Rev	Date	By	Summary of change
A01	15/12/14	PS	First formal issue.
A05	19/05/15	BG	Improvements and refinements
A10	17/05/15	MJ	Detailing of operating procedures and results, addition of this approval sheet.
A11	10/03/16	MJ	Redistribution of what was Section 2; Interface Engineering. Removed sample analysis section. Rewritten flushing and drying. Updated seconds SKID Labels drawing (RevA03)
A12	21/03/16	MJ	Update post review by PS
A13	30/03/16	PS	Typographical corrections. Clarification of 3.9. Amended sequence 3.12.4. Added steps to 3.12.5. for SOV. CR0277 completed.
A14	17/04/17	MJ	Includes flushing and drying changes due to inclusion of PRVs and address change
A15	02/10/17	EI	Renamed from MEG ARTS MANUAL RevA14. CR00492 updated manifold changes require complete review. CR00499 cover template update.
A16	07/12/17	EI	Requires complete review. CR00492 continuing updates. Circulated for comment within OEL.
A17	12/12/17	EI	Updated with comments on A16. See MEG log entry 07/12/17.
A18	09/01/18	EI	Addition of figures. Weight 450kg. Other minor alterations.
A19	15/01/18	EI	Added section 1.9 and modified introduction text to clarify that logged data can be used to calculate MEG purity.
A20	20/04/18	MJ	Various updates
B00	12/03/19	MJ	Updates for V08 Skid.
B01	05/11/20	TL	CR00947: New Front Page

COMMENTS:

CONTENTS **Page**

1. INTRODUCTION

MEG ARTS® is a system for Mono-Ethylene Glycol Analysis, Real Time display of results, and Sampling subsea. The system displays and logs measurements of density, pressure and temperature of Mono-Ethylene Glycol or other fluid received subsea from a pipeline conditioning pig train. These measurements can be used to demonstrate conformity with project purity, dryness, or hydrate suppression requirements. Status can be monitored by ROV camera on a real time high visibility OLED display. Up to 7 physical samples can be captured for recovery to the surface to confirm composition. Samples 1-6 can be captured manually by ROV switch or when there is no vessel and/or ROV present sample capture may be autonomous using pre-set density trigger levels. Sample 7 is fully manual and can only be captured by ROV.

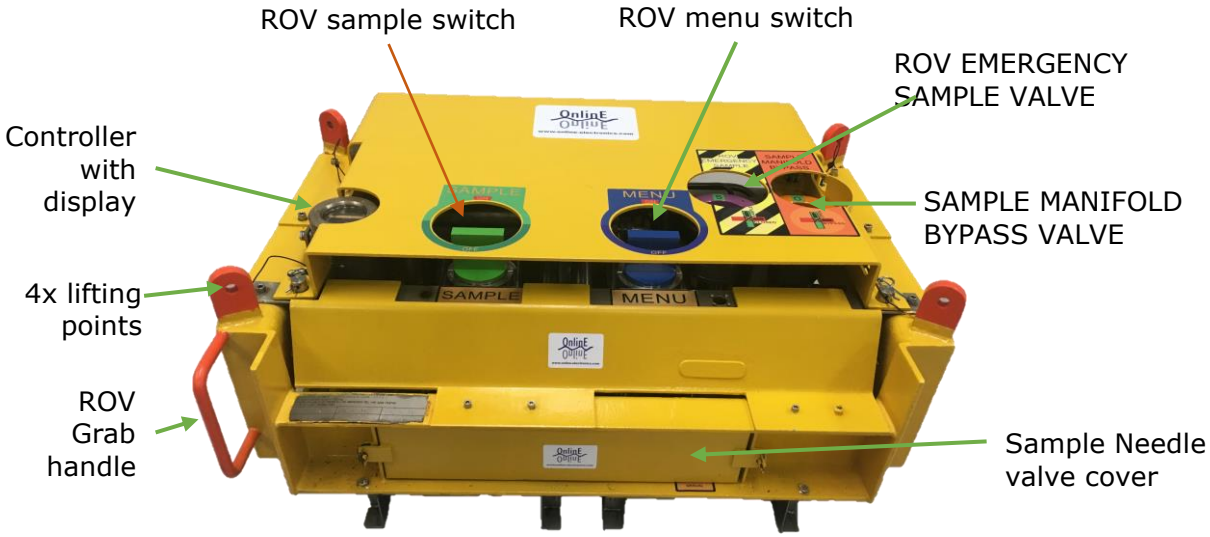


Figure 1 MEG ARTS® skid front view

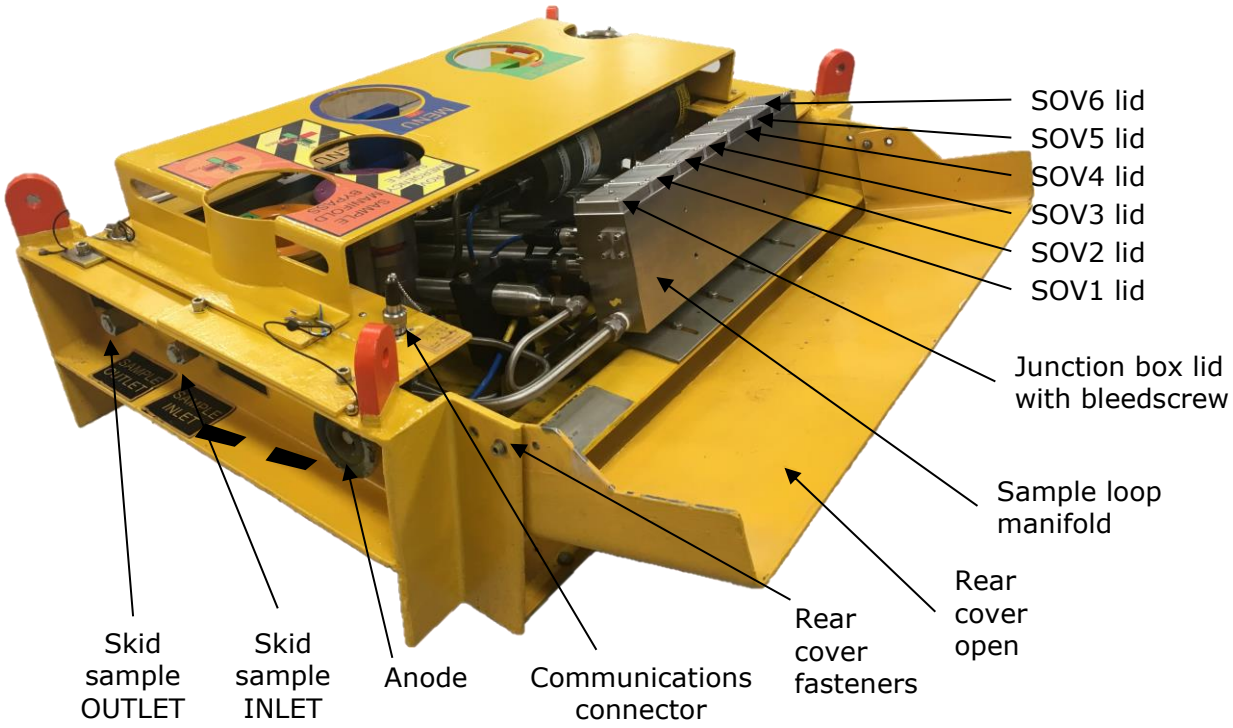


Figure 2 MEG ARTS® skid with rear cover open

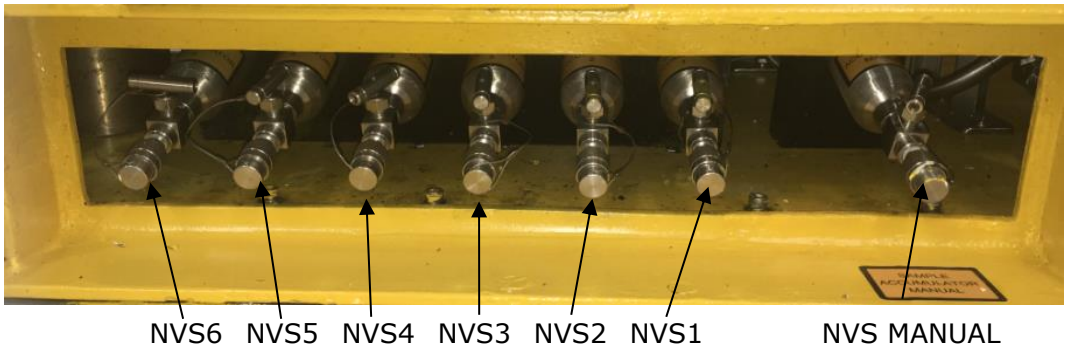


Figure 3 Needle valve cover access

1.1. SYSTEM SCHEMATIC

The MEG ARTS® skid is typically connected to the discharge of a pipeline via the sample INLET and OUTLET ports. The sample INLET and sample OUTLET connections on the skid are JIC 12 male fittings which are typically fitted with closed caps for protection during transit. The pipeline discharge pressure is normally close to the subsea ambient pressure however in some operations there may be significant overpressure.

The pipeline discharge flows into the skid via the skid sample INLET port, past the ROV EMERGENCY SAMPLE valve and into the ROV SAMPLE MANIFOLD BYPASS valve. The flow can then either go direct to the density analyser (bypassing the sample loop manifold – BYPASS MODE) or through the sample loop manifold where it passes 6x Solenoid Operated Valves (SOV*n*), though the sample manifold Non-Return Valve (NRV) and then through the density analyser. From the density analyser, the sample exits via a NRV and the skid sample OUTLET port.

The ROV EMERGENCY SAMPLE valve provides a for a fully manual sample to be collected in the unlikely event that the system is unable to capture a sample via ROV SAMPLE switch or automatically.

