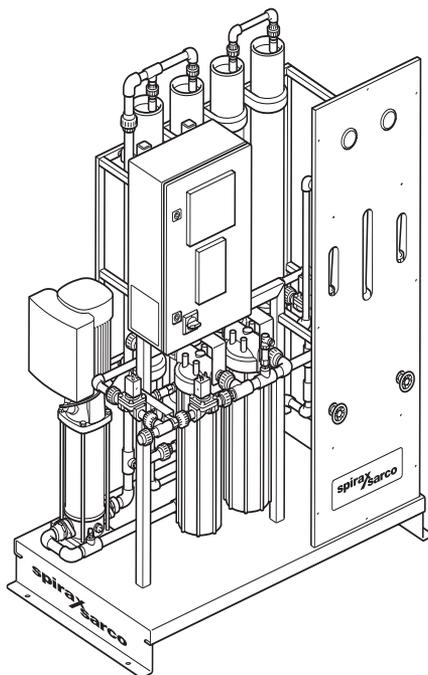


Compact Reverse Osmosis (RO) System

Installation and Maintenance Instructions



1. Safety information
2. General product information
3. Installation
4. Commissioning
5. Operation
6. Maintenance

1. Safety information

Note: This document refers only to the mechanical installation and commissioning of the Spirax Compact Reverse Osmosis System and should be used in conjunction with the relevant IMIs for the other system components and supplementary safety information for all the system components.

Warning

This product is designed and constructed to withstand the forces encountered during normal use.

Use of the product for any purpose other than its intended use could cause damage to the product and may cause injury or fatality to personnel.

Before any installation or maintenance procedure, always ensure that all associated primary steam, condensate return and secondary water lines are isolated.

Ensure any residual internal pressure in the system or connecting pipework is carefully relieved.

Always wear appropriate safety clothing before carrying out any installation or maintenance work.

Lifting

The Spirax Compact Reverse Osmosis System should be lifted by a suitable forklift truck, from the base, placed in position and securely bolted to the floor*.

- * Please note: As the weight of the water is perceived to be sufficient to keep the unit safely in position it only needs to be bolted to the floor at the customers request.

Warning:

On no account is the Spirax Compact Reverse Osmosis System to be lifted by any other part, other than the base.

Note: Sufficient space should be provided around the system location to allow access for maintenance.

Safe operation of these products can only be guaranteed if they are properly installed, commissioned, used and maintained by qualified personnel (see Section 1.11) in compliance with the operating instructions. General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied with.

1.1 Intended use

Referring to the Installation and Maintenance Instructions, name-plate and Technical Information Sheet, check that the product is suitable for the intended use/application. These products comply with the requirements of the European Pressure Equipment Directive 97/23/EC and fall within category 'SEP'. It should be noted that products rated as 'SEP' are required by the Directive not to carry the CE mark.

- i) The product has been specifically designed for use on water which is in Group 2 of the above mentioned Pressure Equipment Directive. The products' use on other fluids may be possible but, if this is contemplated, Spirax Sarco should be contacted to confirm the suitability of the product for the application being considered.
- ii) Check material suitability, pressure and temperature and their maximum and minimum values. If the maximum operating limits of the product are lower than those of the system in which it is being fitted, or if malfunction of the product could result in a dangerous overpressure or overtemperature occurrence, ensure a safety device is included in the system to prevent such over-limit situations.
- iii) Determine the correct installation situation and direction of fluid flow.
- iv) Spirax Sarco products are not intended to withstand external stresses that may be induced by any system to which they are fitted. It is the responsibility of the installer to consider these stresses and take adequate precautions to minimise them.
- v) Remove protection covers from all connections and protective film from all name-plates, where appropriate, before installation on steam or other high temperature applications.

1.2 Access

Ensure safe access and if necessary a safe working platform (suitably guarded) before attempting to work on the product. Arrange suitable lifting gear if required.

1.3 Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required.

1.4 Hazardous liquids or gases in the pipeline

Consider what is in the pipeline or what may have been in the pipeline at some previous time. Consider: flammable materials, substances hazardous to health, extremes of temperature.

1.5 Hazardous environment around the product

Consider: explosion risk areas, lack of oxygen (e.g. tanks, pits), dangerous gases, extremes of temperature, hot surfaces, fire hazard (e.g. during welding), excessive noise, moving machinery.

1.6 The system

Consider the effect on the complete system of the work proposed. Will any proposed action (e.g. closing isolation valves, electrical isolation) put any other part of the system or any personnel at risk?

Dangers might include isolation of vents or protective devices or the rendering ineffective of controls or alarms. Ensure isolation valves are turned on and off in a gradual way to avoid system shocks.

1.7 Pressure systems

Ensure that any pressure is isolated and safely vented to atmospheric pressure. Consider double isolation (non return valve) and the locking or labelling of closed valves. Do not assume that the system has depressurised even when the pressure gauge indicates zero.

