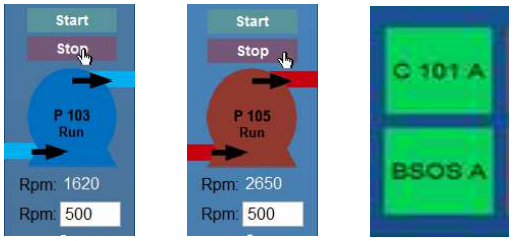
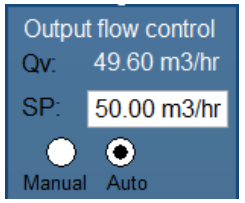
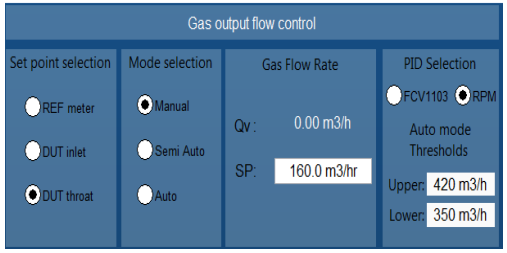
8.	☐ **(OPTIONAL) Turn on the FIC selection mode by pressing AUTO**	
9.	● Verify that the output flow rate stabilizes close to the set point within a +/- 1% interval ● Make sure that the correct reference flow meter size is selected by cross-checking with the reference meters flow ranges	
10.	● Check that there is a stable flow rate on the liquid recirculation line by looking at the FIC 1201 measurement. The liquid recirculation flow rate shall be of at least: - 2-3 m3/h at low speeds (<600 RPM) - 8-18 m3/h at high speeds (>600RPM) ☐ **If not, reduce the liquid level set point in the scrubber until a minimum flow is established**	

6 STARTING THE LIQUID CIRCULATION

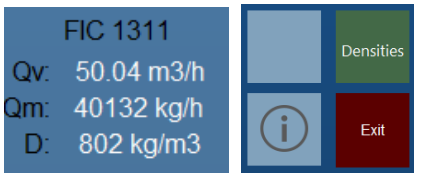
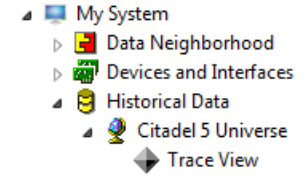
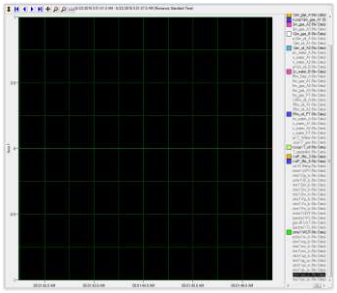
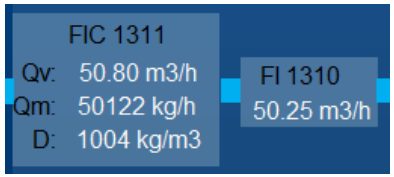
	Location: Flow loop, Control room **Operator level: 1**	**Time required: 10 min**
1.	◆ Verify that the compressor status is ON if planning for a MP test. The liquid pumps will not start otherwise ◆ Check that the chiller(s) status is ON ◆ The flow loop shall be configured in “Main circulation mode” ◆ Verify that there are no active alarms in the alarms summary table and that the selected pump (P105 or P103) is in IDLE state	
2.	☐ **Start the oil (P105) or water (P103) pump by pressing the ‘Start’ button** ★ The pumps start up sequence lasts for about 1 minute ● Verify that the selected pump enters the RUN state	
3.	☐ **Set a 20% opening on the bypass control valves (FCV 1303 or FCV 1305)** ● Verify that the selected by-pass valve opens to 20% (+/- 1%) by looking at the position feedback	
4.	☐ **Set the set point to 1 bar in the “Discharge Pressure” control block** ☐ **Turn on the discharge pressure control loop by selecting ”AUTO”** ● Wait for the discharge pressure of the pump to reach a 1 bar pressure difference ★ The dP set point may need to be increased further if the required flow rate is not achieved. ★ For SPL3 or SPL6 tests (single phase liquid), the discharge pressure control shall be set to Manual and the speed adjusted manually to meet the required flow rate.	

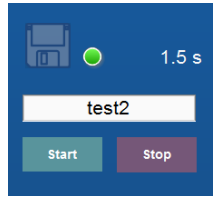
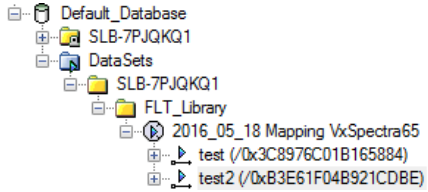
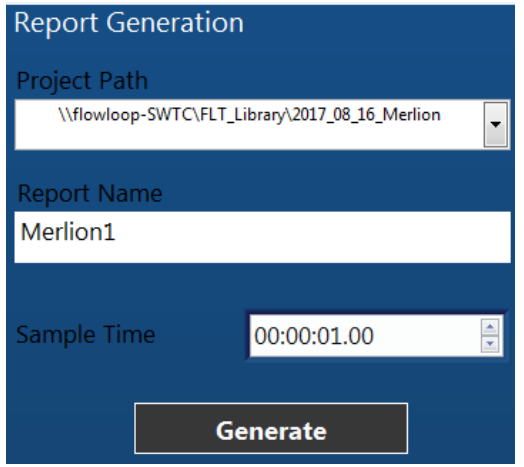
5.	☐ **Enter 33°C in the "Temperature" control block** ☐ **Turn on the discharge temperature control loop by selecting "AUTO"** ★ The oil and water temperatures vary slowly. As soon as they are within a +/- 3°C difference, the test can start	
6.	☐ **(OPTIONAL) Turn on the "FIC – selection" control block by selecting "AUTO"**	
7.	☐ **Enter the desired flow rate as a set point in the "Output flow" control block** ☐ **Turn on the "Output flow" control block by pressing "AUTO"** ● Verify that the output flow rate stabilizes close to the set point within a +/- 1% interval ● Make sure that the correct reference flow meter is selected by cross-checking with the reference meters flow ranges	

7 SETTING NEW FLOW PERIODS (MP MODE)

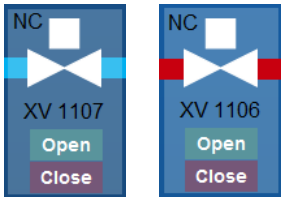
	Location: Flow loop, Control room **Operator level: 1**	**Time required: 10 min**
1.	◆ The gas compressor is RUNNING ◆ Any one of the liquid pumps is RUNNING	
2.	■ **Configure the flow rate of the liquid lines first (Oil or Water) as mentioned in Section 6: Steps 3 -7** ● Verify the liquid flow rate is stable ★ It has been noticed that there are more chances of the system to go into oscillations and takes more time to stabilise if we configure the 'Gas Line' first	
3.	■ **Configure the flow rate of the Gas as mentioned in Section 5: Steps 4 -8** ● Verify the gas flow rate is stable ★ It has been noticed that there are more chances of the system to go into oscillations and takes more time to stabilise if we configure the 'Gas Line' before liquid lines.	