When the ROV EMERGENCY SAMPLE valve or SOV is opened a sample is drawn into one of seven sample cylinders (SCn) and captured. Each sample cylinder is fitted with a sample needle valve (NVS*n*) for unloading of a captured sample as per section 4.2 SAMPLE UNLOADING. Each sample needle valve is fitted with a Swagelok SS-QF4-S full flow quick connect stem. OEL provide all required hoses and fittings.

The controller provides logging and display of date, time, density, pressure, temperature and status as well as providing control of the SOVs. The ROV sample and menu switches allow ROV interaction with the controller and manual control of the SOV sampling. See the dedicated controller manual for more details.

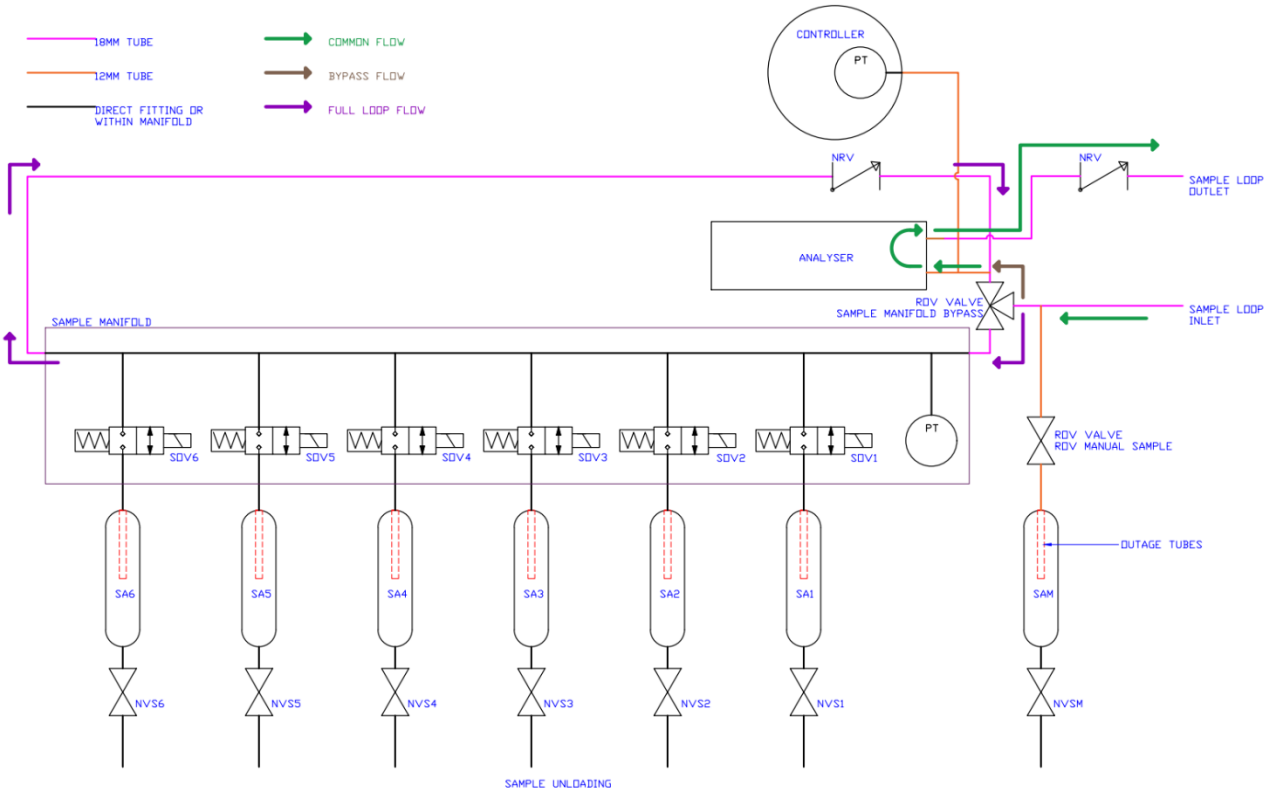


Figure 4 System schematic

1.2. CONTROLLER DEFAULT SCREEN

Figure 5 Default controller screen shows the default controller screen which will appear when the controller is turned on.

Figure 5 Default controller screen

- DNS is the density reading from the density sensor in kg/m^3.
- TMP is the temperature reading from the density sensor in °C.
- PR1 is the pressure reading from the controller pressure sensor (PR1) or the sample loop manifold pressure sensor (PR0) in barg. The preference is from the controller pressure sensor.
- ST provides status information:
  - **.2...6** provides sample status information for each of the six samples. A dot shows that the respective sample has not been triggered. A steady sample number shows the sample has been triggered and is complete. E.g. "**.2...6**" indicates that samples 2 and 6 have been triggered and all other samples are un-triggered.
  - **00** provides status information for the density sensor. "**00**" indicates that there are no errors.

- **L** provides logging status information. An "L" indicates that the system is configured to log data. The "." or "," after the "L" alternates between "." and "," each time a log is taken.

- Two battery indicators are located at the bottom right corner of the screen, "V" indicator shows the SOV battery level and "C" indicator shows the controller battery level.

1.3. ROV SWITCHES

The MEG system includes two ROV switches.

The ROV MENU switch provides the same functionality as the small push button mounted on the side of the controller which allows access to the controller menu system.

The ROV SAMPLE switch allows manual triggering of samples as per section 6.5 SAMPLE MODES AND TRIGGER LEVELS.

The switches themselves are robust, rotary switches which can be rotated indefinitely in either direction. The switch contact closes when in the ON position and will open after turning the switch approximately 45° in either direction. When not in use the switches should be rotated 180° away from the ON position to prevent accidental activation. They may be fixed in this position with a plastic tie wrap using the 5mm 'locking' hole provided.

If the ROV MENU switch is left in the ON position for more than 10 seconds or has developed a fault, then the controller will show an error message and the controller will attempt to resume normal function. Please contact Online Electronics Ltd if this error message appears without explanation.

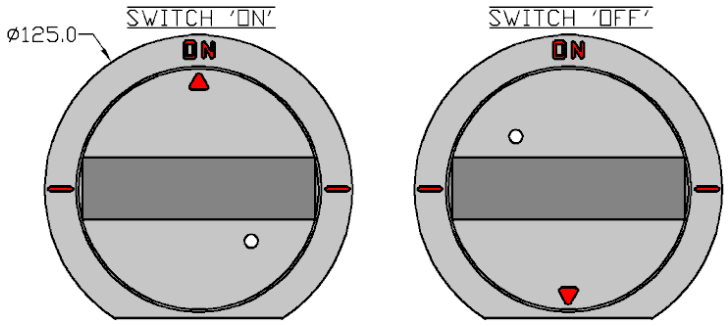


Figure 6 - ROV Switch

1.4. SAMPLE MANIFOLD BYPASS VALVE

The SAMPLE MANIFOLD BYPASS valve allows the sample manifold to be bypassed by the sample flow during the early stages of the dewatering operation. This provides some protection to the SOVs from debris.

The SAMPLE MANIFOLD BYPASS Valve can be deployed in BYPASS or OPEN (through sample manifold). In BYPASS mode, there must be an ROV on hand to open the SAMPLE MANIFOLD BYPASS valve just prior to arrival of pig 1.

In both modes, the sample flow is analysed and logged by the density analyser.

The SAMPLE MANIFOLD BYPASS Valve is dimensionally compliant to ISO 13628-8 and has a maximum operating torque of 250Nm.

The SAMPLE MANIFOLD BYPASS Valve is operated by turning the valve ¼ turn from BYPASS to OPEN.

1.5. ROV EMERGENCY SAMPLE VALVE

The MEG system includes a fully manual sample capture option. This sample can be captured by an ROV and is a single capture sample.

The ROV EMERGENCY SAMPLE Valve is dimensionally compliant to ISO 13628-8 and has a maximum operating torque of 250Nm.

The ROV EMERGENCY SAMPLE Valve is operated by turning the valve ¼ turn into the SAMPLE position, holding for 5 seconds and returning to the CLOSED position.

1.6. COMMUNICATION CONNECTION

See Figure 2 MEG ARTS® skid with rear cover open in section 1 INTRODUCTION for connector location. This interface allows logged data to be downloaded from the controller, allows the controller to be powered externally rather than using the internal battery, and allows the controller to be quickly configured from a PC using serial commands. A download cable is provided to allow connection of the skid to a PC USB port.

The skid connector is a Burton 55A6-1504 which must be fitted with a Burton 5501-1504-0000 Blanking Plug prior to and during deployment to prevent water ingress, conduction across pins and malfunction.

The terminal program should have the following settings:

- Baud Rate: 115200
- Bata Bits: 8
- Parity: None
- Stop Bits: 1

1.7. LIFTING AND MOVEMENT

The skid has a maximum gross weight of 500 kg and has been designed and tested for a 4-point lift. Each padeye is suitable for a 3.25 tonne shackle.

The skid can be conveniently moved on its bolt-on fork pockets or on a pallet but will overhang as the length is greater than 48” (~1250 mm).

The unit may be crated, shipped in a basket suitable for offshore deployment, or shipped in a container with a service subcontractor’s equipment as nominated by the client.

1.8. CHARGE MANIFOLD

The charge manifold is provided to allow isolation and a pressure monitoring during pre-charging of the sample cylinders as per section 2.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE, during unloading of the samples as per section 4.2 SAMPLE UNLOADING, and during several of the operations described in section 5 RETURN / RE-DEPLOYMENT OPERATIONS.