1.8 Temperature

The Spirax Compact Reverse Osmosis System is a cold water device, designed for maximum temperatures of 40°C - this temperature should not be exceeded. Failure to do so would cause critical membrane failure.

1.9 Tools and consumables

Before starting work ensure that you have suitable tools and/or consumables available. Use only genuine Spirax Sarco replacement parts.

1.10 Protective clothing

Consider whether you and/or others in the vicinity require any protective clothing to protect against the hazards of, for example, chemicals, high/low temperature, radiation, noise, falling objects, and dangers to eyes and face.

1.11 Permits to work

All work must be carried out or be supervised by a suitably competent person. Installation and operating personnel should be trained in the correct use of the product according to the Installation and Maintenance Instructions.

Where a formal 'permit to work' system is in force it must be complied with. Where there is no such system, it is recommended that a responsible person should know what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety.

Post 'warning notices' if necessary.

1.12 Handling

Manual handling of large and/or heavy products may present a risk of injury. Lifting, pushing, pulling, carrying or supporting a load by bodily force can cause injury particularly to the back. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done.

Please note that if lifting straps are required we would recommend that they be fitted around the baffle plate legs to prevent damage to the unit.

2. General product information

2.1 General information

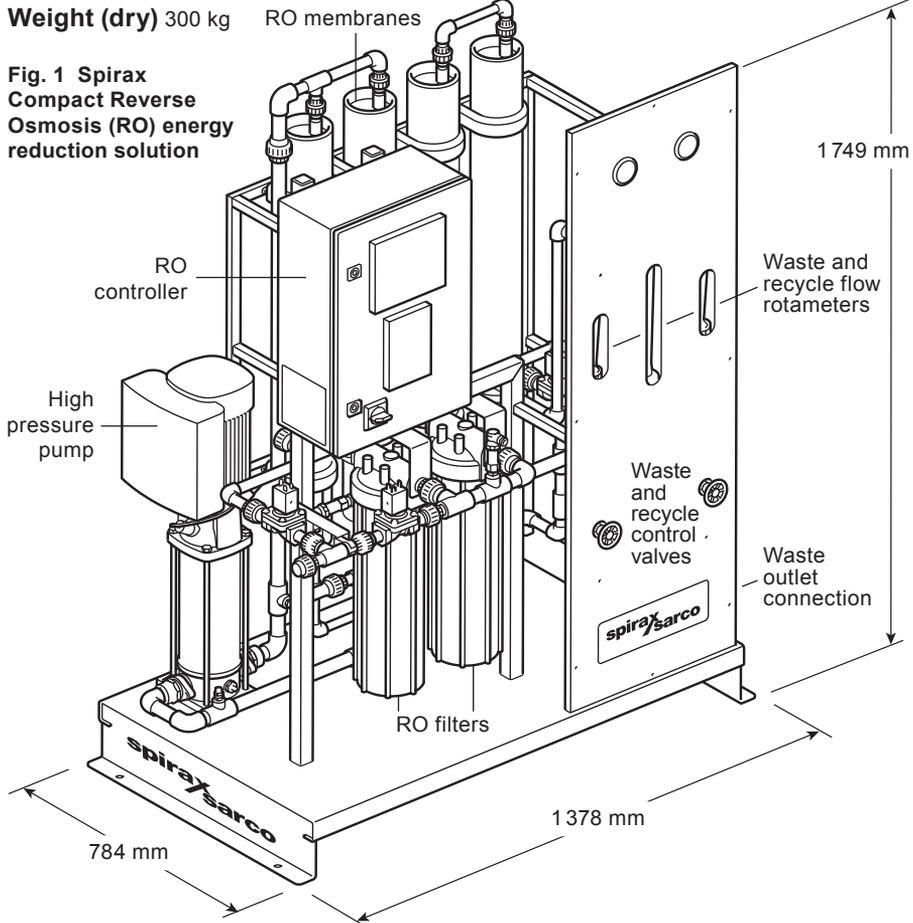
The Spirax Compact Reverse Osmosis (RO) System is designed to provide high quality water for boiler feedwater, process applications and effluent treatment. Used with the correct water treatment, it can provide energy savings by reducing boiler blowdown. It also reduces steam side corrosion by reducing the feedwater alkalinity.

The standard unit caters for flowrates of up to 2 m³/h, but is scalable to 6 m³/h.

The unit is supplied fully assembled and tested, ready for installation.

2.1.1 Dimensions / weight and key RO components

The Spirax Compact Reverse Osmosis (RO) System consists of the following core items:



Notes:

1. For additional information about any particular product used in the construction of this unit see the relevant product specific Technical Information (TI) sheet.
2. For further technical information regarding the Spirax Compact Reverse Osmosis (RO) System see the Technical Information sheet TI-UK-RO.

2.2 Reverse osmosis operation

The control system of the Spirax Reverse Osmosis plant is based around a control device with fixed algorithms. This controller governs the automation and control of the process. A series of valves are used with a high pressure pump and membranes, regimented and controlled by a HMI and PLC.