8 LOGGING OF FLOW PERIODS

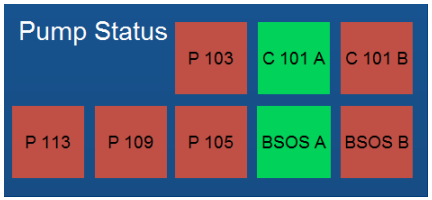
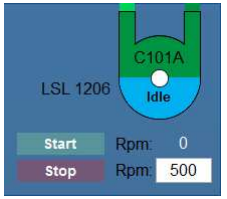
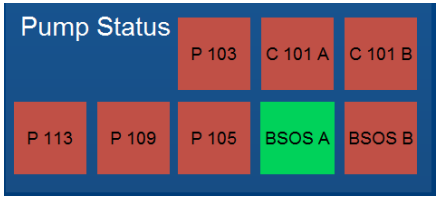
	Location: Flow loop, Control room — Operator level: 1	Time required: 15 min
1.	◆ Verify that the oil and water densities measured by the Coriolis flow meters (FIC 1311 / FIC 1313 for water and FIC 1318 / FIC 1320 for oil) are stable and close to their expected values within a +/2 kg/m3 interval ★ The expected densities can be verified in the "densities" panel, accessible from the Home view.	
2.	☐ **Open the Historical Data Viewer by clicking on 'Start > NI MAX'** ☐ Click on 'Historical Data' ☐ Select 'Citadel 5 Universe' ☐ Click any of the pre-defined Trace views to look at the trends	
3.	◆ <u>Stability checks:</u> - Check that the **Flow loop** oil, water and gas mass flow rates are stable by looking at their trends - Check that the **Vx Spectra** DP is stable - Check that the **Vx Spectra** oil, water and gas mass flow rates are stable by looking at their trends ★ There may be some delay between the flow loop and Vx Spectra flow rates due to transit times	
4.	◆ <u>Consistency checks:</u> - Check that the measured **densities** match with the calculated densities - Check that the **gas mass flow rates** match between the primary and secondary flow meters - Check that the **liquid volume flow rates** match between the primary and secondary flow meters Refer to the *SWTC Flow loop – Reference Measurements and Calculations* **[5]** document for more detailed information about the quality assurance indicators.	

5.	☐ **Enter the Flow period name in the Home view text box** ☐ Click on the "start" button to start logging data ● Check that the logging status light toggles and that the timer starts incrementing	
6.	☐ **On the Historian, explore the datasets created under the current job** ● Check that the dataset corresponding to the last flow period has been created in the Historian ★ It may take a few seconds for the last dataset to appear in the dataset list	
7.	☐ **At the end of the test, All the flow periods can be exported by using Report Generation utility on Test Record Page:** 1. Selecting the Project Path 2. Giving Name to the folder where files need to saved 3. Press Generate (Keep the sample time at 1 second) ★ It is recommended to check the consistency of the flow period data before exporting it (no outliers, no data loss)	

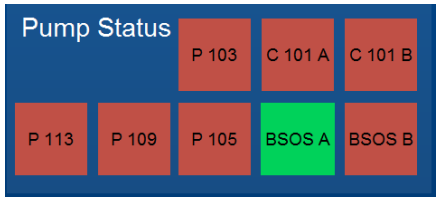
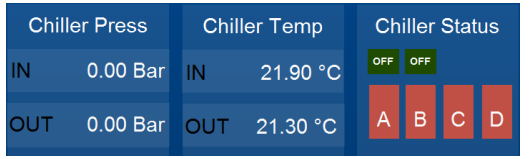
9 STOPPING THE LIQUID CIRCULATION

	Location: Flow loop, Control room — Operator level: 1	Time required: 5 min
1.	**Click on the "stop" button to stop the liquid pump** ★ The oil and water pumps can be stopped simultaneously ★ It is recommended to gradually reduce the output flow rate of the pump down to 10m3/h before starting the stop sequence to avoid abrupt flow and discharge pressure variations ★ The pumps stop sequence lasts for about 30s	
2.	Check that the pumps are in IDLE mode Check that they are no active alarms Check that the ESD valves (XV 1106 and XV 1107) are closed	

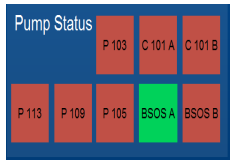
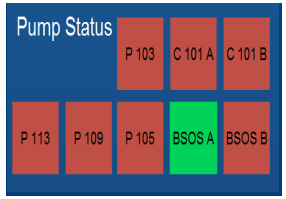
10 STOPPING THE GAS CIRCULATION

	Location: Flow loop, Control room — Operator level: 1	Time required: 20 min
1.	◆ Check that the liquid pumps are IDLE. Otherwise the compressor will not stop	
2.	☐ **Keep running the gas compressor at a moderate flow rate for 5 minutes to flush the test lines** ● Verify that the liquid level in the Scrubber is still stable around set point (from 300mm to 600mm) ● Verify that the test line is dry by looking through the sight flow (both 3” and 6”) ★ The pipes (especially when using the corrugated flexible hoses) will generate a whistling noise when reaching a nearly dry gas.	
3.	☐ **Click on the “stop” button to start the stop sequence** ★ It is recommended to gradually reduce the output flow rate of the compressor down to 150m3/h before starting the stop sequence to avoid abrupt flow and discharge pressure variations ★ The compressor stop sequence lasts for about 1 min	
4.	● Check that the compressor is in IDLE mode ● Check that they are no active alarms	