Figure 7 Charge manifold

1.9. SPECIFICATIONS

GENERAL DATA:

Maximum operating depth ..... 3000 m (9800 ft)

Minimum operating depth ..... 50m (164ft) depending on MEG batch size and speed

Sample loop inlet and outlet connections ..... JIC 12 male

Density sensor ..... range 500 kg/m^3 to 1500 kg/m^3
accuracy ±0.5 kg/m^3 (0.6% span seawater to pure MEG), resolution 0.1 kg/m^3

Temperature sensor range ..... range 0°C to 70°C, accuracy ±1.0°C, resolution 0.1°

Pressure sensor ..... range 0 barg to 300 barg, accuracy ±0.1% full scale, resolution 0.1 bar

Display ..... 63 mm x 33 mm (2.5” x 1.3”)

Logging capacity ..... 258,000 records at 1 s to 10 s interval, memory wrap option
each record contains Date, Time, Density, Pressure, Temperature, and Sample Status

Battery life at 5°C logging including taking 6 samples ..... 10 days

Minimum volume of each sample ..... 0.35 L (13 US fl oz)

Operating temperature ..... Controller -5°C to +30°C (23°F to 86°F)
Storage -20°C to +50°C (-4°F to 122°F)

Weight in air ..... 450 kg (992 lbs)

Dimensions ..... 1250 mm x 900 mm x 410 mm

MATERIALS:

Controller and sensor housings ..... Alloy Bronze CA104

Frame, manifold, sample cylinders, tubing and ROV switches ..... Stainless Steel

OPTIONS:

External power ..... +23V to +28V, 1 A maximum

Data communication ..... RS485 Half Duplex

Logging ..... Various regimes available

1.10. ABBREVIATIONS & DEFINITIONS

Term	Definition
ARTS	Analyser with Real Time display and Sampling.
bara	Absolute pressure in bar. Atmospheric pressure is 1bara.
barg	Gauge pressure in bar. This is the pressure relative to atmospheric pressure (1bara). Atmospheric pressure 1bara = 0barg.
Client	Company purchasing or inviting a tender for services involving the use of MEG ARTS®.
DNS	Density on the Controller display.
EFLASH	Non-Volatile Electrically Erasable Flash Memory.
GMT	Greenwich Mean Time.
HDD	Hard Disc Drive.
JIC	Joint Industry Council hydraulic connection.
MEG	Monoethylene glycol, also known as ethylene glycol and ethane 1-2 diol, CAS number 107-21-1. The abbreviation is used as a prefix for MEG ARTS® product drawings.
NPT	National Pipe Thread U.S. standard for tapered pipe threads.
NVS*n*	Needle Valve connected to the sample cylinders where *n* is the sample cylinder number.
NA	Not Applicable.
OD	Outside Diameter.
OEL	Online Electronics Ltd.
OLED	Organic Liquid Crystal Display.
OSPAR Convention	Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic.
PC	Personal Computer.
PLONOR	Posing little or no risk to the environment.
PR	Pressure on the Controller display.
PRV	Pressure Relief Valve.
Project	Scope of work to be completed for a client.
PSU	Power Supply Unit.
RAM	Random Access Memory.
SC*n*	Sample cylinder where *n* is the sample cylinder number.
SN	Serial Number.
ROV	Remotely Operated Vehicle.
SOV	Solenoid Operated Valve.
SS	Stainless Steel.
ST	Status of samples on the Controller display.
Supplier	Company to which OEL has issued a purchase order or requested a quote for the supply of materials or services.
TMP	Temperature on the Controller display.
UK	United Kingdom.
USB	Universal Serial Bus.
WEEE	Waste Electrical and Electronic Equipment.

1.11. CALCULATING MEG CONCENTRATION FROM LOGGED DATA

The density of a mixture of MEG and water varies with the following parameters:

- MEG concentration
- Water salinity
- Temperature
- Pressure

OEL can construct graphs or tables for project-specific conditions. The method uses curve fits to published data and is provided with no guarantee or warranty and is not intended to replace specialist calculations with equations of state.

> E.g. OEL curve fits indicate that the expected density of a mixture of 95% MEG and 5% fresh water at +4°C and 100barg is 1123.8kg/m^3.

> E.g. OEL curve fits indicate that the expected density of a mixture of 90% MEG and 10% fresh water at +4°C and 100barg is 1119.6kg/m^3.

Typically seawater is 27kg/m^3 denser than freshwater at standard temperature and pressure. The effect on mixture density of water salinity reduces with increasing MEG concentration. Pipeline conditioning trains often include freshwater between the MEG and the line fill of seawater and salinity can be neglected in these cases.

> E.g. OEL curve fits indicate that the expected density of a mixture of 95% MEG and 5% saltwater at +4°C and 100barg is 1125.4kg/m^3.

The sea temperature is close to 4°C at depths greater than 1000m in most areas of the world. In shallow water temperature may vary significantly.

> E.g. OEL curve fits indicate that the expected density of a mixture of 95% MEG and 5% fresh water at +10°C and 100barg is 1120.5kg/m^3.

The effect of pressure must be considered.

> E.g. OEL curve fits indicate that the expected density of a mixture of 95% MEG and 5% fresh water at +4°C and 50barg is 1122.4kg/m^3.

Note that MEG concentrations are usually expressed as a percentage of total mass (all values above are expressed as a percentage of total mass). Concentrations may also be expressed as a volume fraction or a mole fraction and there are significant differences between the 3 values.

2. PRE-DEPLOYMENT OPERATIONS

The MEG ARTS® system will normally be prepared by Online Electronics Ltd at their premises prior to mobilisation for a project. Where possible the system will be mobilised ready for almost immediate deployment subsea.

Pre-deployment operations are completed on-vessel by the MEG ARTS operator prior to the system being deployed subsea.

2.1. PRE-DEPLOYMENT GENERAL CHECKS

OPERATION	RESULT/COMMENT
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification label.	
6. Visually inspect the unit for any signs of damage in transit and record damage or confirm no damage.	
7. Check that all cables are connected, undamaged and secure. Refer to 7.3 CONNECTOR MAINTENANCE.	
8. Confirm that new battery packs have been fitted to the controller (recommended).	
9. Check that the communication connector is blanked. Refer to 1.6 COMMUNICATION CONNECTION	
10. Check that all sample needle valves (NVS*n*) are closed. Note that NVS1 is on the right and NVS6 is on the left when looking into the needle valve access.	NVS1
	NVS2
	NVS3
	NVS4
	NVS5
	NVS6
	NVS Manual
11. Check that the SAMPLE ROV switch is rotated 180° away from the ON position and secure if required as per 1.3 ROV SWITCHES.	

<table>
<tr><th>OPERATION</th><th colspan="8">RESULT/COMMENT</th></tr>
<tr><td>12. Check that the MENU ROV switch is rotated 180° away from the ON position and secure if required as per 1.3 ROV SWITCHES.</td><td colspan="8"></td></tr>
<tr><td>13. Ensure the ROV EMERGENCY SAMPLE Valve is in the CLOSED position</td><td colspan="8"></td></tr>
<tr><td>14. Ensure the SAMPLE MANIFOLD BYPASS valve is in the position defined by the customer, record position here.</td><td colspan="8"></td></tr>
<tr><td>15. If in BYPASS, the SAMPLE MANIFOLD BYPASS valve must be opened by ROV prior to pig 1 arrival, if an ROV will not be available this valve must be left in the OPEN (non-bypass) position.
Confirm the customer is aware that the valve must be operated by ROV.</td><td colspan="8"></td></tr>
<tr><td>16. Confirm that the SAMPLE INLET connection fitted is suitable and ready for termination to the pipeline subsea.</td><td colspan="8"></td></tr>
<tr><td>17. Confirm that the SAMPLE OUTLET connection fitted (if any) is suitable and ready for termination subsea. If no connections required on the SAMPLE OUTLET, ensure the blanking cap is removed.</td><td colspan="8"></td></tr>
<tr><td>18. Confirm that all relevant parties (e.g. divers, ROV operators) are familiar and trained with the operations of the system relevant to them.</td><td colspan="8"></td></tr>
<tr><td rowspan="8">19. Confirm that all operations within section 5 RETURN / RE-DEPLOYMENT OPERATIONS have been completed. If the system has come directly from Online Electronics Ltd then these operations will have been completed already unless otherwise agreed. These operations must be repeated if this is a re-deployment.</td><td colspan="7">5.1 RE-DEPLOYMENT SAMPLE LOOP FLUSHING</td><td>tick</td></tr>
<tr><td colspan="7">5.2 RE-DEPLOYMENT SAMPLE CYLINDER FLUSHING</td><td></td></tr>
<tr><td colspan="7">5.3 RE-DEPLOYMENT SAMPLE CYLINDER DRYING</td><td></td></tr>
<tr><td colspan="7">5.4 RE-DEPLOYMENT SOV INSTALLATION</td><td></td></tr>
<tr><td colspan="7">5.5 RE-DEPLOYMENT SAMPLE LOOP PRESSURE TEST</td><td></td></tr>
<tr><td colspan="7">5.6 RE-DEPLOYMENT SAMPLE MANIFOLD BYPASS VALVE INTEGRITY TEST</td><td></td></tr>
<tr><td colspan="7">5.7 RE-DEPLOYMENT SAMPLE CYLINDER PRESSURE TEST</td><td></td></tr>
<tr><td></td><td colspan="8"></td></tr>
<tr><td>20. Confirm all SOV lids and the bleedscrew on the sample loop manifold are secure.</td><td colspan="8">Tick</td></tr>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>M</td><td></td></tr>
<tr><td>21. Confirm all NVSn sample needle valves are closed and stem protectors fitted.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>M</td><td></td></tr>
</table>

OPERATION	**RESULT/COMMENT**	
22. Confirm that all skid covers are fitted and secure.		
23. Check skid anodes and replace if necessary. 7.2 ZINC ANODES.		
24. Confirm system pressure sensor calibration is in date and suitable for the project requirements. Record certificate number.	Cal. Cert No	Cal. Date
25. Confirm system density sensor calibration is in date and suitable for the project requirements. Record certificate number.	Cal. Cert No	Cal. Date
26. Confirm skid lifting certification is in date and suitable for the project requirements. Record certificate number.	Cert No	Inspection Date

NOTES:

2.2. PRE-DEPLOYMENT CONTROLLER CONFIGURATION

While completing this section compare the controller configuration against the requirements for the project. The density sample trigger levels may need to be adjusted if the expected sea temperature or sample pressure has changed since last configuration. Refer to the MEG ARTS CONTROLLER manual if required.