11 STOPPING THE CONTROL SYSTEM

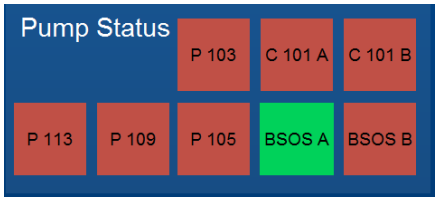
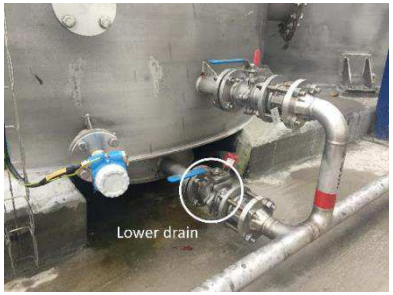
	Location: Flow loop, Control room — Operator level: 1	Time required: 5 min
1.	◆ Verify that all pumps (P113, P109, P103, P105 and C101A) are OFF ◆ The Seal oil system (BSOS) remains ON even if the compressor is OFF	
2.	✚ **Stop the chiller(s) G101/A and G101/B by clicking on their ON/OFF buttons** ★ The chillers can take around 1 min to switch off ● Check that the chillers status turn to red	
3.	■ **Switch OFF the Start/Stop key on the local console** ● Verify that the ON light turns off ● Verify that the FAULT light is off ■ **In case of fault, identify the issue by looking at the alarms summary** ■ **Once the issue is resolved, press the ACKNOWLEDGE button**	

12 RESETTING FROM E-STOP

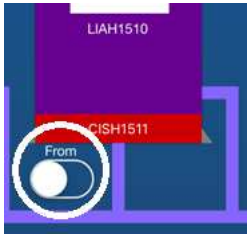
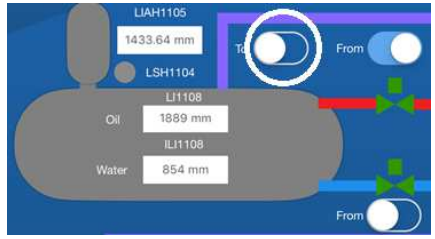
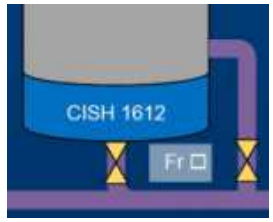
	Location: Flow loop Control room and Electrical Room	Operator level: 1	Time required: 10 min
1.	◆ Verify that all pumps (P113, P109, P103, P105 and C101A) are OFF ◆ The Seal oil system (BSOS) remains ON even if the compressor is OFF ◆ The Fault indicator on the local console is ON ◆ The Alarm screen on the monitor shows Estop Alarm		 
2.	✚ **Check and rectify the issue for which Estop was pressed** ● Make sure the system is safe to run again		
3.	☐ **Reset the Estop by unlatching the button which was pressed** ◆ Verify the VFD's are still in Estop and Reset LED is ON ☐ **Press Estop on the VFD in electrical room and unlatch just after that**		 
4.	☐ **Press Reset on the VFD Panel** ◆ Verify there is no alarm on the VFD ☐ **Reset the VFD Panel if there is any alarm** ☐ **Do the same for the other VFD Panels**		 

5.	☐ **Acknowledge and Reset the alarm on the BSOS Panel in Electrical Room** ◆ Make sure the fault goes away when Reset is pressed on the BSOS Screen ☐ **Press the reset button on the cabinet** ◆ Make sure the BSOS screen shows no fault and Open Loop shows Standby (Green)	
6.	☐ **Go in the control room and press the Acknowledge button on the local console** ● Verify the alarm on the SCADA are reset (Closed) by acknowledging the Alarms from the Alarm screen ● Verify the Fault LED on local console is OFF	

13 FILLING THE OWS WITH WATER

	Location: Flow loop, Transfer manifold Operator level: 3	Time required: 120 min
1.	◆ This operation requires that all pumps and compressors be in IDLE state ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Fluid transfer" on the desktop Home view** ● Verify that the control system has switched to the "Fluid Transfer" mode. It should be highlighted with light green	
3.	☐ **Remove the pad lock and open the lower drain on the water storage tank (D111, D112 or D113)** - **D111**: open MV 1512 - **D112**: open MV 1514 - **D113**: open MV 1614 ◆ Check that all the drain valves are closed on the other tanks	

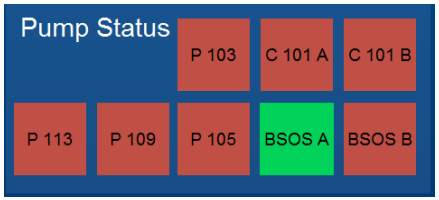
4.	☐ **Open the transfer pump suction valves (MV 1632 and MV 1635)**	
5.	☐ **Open the Liquid export valve on the transfer manifold (MV 1607)** ☐ Check that all the other valves are closed on the transfer manifold	
6.	☐ **Open the "Fluid transfer" panel on the tablet**	

7.	☐ **Select the drain on the water storage tank as the source tank by clicking on "FROM"** ◆ Check the liquid level on the source tank	
8.	☐ **Select the liquid inlet on the OWS as the destination tank by clicking on "TO"** ◆ Check the liquid level on the OWS	
9.	◆ Check that the bottom of the water tank is BLUE.	
10.	☐ **Start the transfer pump (P109) by pressing the "START" button** ◆ Verify that the discharge valve (XV 1602) opens before the pump starts	

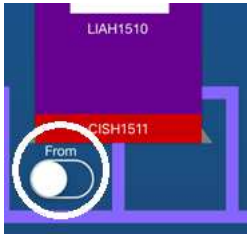
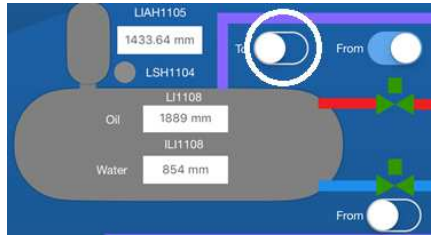
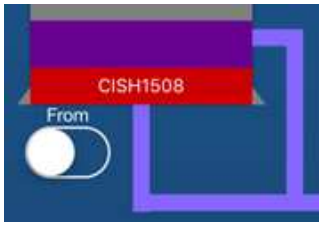
11.	◆ Check that there is a continuous flow of liquid by looking at the sight glass (FG 1602) ◆ Monitor the pump temperature (TISH 1617) ◆ Monitor the water tank level - **D111**: LIAH 1507 - **D112**: LIAH 1511 - **D113**: LIAH 1611 ◆ Monitor the OWS level (LI 1108)	
12.	■ **Stop the transfer pump (P109) once the desired level is reached in the OWS** ● Verify that the discharge on-off valve (XV 1602) closes right after the pump stops ★ Filling the OWS up to 50% with water takes around 2 hours	
13.	■ **Close the Liquid export valve on the transfer manifold (MV 1607)**	

14.	☐ **Close the transfer pump suction valves (MV 1632 and MV 1635)**	
15.	☐ **Close the lower drain on the water storage tank (D111, D112 or D113)** - **D111**: close MV 1512 - **D112**: close MV 1514 - **D113**: close MV 1614 ✚ Lock-out the valve	