OPERATION	**RESULT/COMMENT**			
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.				
2. Record the name of the operator completing these operations.				
3. Record the date that these operations were completed.				
4. Record project and pipeline names and/or reference numbers.				
5. Record MEG skid serial number which can be found on the frame identification plate.				
6. Power on the controller.				
7. Set and record controller time so that it is synchronised with the required time zone. Refer to 6.1 CONTROLLER DATE AND TIME.				
8. Set and record controller date. Refer to 6.1 CONTROLLER DATE AND TIME.				
9. Record controller firmware version from status screen.				
10. Set and record the controller log interval from status screen. Refer to 6.2 LOG INTERVAL.				
11. Erase the controller log and ensure logging is enabled from status screen.				
12. Set and record controller log overwrite status from status screen. Refer to 6.3 LOG OVERWRITE.				
13. Set and record controller sample time. Refer to 6.2 LOG INTERVAL.				
14. Set and record controller sample modes and trigger levels. For all samples record target trigger level. Record the trigger level, (A)bove, (B)elow or (M)anual) and the expected (target) MEG % purity. Refer to 6.5 SAMPLE MODES AND TRIGGER LEVELS NOTE: The ROV EMERGENCY SAMPLE can only be triggered by an ROV.	Sample No	Trigger Level (kg/m^3)	A/B/M	Target %
	1			
	2			
	3			
	4			
	5			
	6			

	MAN		M	
15. Record who supplied the density/purity levels and which was calculated from OEL spreadsheet.				
16. Record the expected sample temperature used to calculate any trigger levels above.				
17. Record the expected sample pressure used to calculate any trigger levels above.				
18. Confirm that the controller battery indicator reads full. It is recommended to fit new battery packs prior to each deployment. Refer to 1.2 19. CONTROLLER DEFAULT SCREEN and 6.8 BATTERY PACKS. Record No of bars displayed.	MAN:		SOV:	
20. Record density reading and confirm that it is as expected. If the sensor is filled with air then this may be low. Refer to 1.2 CONTROLLER DEFAULT SCREEN.				
21. Record temperature reading and confirm that it is as expected. Refer to 1.2 CONTROLLER DEFAULT SCREEN.				
22. Record pressure reading and confirm that it is as expected (e.g. 000.0barg). Refer to 1.2 CONTROLLER DEFAULT SCREEN.				
23. Record the controller status information and confirm all sample are un-triggered and ready. E.g. "**ST...../00L**". Refer to 1.2 CONTROLLER DEFAULT SCREEN. Reset the samples if required.				
24. Shutdown the controller.				
NOTES:				

2.3. PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE

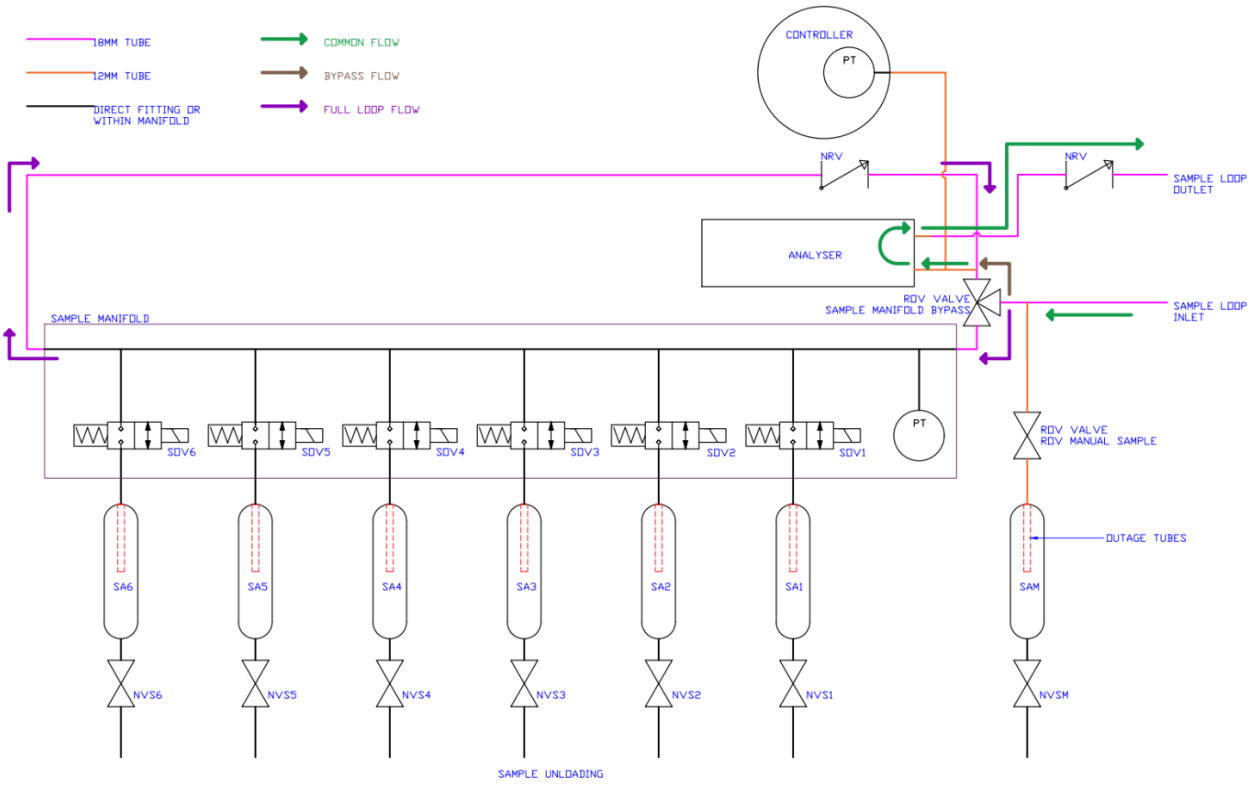


Figure 8 System schematic

Nitrogen pre-charging of the sample cylinders is required to restrict the potential pressure increase of the samples caused by thermal expansion of the sample. The required nitrogen pre-charge pressure is related to the expected sampling pressure subsea (water depth plus any pipeline pressure) and the temperatures during pre-charging, sampling and unloading. Guide values for pre-charge pressures are provided in Table 1 Guidance nitrogen pre-charge levels which assume a surface temperature during pre-charge and sample unload of +40°C, a subsea temperature of +4°C and a target sample pressure limit of 344barg.

SAMPLE PRESSURE (barg)	**PRE-CHARGE** (barg)	**EXPECTED SAMPLE VOLUME** (ml)
5..30	0	426..497
30..150	7	385..488
150..265	50	350..425

Table 1 Guidance nitrogen pre-charge levels

Nitrogen charging must be from a gas cylinder fitted with a regulator. Nitrogen pumps which may be available for pipe purging or other operations are not suitable for the small volumes within the sample cylinders. Gas regulators have different pressure ranges. Ensure the regulator range is suitable and set for the required pressure. If the intended charge pressure is 0 barg then no pre-charge is required.

OPERATION	**RESULT/COMMENT**
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	

2. Record the name of the operator completing these operations.							
3. Record the date that these operations were completed.							
4. Record project and pipeline names and/or reference numbers.							
5. Record MEG skid serial number which can be found on the frame identification plate.							
6. Remove all NVSn stem protectors.	Tick:						
	1	2	3	4	5	6	M
7. If the required pre-charge is 0barg then fully open and then fully close each NVSn in turn to ensure each sample is at atmospheric pressure. Record pressure (0barg) in each sample at step 13 and then jump to step 16.							
8. Otherwise connect the charge manifold to the NVSn quick connect stem. See 1.8 CHARGE MANIFOLD.							
9. Connect the nitrogen supply to the charge manifold.							
10. Open the charge manifold needle valve.	Tick:						
	1	2	3	4	5	6	M
11. Open NVSn.	1	2	3	4	5	6	M
12. Open the nitrogen regulator valve and increase nitrogen pressure until the desired pressure is reached. Refer to Table 1 Guidance nitrogen pre-charge levels.							
13. When pressure is stable record the charge pressure and close NVSn. Note that NVSM is in the far right then NVS1 through to NVS6 on the left when looking into the needle valve access.	NVS1:						barg
	NVS2:						barg
	NVS3:						barg
	NVS4:						barg
	NVS5:						barg
	NVS6:						barg
	NVSM:						barg
14. Remove the pressure from the nitrogen regulator and hose. Nitrogen is an asphyxiant and must be vented to a well ventilated area. Remove the charge manifold.							
15. Repeat steps 8 to 14 for each sample cylinder.							
16. Replace all NVSn stem protectors.	Tick:						
	1	2	3	4	5	6	M
17. Replace and secure all skid covers.							
NOTES:							

3. DEPLOYMENT OPERATIONS

3.1. DEPLOYMENT POWER UP

The unit may be powered up on deck shortly prior to deployment or powered up while on the seabed utilising a diver or ROV to manipulate the ROV MENU switch.

1. Turn the ROV MENU switch to the ON position.
2. Wait for the OnlinE logo to appear on the controller display (approximately 5 seconds).
3. Turn the ROV MENU switch 180° away from the ON position and leave in this position.
4. The system will scroll through several status screens before displaying sensor data as per 1.2 CONTROLLER DEFAULT SCREEN..
5. Confirm that valid sensor readings are being displayed.

3.2. DEPLOYMENT LOCATION

If lifting sling set or chains are to be used, make sure they are attached. Make sure the unit is lifted according to the project lifting plan or other controlled procedure and lowered into the sea.