14 FILLING THE OWS WITH OIL

	Location: Flow loop, Transfer manifold — Operator level: 3	Time required: 120 min
1.	◆ This operation requires that all pumps and compressors be stopped ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Fluid transfer" on the desktop Home view** ● Verify that the control system has switched to the "Fluid Transfer" mode. It should be highlighted with light green	
3.	☐ **Open the upper drain on the oil storage tank (D111, D112 or D113)** - **D111**: open MV 1511 - **D112**: open MV 1513 - **D113**: open MV 1613 ◆ Check that the drain valves are closed on the other tanks	

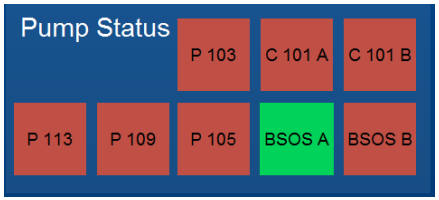
4.	☐ **Open the transfer pump suction valves (MV 1632 and MV 1635)**	
5.	☐ **Open the Liquid export valve on the transfer manifold (MV 1607)** ☐ Check that all the other valves are closed on the transfer manifold	
6.	☐ **Open the "Fluid transfer" panel on the tablet**	

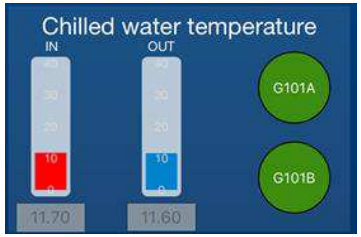
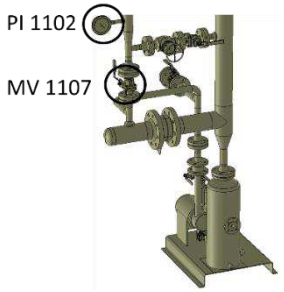
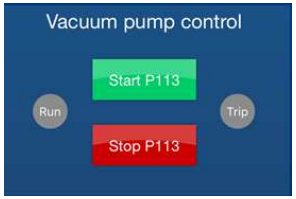
7.	☐ **Select the drain on the oil storage tank as the source tank by clicking on "FROM"** ◆ Check the liquid level on the oil tank	
8.	☐ **Select the liquid inlet on the OWS as the destination tank by clicking on "TO"** ◆ Check the liquid level on the destination tank	
9.	◆ Check that the bottom of the oil storage tank is RED. **If not,** ☐ Close the upper drain and open the lower drain on the same tank. ☐ Proceed with activity 22 (TRANSFERRING FROM ONE STORAGE TANK TO THE OTHER) to dispose the residual water phase in the waste tank until the oil/water interface indicator becomes RED ☐ Continue with step 9	
10.	☐ **Start the transfer pump (P109) by pressing the "START" button** ◆ Verify that the discharge valve (XV 1602) opens before the pump starts	

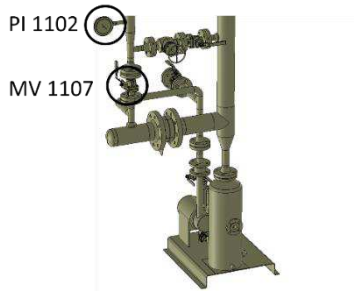
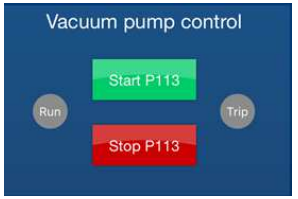
11.	◆ Check that there is a continuous flow of liquid by looking at the sight glass (FG 1602) ◆ Monitor the pump temperature (TISH 1617) ● Monitor the oil tank level - **D111**: LIAH 1507 - **D112**: LIAH 1511 - **D113**: LIAH 1611 ● Monitor the OWS level (LI 1108) first, then the GLS level (LIAH 1105) once the OWS is full	
12.	■ **Stop the transfer pump (P109) once the desired level is reached in the GLS (LIAH 1105)** ● Verify that the discharge on-off valve (XV 1602) closes right after the pump stops ★ Filling the OWS completely with oil up to 25% of the GLS level takes around 2 hours	
13.	■ **Close the Liquid export valve on the transfer manifold (MV 1607)**	

14.	☐ **Close the transfer pump suction valves (MV 1632 and MV 1635)**	
15.	☐ **Close the upper drain on the oil storage tank (D111, D112 or D113)** - **D111**: close MV 1511 - **D112**: close MV 1513 - **D113**: close MV 1613 ✚ Lock-out the valve	

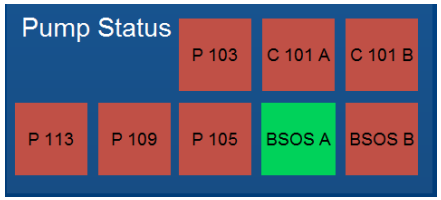
15 VACUUM PURGING THE FLOW LOOP

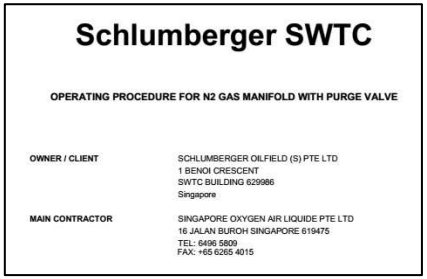
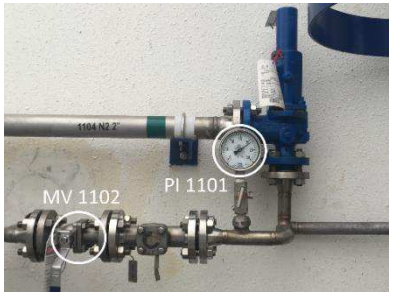
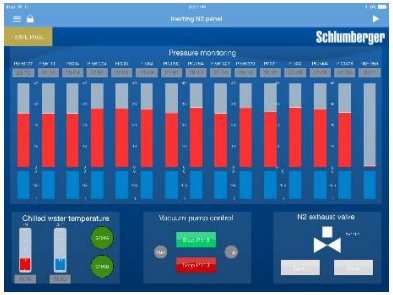
	Location: Flow loop, Vacuum manifold Operator level: 3	Time required: 60 min
1.	◆ This operation requires that all pumps and compressors be stopped ◆ There should be no active alarms on the alarm table ◆ **The flow loop shall be fully depressurized**	
2.	☐ **Set the operating mode to "Inerting / N2" on the desktop Home view** ● Verify that the controller has switched to the "Inerting / N2" mode. It should be highlighted with light green	
3.	☐ **Open the 'N2/Inerting' screen on the tablet**	