Ensure the unit is to be placed on a protective structure (if required) near the pipeline system as defined by interface engineering and within the sample hose length from the sample point. Typical distance would be 5m or 10m.

If the identified location is on the seabed then mattresses may be needed for support.

The MEG ARTS® sample hose should be connected to the nominated stab or other connection.

Pipeline valves may be operated as required.

3.3. DEPLOYMENT ANALYSIS AND SAMPLING

MEG ARTS® will log data and capture samples according to the settings recorded in section 2.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION.

Samples configured in manual mode during section 2.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION will trigger when the ROV SAMPLE switch is rotated from the OFF position to the ON position and held in this position for at least 1 second. See section 6.5 SAMPLE MODES AND TRIGGER LEVELS for more details.

Samples that configured in automatic mode during section 2.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION will trigger when the live density value matches the configured trigger level. See section 6.5 SAMPLE MODES AND TRIGGER LEVELS for more details.

4. RECOVERY OPERATIONS

4.1. RECOVERING UNIT TO DECK

After pipeline conditioning MEG ARTS® can be disconnected and recovered to deck. The unit may be shutdown subsea to limit logging of unnecessary data but this is not recommended due to the possibility of inadvertent menu selections.

Subsea shut down can be achieved using the ROV MENU switch to select the SHUTDOWN menu item and then leaving ROV MENU switch rotated 180° away from the ON position.

4.2. SAMPLE UNLOADING

The skid will be recovered from subsea deployment with the samples stored at pressure. The pressure may be above the subsea ambient pressure due to thermal expansion of the sample. The Nitrogen pre-charge will be at the same elevated pressure.

OPERATION	RESULT/COMMENT
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification plate.	
6. Disconnect the sample inlet hose and then plug to prevent possible contamination.	
7. Disconnect the sample outlet hose and then plug to prevent possible contamination.	
8. Confirm that the sample cylinders are pointing at least 15° downwards with each NVSn at the lowest point so that any liquid in the sample runs downwards to the needle valves. This will be achieved if the skid frame is level. If this is not the case then this unload procedure shall not work.	
9. Confirm the charge manifold is clean and dry to prevent contamination of the sample. Blow through with clean water and then clean air or Nitrogen if required. Nitrogen is an asphyxiant and must be vented to a well ventilated area. See 1.8 CHARGE MANIFOLD.	

10. Connect the charge manifold to NVSn. Ensure that the charge manifold is positioned so that the pressure gauge can be observed and the outlet will safely discharge any contained pressure away from personnel. Note that NVS1 is on the right and NVS6 is on the left when looking into the needle valve access.	Tick						
	1	2	3	4	5	6	M
11. Ensure manifold gauge powered on and reading 0barg							
12. Close the charge manifold needle valve.							
13. Open sample needle valve NVSn which will equalise pressure between sample SCn and the manifold. Note that NVS1 is on the right and NVS6 is on the left when looking into the needle valve access.	Tick						
	1	2	3	4	5	6	M

14. Before unloading sample SCn record pressure of sample SCn. Note that this should be at pipeline pressure if a sample was triggered or pre-charge pressure (see section 2.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE) if no sample was triggered. If the sample is not at either of these pressures then it indicates a problem and should be recorded and reported.	SC1	barg
	SC2	barg
	SC3	barg
	SC4	barg
	SC5	barg
	SC6	barg
	MANUAL	barg
15. Slowly open the charge manifold needle valve to eject the sample into the sample container (expect 350 to 500ml). Note that once the liquid sample has been ejected any residual gas shall be released. Record the pressure when the last of the liquid is ejected and gas starts to be released for each sample. This should be at the pre-charge pressure if a full liquid sample was captured. If this is not the case then the pressure should be recorded and reported. Nitrogen is an asphyxiant and must be vented to a well ventilated area. NOTE: The MANUAL sample may have a larger capacity due to the pipework supplying the cylinder	SC1	ml
	SC2	ml
	SC3	ml
	SC4	ml
	SC5	ml
	SC6	ml
	MANUAL	ml

16. If it is suspected that 0barg was reached before the complete liquid sample was unloaded (which can occur if e.g. the SOVs have failed to re-seal after sample capture or the sample is "foamy") then sample cylinder SCn can be temporarily re-charged to an elevated pressure with Nitrogen via NVSn to eject the remaining sample as per step 15. Ensure that sample pressure is 0barg before attempting re-charge. Ensure the sample needle valve is closed while changing connections when re-charging and connecting back the sample bottle.							
17. Confirm sample pressure is 0barg before proceeding.	Tick						
	1	2	3	4	5	6	M
18. Close NVSn valve.	1	2	3	4	5	6	M
19. Seal and label the sample container with the following information. • Project number/name • Sample cylinder number • Sample time and date (see step 22) • Sample volume • Name of person extracting sample • Current Time/Date	1	2	3	4	5	6	M
20. Record and report the presence of any significant debris in any of the samples. E.g. take a sample of the debris and/or take photographs.	SC1						
	SC2						
	SC3						
	SC4						
	SC5						
	SC6						
	MANUAL						
21. Repeat steps 9 to 20 for each sample.							
22. Connect a PC to the communication connector using the download cable and power on the controller. Using the "Q" command, record the sample time/date on the sample bottle labels.							

23. Clean the charge manifold by flushing through with clean water and then dry by blowing through with clean air or Nitrogen. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	
24. Within 72 hours of recovering the MEG skid to the deck section 5.1 RE-DEPLOYMENT SAMPLE LOOP FLUSHING should be completed to prevent permanent debris build up within the density sensor.	

NOTES:

4.3. DATA DOWNLOAD

Download data following the instructions in the MEG ARTS® CONTROLLER MANUAL.

OPERATION	RESULT/COMMENT
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification plate.	
6. Using the supplied download cable connect the MEG communications connector to a PC USB port.	
7. On the terminal program, set the baud rate to 115,200, 8 data bits, no parity and 1 stop bit.	
8. Start the recording feature in the terminal program and assign filename in format "YYMMDD HHMM - PROJECT NAME - PIPELINE NAME.txt" where "YYMMDD" is the current date backwards and "HHMM" is the current time. Record the filename.	
9. Send serial status "S" command to receive status of the controller.	
10. Send serial "W", "X", "Y", "Z" commands to receive reliability information.	
11. Send serial "Q" command to receive the trigger times.	
12. Send serial "U" command to unload the entire log. This may take up to 50 minutes depending on the amount of logged data.	
13. Once all data has been received, close the recording feature and confirm that the file has been saved and copy a backup onto a USB pen drive. Pass copies to OEL and customer	
14. Disconnect the PC and power down the controller.	
NOTES:	

5. RETURN / RE-DEPLOYMENT OPERATIONS

All operations within this section should be completed in the order written after recovery from the seabed and unloading of samples and data so that the system is ready for re-deployment.

If the unit is to be returned to Online Electronics Ltd before the next re-deployment then only 5.1 RE-DEPLOYMENT SAMPLE LOOP FLUSHING needs to be completed.

The system is typically transported depressurised with all needle valves (NVs) closed and sample loop ends capped to prevent contamination. Solenoid operated valves (SOVs) are normally closed when not energised. There may be trapped pressure due to temperature changes or previous inadvertent or incomplete operations.

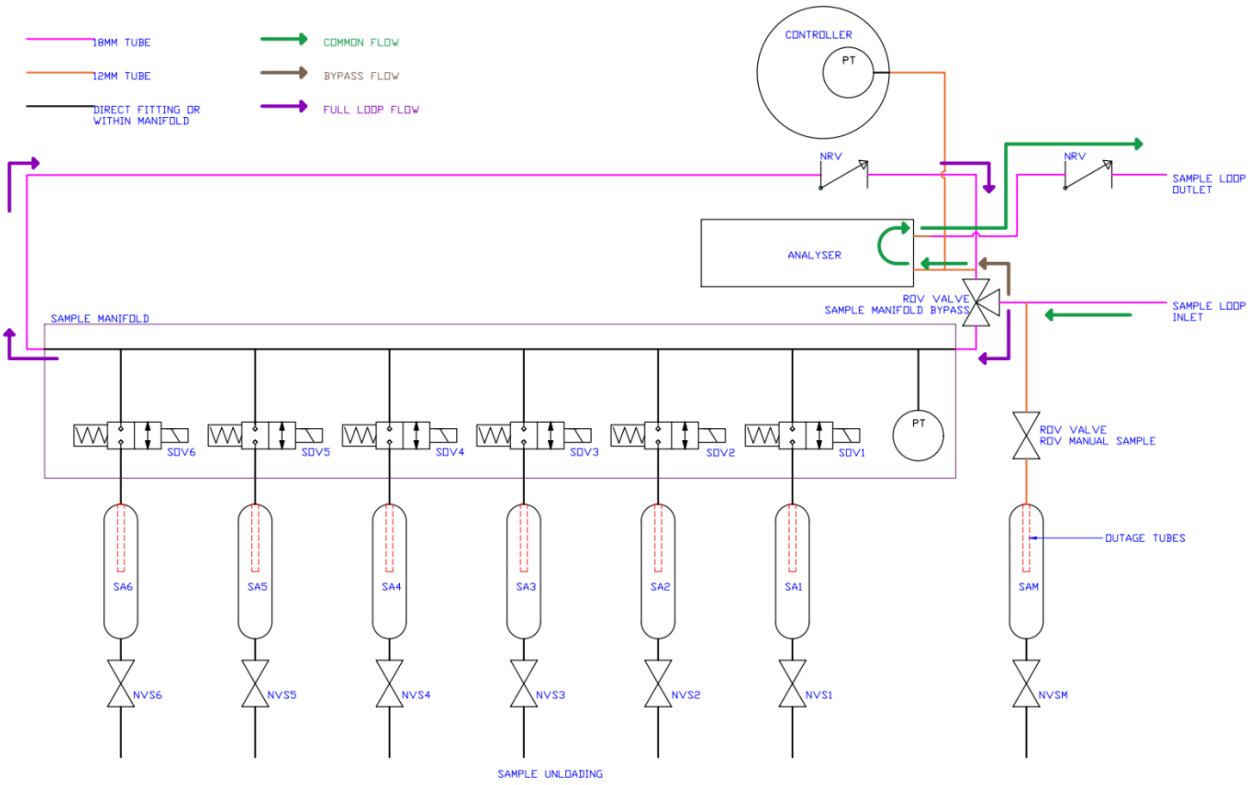


Figure 9 System schematic

5.1. RE-DEPLOYMENT SAMPLE LOOP FLUSHING

The sample loop must be flushed with clean water within 72 hours of being recovered to deck after deployment to prevent permanent debris build up within the density sensor. This operation should be completed prior re-deployment or prior to returning the MEG skid to OEL.