4.	◆ Check on the tablet that at least one of the chillers is ON ◆ Check that the chilled water temperature is close to 10 degC ★ Running 1 chiller produces enough cooling power for the vacuum pump operation	
5.	◆ Check that the water level in the vacuum pump separator is high. **If not,** ☐ **Refill the vacuum pump separator with fresh water** ✚ Running the vacuum pump dry can damage it	
6.	◆ Check that the pressure gauge (PI 1102) located above the vacuum pump shows 0 barg ☐ **Open the vacuum pump isolation valve (MV 1107)** ✚ **Opening the vacuum pump when the flow loop is not completely depressurized can burst the rupture disc PSE 1107 and cause a major pressure hazard.**	
7.	☐ **Start the vacuum pump (P113) by clicking on "Start P113" from the tablet**	

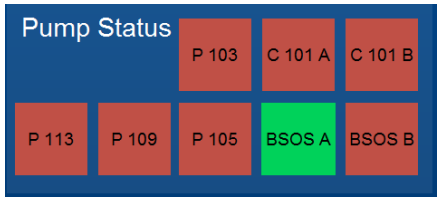
8.	● Verify that the pressure reduces in every section of the flow loop by looking at the pressure gauges readings on the tablet ★ Vacuum purging the whole loop can take up to 1 hour	
9.	■ **Close the vacuum pump isolation valve (MV 1107) when all the pressure gauges reach a negative pressure of about -900 mbarg** ★ The vacuum pressure is limited by the vapour pressure of water, which itself depends on the water temperature.	
10.	■ **Stop the vacuum pump (P113) by clicking on "Stop P113" from the tablet**	
11.	● Verify that the pressure measurements are stable over at least 15 minutes ★ Vacuum purging can serve as a preliminary leak test	

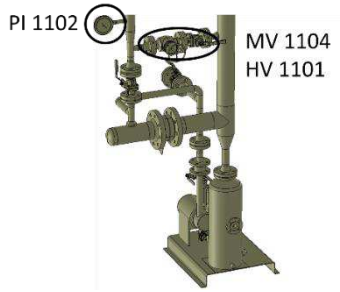
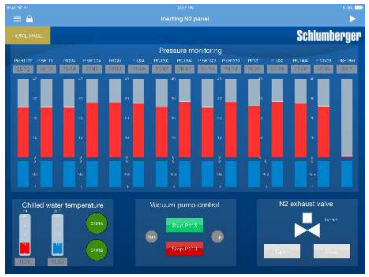
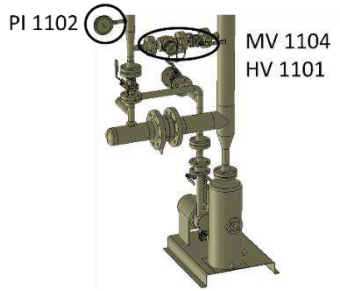
16 PRESSURIZING THE FLOW LOOP

	Location: Flow loop, Gas supply manifold Operator level: 3	Time required: 300 min
1.	◆ This operation requires that all pumps and compressors be stopped ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Inerting / N2" on the desktop Home view** ● Verify that the controller has switched to the "Inerting / N2" mode. It should be highlighted with light green	
3.	◆ **Open the 'N2/Inerting' screen on the tablet**	

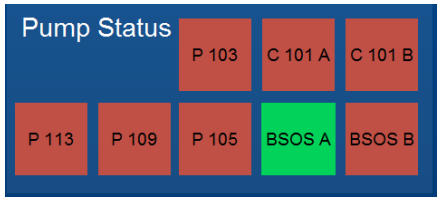
4.	☐ **Follow the "OPERATING PROCEDURE FOR N2 GAS MANIFOLD WITH PURGE VALVE" [6] to prepare the Nitrogen supply manifold for pressurization** ☐ **Set the pressure regulator to the desired pressure (from 3 to 28barg)**	 **Schlumberger SWTC** **OPERATING PROCEDURE FOR N2 GAS MANIFOLD WITH PURGE VALVE** **OWNER / CLIENT** SCHLUMBERGER OILFIELD (S) PTE LTD, 1 BENOI CRESCENT, SWTC BUILDING 629986, Singapore **MAIN CONTRACTOR** SINGAPORE OXYGEN AIR LIQUIDE PTE LTD, 16 JALAN BUROH SINGAPORE 619475, TEL: 6496 5809, FAX: +65 6265 4015
5.	● Check that PI 1101 has reached the desired pressure ☐ **Open the gas supply isolation valve (MV 1102)** ★ The gas supply line is fitted with a non-return valve that may produce a clicking sound when opening the isolation valve	
6.	● Verify that the pressure increases homogeneously in the flow loop by looking at the pressure gauges measurements on the tablet ★ Pressurizing the whole loop can last up to 5 hours	
7.	☐ **Close the gas supply isolation valve (MV 1102) once the desired pressure is reached** ☐ **Close the gas supply manifold and Nitrogen pallet.**	

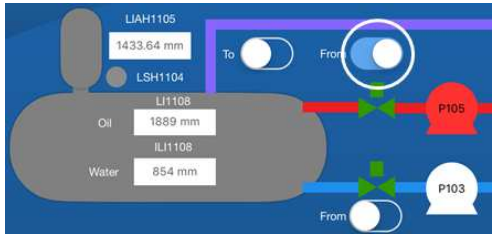
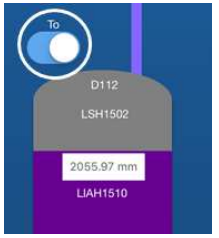
17 DEPRESSURIZING THE FLOW LOOP

	Location: Flow loop, Vacuum manifold — Operator level: 3	Time required: 90 min
1.	◆ This operation requires that all pumps and compressors be stopped ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Inerting / N2" on the desktop Home view** ● Verify that the controller has switched to the "Inerting / N2" mode. It should be highlighted with light green	
3.	☐ **Open the 'N2/Inerting' screen on the tablet**	

4.	☐ **Proceed to the Vacuum purging manifold** ✚ Check that the throttle valve HV 1101 is fully closed to avoid an abrupt gas discharge when opening the flow loop to the exhaust pipe ☐ **Fully open the vent isolation valve MV 1104** ☐ **Slowly open the throttle valve HV 1101 to start venting gas**	
5.	● Verify that the pressure drops evenly in the flow loop by monitoring the pressure transmitters on the tablet ✚ It is important to make sure that they are is no pressure trapped in the process if planning for an equipment maintenance	
6.	☐ **Once all the pressure transmitters (including PI1102) are showing a static pressure close to the desired value, close HV 1101 and MV1104 successively** ☐ **Lockout the 2 valves**	