OPERATION	RESULT/COMMENT
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the date that these operations were completed.	

4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification plate.	
6. Connect a filtered water supply to the skid sample INLET	
7. Connect a waste hose to the skid sample OUTLET.	
8. Direct the waste hose into a container so that any debris ejected can be witnessed.	
9. Flush water through the sample loop for at least 5 minutes.	
10. Record and report the presence of any significant debris. E.g. take a sample of the debris and/or take photographs.	
NOTES:	

5.2. RE-DEPLOYMENT SAMPLE CYLINDER FLUSHING

All sample cylinders should be flushed with clean water within 72 hours of being recovered to deck after deployment to remove any debris. This operation involves opening the sample loop manifold and should only take place somewhere clean, dry and tidy.

OPERATION	RESULT/COMMENT					
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.						
2. Record the name of the operator completing these operations.						
3. Record the date that these operations were completed.						
4. Record project and pipeline names and/or reference numbers.						
5. Record MEG skid serial number which can be found on the frame identification label.						
6. Open the rear cover by removing the 2x inner fasteners and hinging the cover open on the 2x outer fasteners.						
7. Using a phillips head screwdriver remove the manifold bleedscrew from the junction box lid to relieve any internal pressure. Once removed refit the manifold bleedscrew so that it is not lost.						
8. Using a 3mm allen key remove the 6x SOV lids from the sample loop manifold. Do not remove the junction box lid (which has the manifold bleedscrew attached). While these lids are removed be very careful not to damage or contaminate the lid Orings in any way. Keep the workplace clean, dry and tidy.	Tick					
	1	2	3	4	5	6
9. Remove the thumb screw from each SOV cartridge.	1	2	3	4	5	6
10. Pull apart the bullet connectors connected to each SOV coil and withdraw the SOV coil from each SOV cartridge. Note that there is an Oring fitted on either side of the SOV coil which must not be lost. Set aside the SOV coils, Orings and thumb screws somewhere clean, dry and tidy.	1	2	3	4	5	6
11. Using a 27mm box spanner unscrew and withdraw each SOV cartridge and set aside somewhere clean, dry and tidy.	1	2	3	4	5	6
12. For future investigations individually tag and bag each SOV. Record at least project reference, current date, and SOV position on the tag.	1	2	3	4	5	6

13. Record the presence of any significant debris within the SOV cavities. Remove any larger debris prior to flushing to prevent unnecessary contamination of the sample cylinders or needle valves during flushing.	SOV1
	SOV2
	SOV3
	SOV4
	SOV5
	SOV6

14. Using an 8mm allen key fit an M22 blank over each SOV port within the manifold.	Tick					
	1	2	3	4	5	6

15. Open the ROV EMERGENCY SAMPLE valve	
16. Connect a filtered water supply to the skid sample INLET.	
17. Blank off the skid sample OUTLET.	

18. Connect a waste hose to sample cylinder needle valve NVSn. Direct the waste hose into a container so that any debris ejected can be witnessed.	Tick						
	1	2	3	4	5	6	M
19. Close all sample cylinder needle valves and then open only the NVSn to be flushed.	1	2	3	4	5	6	M

20. Flush water through sample cylinder SCn for at least 5 minutes. Close NVSn momentarily on at least two occasions half way through to ensure the sample cylinder is filled. Record and report the presence of any significant debris. E.g. take a sample of the debris and/or take photographs.	SC1
	SC2
	SC3
	SC4
	SC5
	SC6
	SCM
21. Repeat steps 18 to 20 for each sample cylinder SCn.	

NOTES:

5.3. RE-DEPLOYMENT SAMPLE CYLINDER DRYING

All sample cylinders should be dried of as much liquid as possible to prevent contamination of samples during the next deployment. Drying is accomplished by flowing dry, clean nitrogen (preferred) or air through each sample cylinder SC*n* to blow any liquid downwards and out of the sample cylinder NVS*n*. When the skid is on a level surface the sample cylinders are oriented tilted approximately 15° downwards to facilitate drying. This operation involves opening the sample loop manifold and should only take place somewhere clean, dry and tidy.

OPERATION	**RESULT/COMMENT**					
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.						
2. Record the name of the operator completing these operations.						
3. Record the date that these operations were completed.						
4. Record project and pipeline names and/or reference numbers.						
5. Record MEG skid serial number which can be found on the frame identification plate.						
6. Confirm that the skid is on a level surface so that the sample cylinders are oriented tilted approximately 10° downwards to facilitate drying.						
7. Connect a Nitrogen supply to the skid sample INLET.						
8. Blank off the skid sample OUTLET.						
9. Close all sample cylinder needle valves and then open only the NVSn to be dried.	Tick					
	1	2	3	4	5	6
10. Blow through sample cylinder SCn until no more liquid is ejected from the sample cylinder needle valve. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	1	2	3	4	5	6
11. Blow through sample cylinder SCn with at least 5 sharp bursts and until no more liquid is ejected from the sample cylinder needle valve. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	1	2	3	4	5	6
12. Repeat steps 9 to 11 for each sample cylinder SCn.						
13. Open ROV EMERGENCY SAMPLE valve						
14. Blow through sample cylinder SCM until no more liquid is ejected from the sample cylinder needle valve. Nitrogen is an asphyxiant and must be vented to a well ventilated area.						

15. Blow through sample cylinder SCM with at least 5 sharp bursts and until no more liquid is ejected from the sample cylinder needle valve. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	
16. Close the ROV EMERGENCY SAMPLE valve.	

NOTES:

5.4. RE-DEPLOYMENT SOV INSTALLATION

SOV cartridges which have been previously deployed should not be re-used and should be returned to Online Electronics for refurbishment. A complete set of new SOV cartridges should be fitted prior to each re-deployment.

OPERATION	RESULT/COMMENT					
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.						
2. Record the name of the operator completing these operations.						
3. Record the date that these operations were completed.						
4. Record project and pipeline names and/or reference numbers.						
5. Record MEG skid serial number which can be found on the frame identification plate.						
6. Fill a small container with 20mm depth of clean Enerpac HF95 hydraulic oil which will be used to prime the SOV cartridges before fitting.						
7. Remove the M22 blank from SOVn cavity within the sample loop manifold.	Tick 1	2	3	4	5	6
8. Confirm the new SOV cartridge Orings are clean and undamaged.	1	2	3	4	5	6
9. Prime the SOV cartridge by fully submerging the wetted end in the hydraulic oil above and agitating to wet out the sealing surfaces. Keep the SOV vertical to retain the pool of oil in the SOV valve seat until fitted into the sample loop manifold.	1	2	3	4	5	6
10. Use a 27mm box spanner to fit the SOV cartridge into the sample loop manifold with fastening torque 8.9Nm.	1	2	3	4	5	6
11. Refit the SOV coil removed in section 5.2 RE-DEPLOYMENT SAMPLE CYLINDER FLUSHING ensuring that an Oring is fitted above and below the SOV coil. The thumb screw should be tightened by hand only.	1	2	3	4	5	6
12. Remake the bullet connectors to the SOV coil and tuck into the SOV cavity beside the SOV coil.	1	2	3	4	5	6
13. Refit the SOV cavity lid removed in section 5.2 RE-DEPLOYMENT SAMPLE CYLINDER FLUSHING ensuring that all Orings are clean and undamaged.	1	2	3	4	5	6
14. Repeat steps 7 to 13 for each SOVn.						

15. Ensure the bleedscrew on top of the junction box lid of the sample loop manifold is tight.	

NOTES:

5.5. RE-DEPLOYMENT SAMPLE LOOP PRESSURE TEST

Completing a sample loop pressure test after replacement of SOVs for a re-deployment is essential. The test involves sealing all sample cylinders with atmospheric pressure inside and then increasing the sample loop pressure to 50barg with Nitrogen and holding for a period of time. If any of the SOVs are leaking then the corresponding sample cylinder pressure will increase.

Nitrogen charging must be from a gas cylinder fitted with a regulator. Nitrogen pumps which may be available for pipe purging or other operations are not suitable for the small volumes within the sample cylinders. Gas regulators have different pressure ranges. Ensure the regulator range is suitable and set for the required pressure.