18 DRAINING THE OIL PHASE OF THE OWS

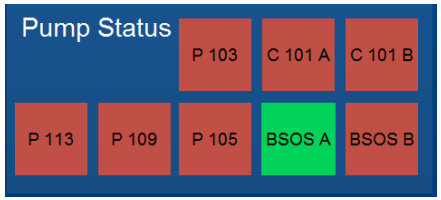
	Location: Flow loop, Transfer manifold **Operator level: 3**	**Time required: 60 min**
1.	◆ This operation requires that all pumps and compressors be stopped ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Fluid transfer" on the desktop Home view** ● Verify that the control system has switched to the "Fluid Transfer" mode. It should be highlighted with light green	
3.	☐ **Remove the pad lock and open the fill port on the oil storage tank (D111, D112 or D113)** - **D111**: open MV 1516 - **D112**: open MV 1517 - **D113**: open MV 1619 ◆ Check that the fill port valves are closed on the other tanks	

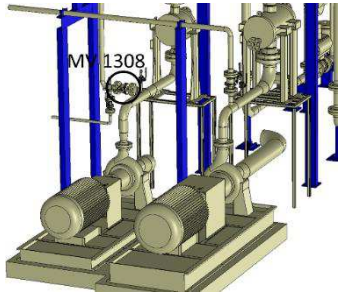
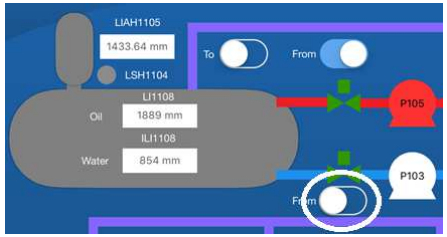
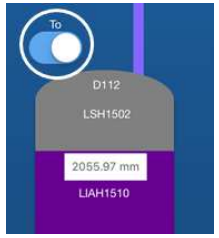
4.	☐ **Open the Oil export valve on the transfer manifold (MV 1302)**	
5.	☐ **Open the "Fluid transfer" panel on the tablet**	
6.	☐ **Select the oil phase outlet on the OWS as the source tank by enabling "FROM"** ◆ Check the liquid level on the OWS	
7.	☐ **Select the liquid inlet on the oil storage tank as the destination tank by enabling "TO"** ◆ Check the liquid level on the destination tank	

8.	**If the flow loop is pressurized, the oil pump does not need to be started. Open the OWS oil drain (XV1110) manually instead.** **If the flow loop is NOT pressurized, start the oil pump (P105) by pressing the "START P105" button** Verify that the OWS oil drain (XV 1110) opens before the pump starts	
9.	Check that the throttle valve (HV 1604) is fully closed to avoid an abrupt liquid discharge when opening the isolation valve **Open the oil transfer isolation valve (MV 1608) on the transfer manifold** **Slowly open the throttle valve (HV 1604) until a reasonable flow rate is reached**	
10.	Monitor the oil tank level on the tablet - **D111**: LIAH 1507 - **D112**: LIAH 1511 - **D113**: LIAH 1611 Monitor the OWS level (LI 1108) on the tablet	
11.	**Stop the oil pump (P105) once the liquid level in the OWS (LI 1108) is less than 50%** Verify that the OWS drain valve (XV 1110) closes right after the pump stops	

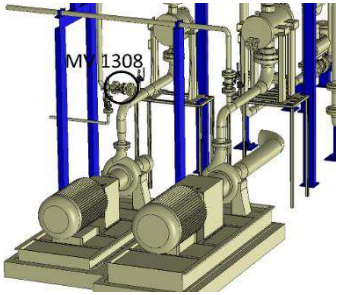
12.	☐ **Close and lock-out the Oil export valve on the transfer manifold (MV 1302)**	
13.	☐ **Close the oil transfer isolation valve (MV 1608) and throttle valve (HV 1604) on the transfer manifold**	
14.	☐ **Close the oil storage tank fill port and lock-out the valve** - **D111**: close MV 1516 - **D112**: close MV 1517 - **D113**: close MV 1619	

19 DRAINING THE WATER PHASE OF THE OWS

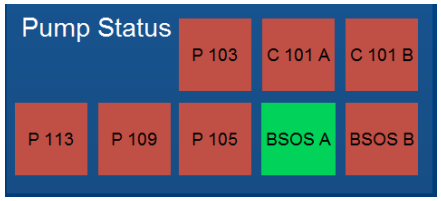
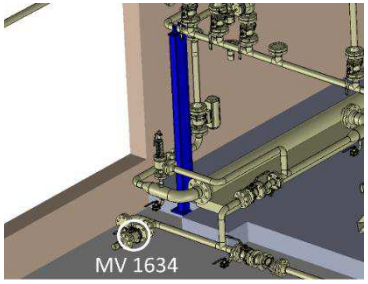
	Location: Flow loop, Transfer manifold **Operator level: 3**	**Time required: 60 min**
1.	◆ This operation requires that all pumps and compressors be stopped ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Fluid transfer" on the desktop Home view** ● Verify that the control system has switched to the "Fluid Transfer" mode. It should be highlighted with light green	
3.	☐ **Remove the pad lock and open the fill port on the water storage tank (D111, D112 or D113)** - **D111**: open MV 1516 - **D112**: open MV 1517 - **D113**: open MV 1619 ◆ Check that the fill port valves are closed on the other tanks	

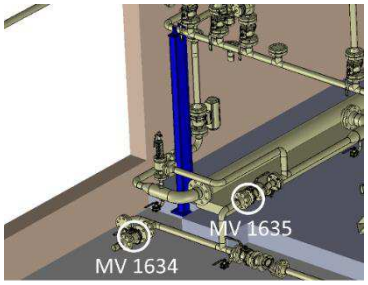
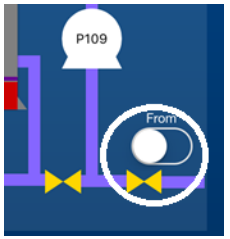
4.	☐ **Open the water export valve on the transfer manifold (MV 1308)**	
5.	☐ **Open the "Fluid transfer" panel on the tablet**	
6.	☐ **Select the water phase outlet on the OWS as the source tank by enabling "FROM"** ◆ Check the liquid level on the OWS	
7.	☐ **Select the liquid inlet on the water storage tank as the destination tank by enabling "TO"** ◆ Check the liquid level on the destination tank	