OPERATION	**RESULT/COMMENT**						
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.							
2. Record the name of the operator completing these operations.							
3. Record the date that these operations were completed.							
4. Record project and pipeline names and/or reference numbers.							
5. Record MEG skid serial number which can be found on the frame identification plate.							
6. Fully open all sample cylinder needle valves to vent the sample cylinder to atmospheric pressure 0barg.	Tick						
	1	2	3	4	5	6	M
7. Fully close all sample cylinder needle valves to trap atmospheric pressure 0barg inside each sample cylinder.	1	2	3	4	5	6	M
8. Ensure the ROV EMERGENCY SAMPLE valve is in the CLOSED position							
9. Ensure the SAMPLE MANIFOLD BYPASS valve is in the OPEN (non-bypass) position.							
10. Seal the skid sample OUTLET.							
11. Connect a Nitrogen supply to the skid sample INLET.							
12. Increase the sample loop pressure to 50barg.							
13. Hold the sample loop pressure for until the pressure drop is within 0.1barg/minute and for at least 1 hour.							
14. Connect the charge manifold to sample cylinder needle valve NVSn. See 1.8 CHARGE MANIFOLD.	1	2	3	4	5	6	M
15. Close the charge manifold needle valve.	1	2	3	4	5	6	M
16. Open sample needle valve NVSn.	1	2	3	4	5	6	M

17. Confirm that the sample cylinder contains atmospheric pressure 0barg. If the sample cylinder contains elevated pressure then it indicates that SOVn or ROV MANUAL SAMPLE valve is leaking.	SC1						
	SC2						
	SC3						
	SC4						
	SC5						
	SC6						
	SCM						
18. Slowly open the charge manifold needle valve to vent any pressure and remove the charge manifold.	1	2	3	4	5	6	M
19. Repeat steps 14 to 18 for each sample cylinder Sn.							
20. Bleed off all pressure from the sample loop and remove the Nitrogen supply. Nitrogen is an asphyxiant and must be vented to a well ventilated area.							
NOTES:							

5.6. RE-DEPLOYMENT SAMPLE MANIFOLD BYPASS VALVE INTEGRITY TEST

Completing a SAMPLE MANIFOLD BYPASS valve integrity test is required if the system is going to be deployed in sample manifold bypass mode. The test involves isolating the sample manifold by closing the SAMPLE MANIFOLD BYPASS valves and then pressurising the outer sample loop (with OUTLET blanked). Any pressure rise in the sample manifold pressure sensor (via the Controller LOG) will illustrated that either the SAMPLE MANIFOLD BYPASS valve or sample manifold NRV are passing.

OPERATION	**RESULT/COMMENT**
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.	
2. Record the name of the operator completing these operations.	
3. Record the time and date that these operations were completed.	
4. Record project and pipeline names and/or reference numbers.	
5. Record MEG skid serial number which can be found on the frame identification plate.	
6. Ensure the sample manifold is at atmospheric pressure by ensuring the skid OUTLET is open and checking the sample manifold pressure; this is achieved by downloading the controller LOG and examining the last entries	
7. Seal the skid sample OUTLET.	
8. Ensure the SAMPLE MANIFOLD BYPASS valve is in the BYPASS position	
9. Power on the Controller	
10. Connect a Nitrogen supply to the skid sample INLET.	
11. Increase the sample loop pressure to 50barg.	
12. Hold the sample loop pressure for until the pressure drop is within 0.1barg/minute	Pressure change: barg/min
13. At the end of the hold period, download last segment of the controller LOG and confirm there has been no pressure change in the sample manifold.	
14. Release pressure and remove the OUTLET seal.	
15. Download the LOG and then Power off the controller	
NOTES:	

5.7. RE-DEPLOYMENT SAMPLE CYLINDER PRESSURE TEST

Completing a sample cylinder pressure test after replacement of SOVs for a re-deployment is essential. The test involves sealing the sample loop with atmospheric pressure inside and then charging each of the sample cylinders with 50barg of nitrogen and holding for a period of time. If one of the SOVs are leaking then the sample loop pressure will increase. If one of the sample cylinder needle valves are leaking then the sample cylinder pressure will decrease but sample loop pressure will remain constant.

Nitrogen charging must be from a gas cylinder fitted with a regulator. Nitrogen pumps which may be available for pipe purging or other operations are not suitable for the small volumes within the sample cylinders. Gas regulators have different pressure ranges. Ensure the regulator range is suitable and set for the required pressure.

OPERATION	**RESULT/COMMENT**						
1. Print a copy of this table and fill in the relevant sections as operations are completed. The completed table should be retained as a record that operations were completed.							
2. Record the name of the operator completing these operations.							
3. Record the time and date that these operations were completed.							
4. Record project and pipeline names and/or reference numbers.							
5. Record MEG skid serial number which can be found on the frame identification plate.							
6. Fully open the skid sample INLET to vent the sample loop to atmospheric pressure 0barg.							
7. Seal both the skid sample INLET and skid sample OUTLET to trap atmospheric pressure 0barg inside the sample loop.							
8. Ensure the SAMPLE MANIFOLD BYPASS valve is on the OPEN (non-bypass) position.							
9. Ensure the ROV EMERGENCY SAMPLE valve is in the CLOSED position							
10. Power up the controller using either the internal battery (pre-change) or external power. Confirm pressure is 0barg.							
11. Connect the charge manifold to the NVSn quick connect stem. See 1.8 CHARGE MANIFOLD.	Tick						
	1	2	3	4	5	6	M
12. Connect the nitrogen supply to the charge manifold.	1	2	3	4	5	6	M

13. Open NVSn.	1	2	3	4	5	6	M
14. Open the nitrogen regulator valve and increase nitrogen pressure to 50barg.	1	2	3	4	5	6	M
15. When pressure is stable, close the sample charge manifold isolation valve and record the charge pressure.	SC1 barg						
	SC2 barg						
	SC3 barg						
	SC4 barg						
	SC5 barg						
	SC6 barg						
	SCM barg						
16. Remove the pressure from the nitrogen regulator and hose. Nitrogen is an asphyxiant and must be vented to a well ventilated area.	1	2	3	4	5	6	M
17. Hold pressure until the pressure drop is less than 0.1barg/minute.	SC1: barg/min						
	SC2: barg/min						
	SC3: barg/min						
	SC4: barg/min						
	SC5: barg/min						
	SC6: barg/min						
	SCM: barg/min						
18. Confirm pressure in sample loop remains at ~0barg (as recorded in step 10). Any increase shows a leakage across the SOV which should be re-oiled or changed (ref 5.4 RE-DEPLOYMENT SOV INSTALLATION).	1	2	3	4	5	6	M
19. Vent the sample cylinder	1	2	3	4	5	6	M
20. Repeat steps 11 to 19 for each sample cylinder.							
21. Power off the controller.							
NOTES:							

6. CONTROLLER SETTINGS

This section provides guidance on several critical controller settings which must be configured and/or checked during section 2.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION. For further details see the MEG ARTS CONTROLLER manual.

6.1. CONTROLLER DATE AND TIME

Every logged reading is time stamped using the controller date and time. The time zone is normally set to GMT however if a project specific time zone is required then date and time can be set using the ROV menu switch.

6.2. LOG INTERVAL

The LOG INTERVAL is the period at which the controller logs readings of the data below.

- Date and time
- Density
- Temperature
- Pressure
- Density status value
- Sample state

The table below provides a guide to the time before the log memory will become full at which point the controller will either stop logging or start overwriting the oldest entries depending on the LOG OVERWRITE setting as per section 6.3 LOG OVERWRITE.

Log Interval (Seconds)	Logging capacity
1	2 days 23 hours
2	5 days 23 hours
5	14 days 22 hours
10	29 days 20 hours

Table 2 Logging capacity

Logging commences as soon as the unit is turned on (or logging is enabled). Logging stops as soon as the unit is turned off (or logging disabled).

The LOG INTERVAL can be set using the ROV menu switch or by using serial command "I".

6.3. LOG OVERWRITE

If the LOG OVERWRITE setting is ON then when the controller memory becomes full the controller shall continue logging by overwriting the oldest data first.

If the LOG OVERWRITE setting is OFF then when the controller memory becomes full the controller shall stop logging.

LOG OVERWRITE can be set via the ROV menu switch or by using the serial command "J".

6.4. SAMPLE TIME

The sample time setting defines how long each SOV shall remain open for when a sample is triggered. The time chosen will depend on the expected pressure differential between the skid sample INLET and the sample cylinder pre-charge pressure (see section 2.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE). Any significant pressure drops at the expected sample flow rate prior to the skid sample INLET must be considered. Guide values are provided in Table 3 Guidance sample time settings.

Pressure differential between skid sample INLET and sample cylinder pre-charge at sample flow rate (bar)	**Assumed sample flow rate** (litres/minute)	**SAMPLE TIME** (seconds)
3..7	6	5
7..40	15	2
40..300	30	1

Table 3 Guidance sample time settings

A sample time that is too short may not collect a full sample. A sample time that is too long may risk losing nitrogen pre-charge (see section 2.3 PRE-DEPLOYMENT SAMPLE NITROGEN PRE-CHARGE).

Sample time can be set via the ROV menu switch or by using the serial command "K".

6.5. SAMPLE MODES AND TRIGGER LEVELS

Samples may be configured to trigger manually via the ROV sample switch or automatically when the density reading is above or below a configured density trigger level.

Once a sample has been captured it cannot be retriggered without resetting all the samples using the ROV menu switch or by using serial command "GR". Resetting all samples should only take place after unloading all physical captured samples.

Sample modes and trigger levels can be set via the ROV menu switch or by using serial command "Ln" where n is the sample number.

Sample status can be determined by referring to section 1.2 CONTROLLER DEFAULT SCREEN.

6.5.1. MANUAL SAMPLES

Samples configured in manual mode during section 2.2 PRE-DEPLOYMENT CONTROLLER CONFIGURATION will trigger when the ROV SAMPLE switch is rotated from the OFF position to the ON position and held in this position for at least 1 second. The next sample will not trigger until the ROV sample switch has been moved back to the OFF position first.

Only one sample can be collected at a time. If a manual sample is requested while another sample is in progress the new request will be ignored.

Samples configured for manual trigger will be triggered in numerical order. E.g. if samples 1, 3 and 6 are configured for manual trigger then they will be triggered in sequence 1, 3, 6.

See also section 1.3 ROV SWITCHES.

6.5.2. AUTOMATIC SAMPLES

Samples configured for automatic trigger will trigger when the density reading is above or below a configured density trigger level. Each sample can be configured with a different density trigger level.