8.	**If the flow loop is pressurized, the water pump does not need to be started. Open the OWS water outlet valve (XV1107) manually instead.** **IF the flow loop is NOT pressurized, start the water pump by pressing the "START P103" button** Verify that the OWS water outlet (XV 1107) opens before the pump starts	
9.	Check that the throttle valve (HV 1617) is fully closed to avoid an abrupt liquid discharge when opening the isolation valve **Open the water transfer isolation valve (MV 1605) on the transfer manifold** **Slowly open the throttle valve (HV 1617) until a reasonable flow rate is reached**	
10.	Monitor the water tank level on the tablet - **D111**: LIAH 1507 - **D112**: LIAH 1511 - **D113**: LIAH 1611 Monitor the OWS level (LI 1108) on the tablet	
11.	**Stop the water pump (P103) once the liquid level in the OWS (LI 1108) has reached 0%** Verify that the OWS water outlet valve (XV 1107) closes right after the pump stops	

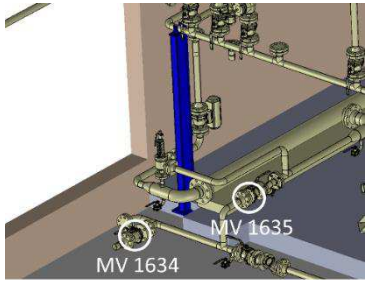
12.	☐ **Close and lock-out the Water export valve on the transfer manifold (MV 1308)**	
13.	☐ **Close the water transfer isolation valve (MV 1605) and throttle valve (HV 1617) on the transfer manifold**	
14.	☐ **Close the water storage tank fill port and lock-out the valve** - **D111**: close MV 1516 - **D112**: close MV 1517 - **D113**: close MV 1619	

20 UNLOADING OF A TANKER TRUCK INTO A STORAGE TANK

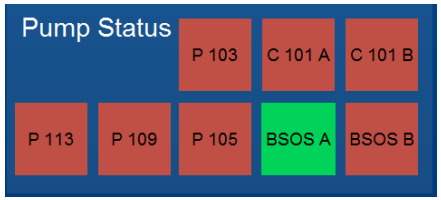
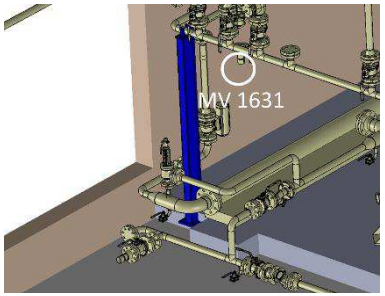
	Location: Flow loop, Transfer manifold **Operator level: 3**	**Time required: 180 min**
1.	◆ This operation requires that all pumps and compressors be in IDLE state ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Fluid transfer" on the desktop Home view** ● Verify that the control system has switched to the "Fluid Transfer" mode. It should be highlighted with light green	
3.	☐ **If the tanker truck does NOT come with its own transfer pump, connect the outlet of the tanker truck to the inlet port of the transfer pump (MV 1634)** ✚ Use a 2" flexible hose terminated with a compatible connection (CAM LOCK coupler)	
4.	✚ Make sure that the tanker truck is properly bonded to the nearest piping, equipment or cable tray to avoid the discharge of static electricity ✚ Secure the connection with a safety whip check	

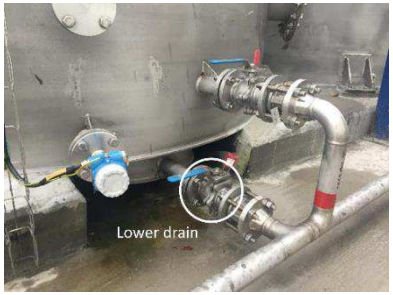
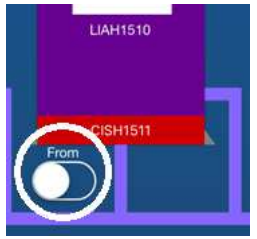
5.	☐ **Remove the pad lock and open the fill port on the destination storage tank (D111, D112 or D113)** - **D111**: open MV 1516 - **D112**: open MV 1517 - **D113**: open MV 1619 ☐ Check that the fill port valves are closed on the other tanks	
6.	☐ **Open the isolation valves (MV1634 and MV 1635) of the transfer pump inlet**	
7.	☐ **Open the "Fluid transfer" panel on the tablet**	
8.	☐ **Select the inlet of the transfer pump as the source tank by clicking on "FROM"** ✚ Ask the supplier to verify that the air vent is opened on the tanker truck	

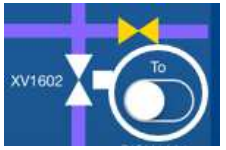
9.	**Select the liquid inlet on the OWS as the destination tank by clicking on "TO"** Check the liquid level on the destination tank	
10.	**Start the transfer pump (P109) by pressing the "START" button** Verify that the discharge valve (XV 1602) opens before the pump starts	
11.	Monitor the pump temperature (TISH 1617) Monitor the storage tank level - **D111**: LIAH 1507 - **D112**: LIAH 1511 - **D113**: LIAH 1611 Ask the supplier to monitor the tanker truck level	
12.	**Stop the transfer pump (P109) once the desired level is reached in the storage tank** Verify that the discharge on-off valve (XV 1602) closes right after the pump stops Filling a storage tank entirely takes around 2 hours	

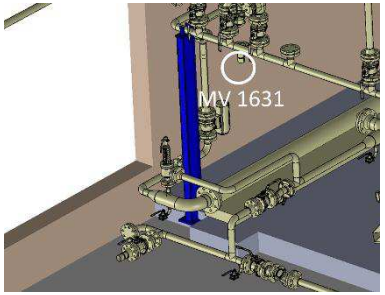
13.	☐ **Close the isolation valves on the transfer pump inlet (MV 1634 and MV 1635).** ☐ **Disconnect the flexible hose** ✚ **Use a bucket to minimize liquid spillage when manipulating the flexible hose**	
14.	☐ **Close the storage tank fill port** - **D111**: close MV 1516 - **D112**: close MV 1517 - **D113**: close MV 1619 ✚ Lock-out the valve	