E.g. if sample 1 is configured with trigger level 1024.0 ABOVE then it will be triggered if the density reading is equal to or above 1024.0kg/m^3.

E.g. if sample 6 is configured with trigger level 1035.6 BELOW then the trigger will be ignored until the density rises above the 1035.6kg/m^3. The sample will then be triggered if the density reading falls to equal to or below 1035.6kg/m^3.

Only one sample can be collected at a time. If an automatic sample is requested while another sample is in progress then the new sample shall not commence until the current sample is finished (assuming the trigger criteria for the new sample is still met). If a manual sample was requested while another sample is in progress, the manual sample must be re-triggered once the current sample completes.

6.6. PRESSURE SENSORS

There are two pressure sensors in the system, one in the controller and one in the sample manifold. Both sensors are logged as this also allows identification that the SAMPLE MANIFOLD BYPASS valve is open or closed.

The controller shows the controller pressure sensor (PR1) unless it has failed where it will then show the manifold pressure (PR0).

6.7. LOG

The controller log records the data for later examination, an entry is made into the log at the LOG INTERVAL rate. The log is produced in the following format.

LOG Address	Date/Time	Battery	Pressure (barg)	Temp. (degC)	Density (kg/m^3)	Controller Status	Density Sensor Status	SOV Status
00:000	20/03/2019 08:00:25	CD	0.0	17.2	1000.0	7	4	0

There are two batteries (controller and SOV) and two pressure (Controller and Manifold) sensors in the system, these are logged interleaved in the log. The Controller Status allows determination of which is being logged.

The Controller Status is made up of binary 4-bits as shown:

Bit Number	3	2	1	0
Function	Reserved Usually 0	Pressure Sensor 0 = Manifold 1 = Controller	Battery Source 0= Controller 1= SOV	Reserved Usually 1

A status of 7 (0111_2) shows Battery Source = SOV and Pressure Sensor source = Controller.

The LOG is downloaded using the "U" command and can take 45 minutes for a full LOG.

6.8. BATTERY PACKS

There are two battery packs in the controller. One for the controller itself and the other to power the SOVs.

The status of both battery packs is shown on the controller.

The SOV battery pack is a dual pack, i.e. it contains two battery sub-packs. It is recommended that once used, the connector that was used is cut off to ensure it cannot be accidentally used again.

7. MAINTENANCE

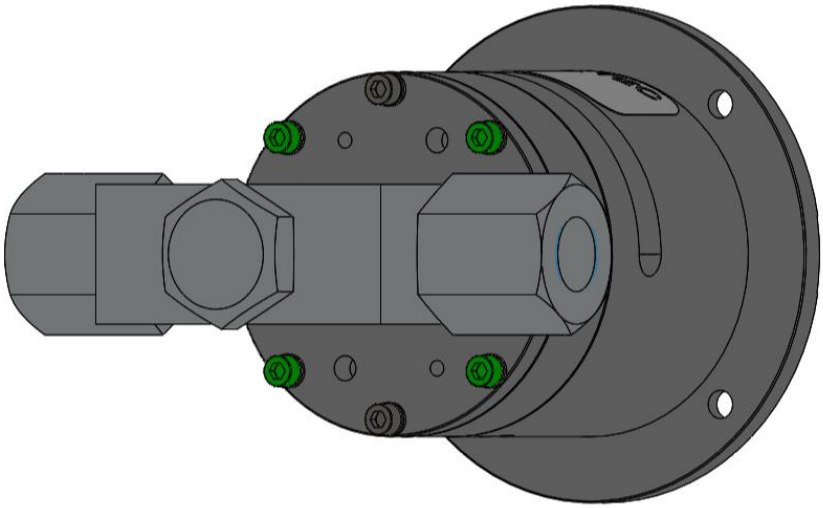
All Online Electronics Ltd products are designed to require minimum maintenance. The unit should be cleaned externally using fresh water and cleaning agents as necessary. Do not use chemicals which could be damaging to the paint, housing, the nitrile rubber O-rings, the acrylic window, or any connectors.

Internal tubing, cylinders, valves etc can be cleaned as per section 5 RETURN / RE-DEPLOYMENT OPERATIONS.

7.1. ROV VALVE MAINTENANCE

The ROV EMERGENCY SAMPLE valve and SAMPLE MANIFOLD BYPASS valves are designed to be low maintenance valves. However, if the valves are found to be passing, the following procedure can be used to change the ball seat assembly.

Remove the valve from the skid, the valve must be split from the ROV actuator via 4x hex bolts in green below:



Ball Seat Assembly Replacement

1. Both ball seat assemblies should be replaced at the same time to ensure even seal quality.
2. While securely holding the seat glands and body, loosen the tubing connections.
3. Hold the body in a vice and unscrew and remove the seat gland assembly. Note the orientation of all the components. Remove the ball seat assembly.
4. Place the replacement ball seat assembly into the seat gland assembly.
5. Lubricate all threads with an anti-seize lubricant.
6. Assemble the seat gland assemblies into the valve body until hand-tight.
7. Complete assembly of the seat glands evenly using a wrench, using the following recommendations:
   -71, -72, -73: 50ft-lb
   -74, -75, -76: 70ft-lb
   -80, -81, -82: 100ft-lb

Reassembly valve into the skid and pressure check using procedures as appropriate:
5.5 RE-DEPLOYMENT SAMPLE LOOP PRESSURE TEST
5.6 RE-DEPLOYMENT SAMPLE MANIFOLD BYPASS VALVE INTEGRITY TEST
5.7 RE-DEPLOYMENT SAMPLE CYLINDER PRESSURE TEST

7.2. ZINC ANODES

The skid is fitted with 2x zinc anodes to prevent corrosion of the unit. When new the anodes have dimensions of ø100mm x 25mm and weight 1.4kg. If the anodes are wasted by 50% or more then follow the steps below to replace them.

1. Remove old Zinc anodes by removing M5 nut and washers
2. Replace Zinc Anode and refit M5 nut and washers
3. Ensure continuity between zinc anode and an exposed part of the skid is less than 1Ω
4. Confirm electrical continuity of less than 1Ω between the new anode and an exposed part of the skid frame.

Figure 10 Zinc anode

7.3. CONNECTOR MAINTENANCE

Subsea connectors require regular cleaning and lubrication to ensure that contacts are clean, electrically isolated from each other and to prevent water intrusion when submerged. Before every deployment all subsea connectors and cables should be visually inspected for any visible signs of damage or mistreatment such as cable sheath damage, crush damage, bending damage, poorly mated or misaligned connectors etc. All subsea connectors must be sealed if submerged subsea to prevent water ingress and corrosion. Seal all unused connectors with appropriate blanking caps or plugs.

Every time a connector is unmated and at least every 12 months all connectors should be inspected as follows:

1. Un-mate the connector without pulling on the cable and with no rocking or twisting motions.
2. Inspect both mating halves of the connector. Check that all connector contacts are free of any accumulation of chemical deposits, saltwater, sand, mud or other debris. Check that all contacts are undamaged and aligned properly.
3. Accumulation of debris or corrosion should first be removed with fresh water and a brush where required and then cleaned with a suitable contact cleaner and lubricant. Do not use chemicals which could damage the connector rubber such as WD40.
4. Any O-rings must be inspected and if marked or damaged they must be replaced.
5. Before mating ensure that all connector rubber surfaces and any O-rings are lightly lubricated to prevent delamination of the rubber during mating. Molykote 111 grease is a suitable lubricant but should be used sparingly as too much build-up of the grease can affect electrical connection integrity and can deform the connector.
6. When mating connectors the two halves should be pushed squarely together with no rocking or twisting motions. If the connectors have to be forced together then something is probably wrong. Do not use the locking sleeve to pull or force the connectors together. Do not over tighten the locking sleeve as this can deform the contact alignment. Locking sleeves should be tightened firmly by hand only, when the connector is subsea the water pressure will hold the connections tightly together.

8. DISPOSAL OF UNIT

Online Electronics Ltd (OEL) takes its responsibilities under the WEEE Regulations extremely seriously and has taken steps to be compliant in line with our corporate and social responsibilities. In the UK, OEL has joined a registered compliance scheme WeeeCare (registration number **WEE/MP3538PZ/SCH**).

Electrical and electronic equipment should never be disposed of with general waste but must be separately collected for the proper treatment and recovery.

The crossed out bin symbol, placed on the product, reminds you of the need to dispose of it correctly at the end of its life.

When buying a new product you will have the possibility to return, free of charge, another end of life product of equivalent type that has fulfilled the same functions as the supplied equipment. These items may be deposited at:

Online Electronics Ltd
Online House
Blackburn Business Park
Woodburn Road
Aberdeen,
AB21 0PS UK

Alternatively, to arrange a collection of any waste electrical equipment, obligated to OEL please telephone WeeeCare on **0844 800 2004**.

8.1. WASTE HANDLING

The following is related to UK and regulations may vary depending on the country of operation.

MEG remaining from processes is hazardous waste (special waste in Scotland) if it contains 25% or more of a harmful substance according to the European Waste Framework Directive Article 2. Classification according to the European Waste Catalogue is 16 01 14 antifreeze fluids containing dangerous substances. The mirror classification for the non-hazardous mixture is 16 01 15 antifreeze fluids other than those mentioned in 16 01 14. Documentation is required showing concentrations for the non-hazardous mixture. Mixing of waste is not allowed. MEG remaining from samples will have been diluted during the process of flushing defined in this procedure.

Use the portable density meter to confirm whether or not there is less than 25% MEG in the water waste.

The density of 25% MEG in water is given below.

Temperature (°C)	5	10	15	20	25
Density (kg/m^3)	1037	1036	1034	1032	1029

The density of 25% MEG in seawater is given below.

Temperature (°C)	5	10	15	20	25
Density (kg/m^3)	1058	1057	1055	1052	1049

A measured density below the relevant value above shows that the waste is non-hazardous.