21 DRAINING A STORAGE TANK INTO A TANKER TRUCK

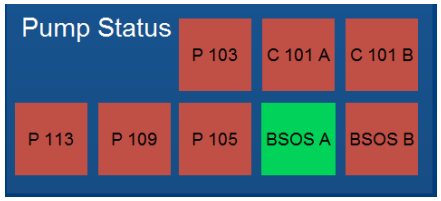
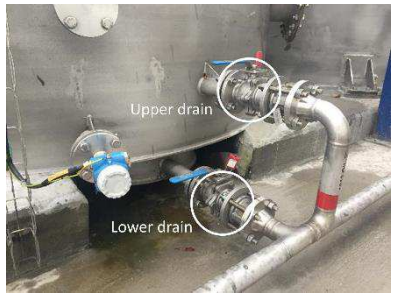
	Location: Flow loop, Transfer manifold **Operator level: 3**	**Time required: 60 min**
1.	◆ This operation requires that all pumps and compressors be stopped ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Fluid transfer" on the desktop Home view** ● Verify that the control system has switched to the "Fluid Transfer" mode. It should be highlighted with light green	
3.	☐ **Connect the inlet of the tanker truck to the outlet port of the transfer pump (MV 1631)** ✚ Use a 2" flexible hose terminated with a compatible connection (CAM LOCK coupler)	
4.	✚ Make sure that the tanker truck is properly bonded to the nearest piping, equipment or cable tray to avoid the discharge of static electricity ✚ Secure the connection with a safety whip check	

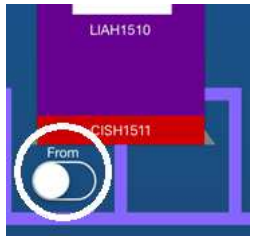
5.	☐ **Remove the pad lock and open the lower drain on the waste storage tank (D111, D112 or D113)** - **D111**: open MV 1512 - **D112**: open MV 1514 - **D113**: open MV 1614 ☐ Check that all the drain valves are closed on the other tanks	
6.	☐ **Open the transfer pump suction valves (MV 1632 and MV 1635)**	
7.	☐ **Open the "Fluid transfer" panel on the tablet**	
8.	☐ **Select the drain on the waste storage tank as the source tank by clicking on "FROM"** ◆ Check the liquid level on the source tank	

9.	☐ **Select the outlet of the transfer pump as the destination tank by clicking on "TO"** ✚ Ask the supplier to open the air vent on the tanker truck	
10.	☐ **Start the transfer pump (P109) by pressing the "START" button** ● Verify that the discharge valve (XV 1602) opens before the pump starts	
11.	● Monitor the pump temperature (TISH 1617) ● Monitor the storage tank level - **D111**: LIAH 1507 - **D112**: LIAH 1511 - **D113**: LIAH 1611 ● Ask the supplier to monitor the tanker truck level	
12.	☐ **Stop the transfer pump (P109) once a zero level is reached on the waste tank** ● Verify that the discharge on-off valve (XV 1602) closes right after the pump stops ★ Draining entirely a storage tank takes around 2 hours	

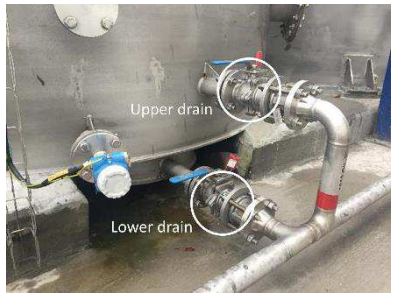
13.	☐ **Close the outlet port of the transfer pump (MV 1631)** ☐ **Disconnect the flexible hose** ✚ Use a bucket to minimize liquid spillage when manipulating the flexible hose	
14.	☐ **Close the isolation valves on the transfer pump inlet (MV 1634 and MV 1635)**	
15.	☐ **Close and lockout the lower drain of the waste tank (D111, D112 or D113)** - **D111**: close MV 1512 - **D112**: close MV 1514 - **D113**: close MV 1614	

22 TRANSFERRING FROM ONE STORAGE TANK TO THE OTHER

	Location: Flow loop, Transfer manifold **Operator level: 3**	**Time required: 60 min**
1.	◆ This operation requires that all pumps and compressors be in IDLE state ◆ There should be no active alarms on the alarm table	
2.	☐ **Set the operating mode to "Fluid transfer" on the desktop Home view** ● Verify that the control system has switched to the "Fluid Transfer" mode. It should be highlighted with light green	
3.	☐ **Remove the pad lock and open the lower (or upper) drain of the source tank (D111, D112 or D113)** - **D111**: open MV 1512 (or MV 1511) - **D112**: open MV 1514 (or MV 1513) - **D113**: open MV 1614 (or MV 1613) ◆ Check that all the drain valves are closed on the other tanks	

4.	☐ **Open the transfer pump suction valves (MV 1632 and MV 1635)**	
5.	☐ **Remove the pad lock and open the fill port on the destination tank** - **D111**: open MV 1516 - **D112**: open MV 1517 - **D113**: open MV 1619 ☐ Check that the fill port valves are closed on the other tanks	
6.	☐ **Open the "Fluid transfer" panel on the tablet**	
7.	☐ **Select the drain port on the source tank by clicking on "FROM"** ◆ Check the liquid level on the source tank ◆ Check that the nature of the fluid at the bottom of the tank matches with the phase that you are willing to transfer (RED for oil, BLUE for water).	

8.	**Select the fill port on the destination tank by clicking on "TO"** Check the liquid level on the destination tank	
9.	**Start the transfer pump (P109) by pressing the "START" button** Verify that the discharge valve (XV 1602) opens before the pump starts	
10.	Check that there is a continuous flow of liquid by looking at the sight glass (FG 1602) Monitor the pump temperature (TISH 1617) Monitor the source and destination tanks levels - **D111**: LIAH 1507 - **D112**: LIAH 1511 - **D113**: LIAH 1611	
11.	**Stop the transfer pump (P109) once the desired levels are reached in the tanks** Verify that the discharge on-off valve (XV 1602) closes right after the pump stops	

12.	☐ **Close the fill port on the destination tank** - **D111**: close MV 1516 - **D112**: close MV 1517 - **D113**: close MV 1619 ✚ Lock-out the valve	
13.	☐ **Close the transfer pump suction valves (MV 1632 and MV 1635)**	
14.	☐ **Close the lower drain (or upper) on the source tank** - **D111**: close MV 1512 (or MV 1511) - **D112**: close MV 1514 (or MV 1513) - **D113**: close MV 1614 (or MV 1613) ✚ Lock-out the valve	

D REFERENCES

Consult the latest valid version of each document referenced.

Title	Document Number
1. SWTC Flow loop – Test skid assembly SWI	DMS# 102677886
2. SWTC Flow loop – Test skid rig-up SWI	DMS# 102677880
3. SWTC Flow loop – Maintenance procedures	DMS# 102679520
4. SWTC Flow loop – General Description	DMS# 102924575
5. SWTC Flow loop – Reference Measurements and Calculations	DMS# 102673252
6. SWTC Flow loop - Gas manifold SWI	DMS# 102687378