Process overview

RO relies on semi-permeable membranes, which have pores so fine that only water molecules are small enough to pass through them. In nature, similar membranes are responsible for regulating the water and nutrient levels in living cells. In industrial applications, pumps apply pressure to the raw water side and force pure water through a synthetic membrane, leaving salts and other contaminating molecules behind. Probably the easiest way to visualize RO is as a filtration system.

For most applications it is envisaged that Spirax RO systems will be used to clean raw water that enters steam generators, boilers and hot water systems. This application ensures the boiler TDS is optimized for the most efficient running capacity. Its primary function will be to reduce boiler blowdown frequency, saving significant energy losses.

2.3 The Spirax RO unit nomenclature

The product nomenclature is a reflection of the core items and unit options that have been ordered and supplied - See table below:

Instrumentation

Tag No.	Description
C01	Feedwater conductivity probe
C02	Product water conductivity probe
PT01	Feedwater pre filter pressure
PT02	Feedwater post filter pressure
PS01	HP pump high pressure switch

Drives

Tag No.	Description
P1	HP pump

Diverters

Tag No.	Description
V1	Feedwater isolation solenoid valve
V2	Feedwater bypass solenoid valve
V3	Product water outlet isolation solenoid valve

2.4 Operation

Manual control

Each of the following plant items shall have the facility for manual control. It remains the responsibility of the person placing any device into manual control to ensure the safety of plant, people and process.

Instrumentation

Tag No. Description

C01	Feedwater conductivity probe
C02	Product water conductivity probe
PT01	Feedwater pre filter pressure
PT02	Feedwater post filter pressure
PS01	HP pump high pressure switch

Drives

Tag No. Description

P1	HP Pump
V1	Feedwater Isolation Solenoid Valve
V2	Feedwater Bypass Solenoid Valve
V3	Product Water Outlet Isolation Solenoid Valve

If any of the items above are placed into Manual control and are therefore unavailable for automatic control an alarm shall be raised on the HMI.

Stopped / Idle

When idle and before entering the start-up routine, i.e. on initial power up, the valves will be orientated as follows;

<input type="checkbox"/>	V01 Feedwater isolation valve	CLOSED
<input type="checkbox"/>	V02 Feedwater bypass valve	OPENED
<input type="checkbox"/>	V03 Product water outlet valve	CLOSED
<input type="checkbox"/>	P1 HP Pump	OFF

Start-up

On receipt of an enable system, either from a remote source or via the start button from the HMI, providing that the RO system has all the required devices in Auto, then the following start up operation will occur;

<input type="checkbox"/>	V01 Feedwater isolation valve	OPENED
<input type="checkbox"/>	V02 Feedwater bypass valve	CLOSED
<input type="checkbox"/>	V03 Product water outlet valve	OPENED
<input type="checkbox"/>	P1 HP Pump	ON

High permeate conductivity (C02)

If the conductivity probe (C02) registers a conductivity measurement higher than the high permeate alarm set point, the HMI alarm shall be raised and the following control actions will take place;

<input type="checkbox"/>	V01 Feedwater isolation valve	OPENED
<input type="checkbox"/>	V02 Feedwater bypass valve	CLOSED
<input type="checkbox"/>	V03 Product water outlet valve	CLOSED
<input type="checkbox"/>	P1 HP Pump	ON

Prolonged high permeate conductivity (C02)

If the conductivity probe C02 continues to register high conductivity measurement the HMI alarm shall be raised and the following control actions will take place;

<input type="checkbox"/>	V01 Feedwater isolation valve	CLOSED
<input type="checkbox"/>	V02 Feedwater bypass valve	CLOSED
<input type="checkbox"/>	V03 Product water outlet valve	OPENED
<input type="checkbox"/>	P1 HP Pump	OFF

High raw water feedline Conductivity (C01)

If the conductivity probe C01 registers a conductivity measurement higher than the raw water set point and the HMI alarm shall be raised and the following controlling actions will take place;

<input type="checkbox"/>	V01 Feedwater isolation valve	CLOSED
<input type="checkbox"/>	V02 Feedwater bypass valve	CLOSED
<input type="checkbox"/>	V03 Product water outlet valve	OPENED
<input type="checkbox"/>	P1 HP Pump	OFF

Feedwater pre filter pressure (PT01)

If the feedwater pre filter pressure transducer (PT01) registers a high pressure measurement, the HMI alarm shall be raised and the following control actions will take place;

<input type="checkbox"/>	V01 Feedwater isolation valve	CLOSED
<input type="checkbox"/>	V02 Feedwater bypass valve	CLOSED
<input type="checkbox"/>	V03 Product water outlet valve	OPENED
<input type="checkbox"/>	P1 HP Pump	OFF

High HP pump pressure (PS01)

If the pressure switch (PS01) is registering a high pressure, the HMI alarm shall be raised and the following control actions will take place;

<input type="checkbox"/>	V01 Feedwater isolation valve	CLOSED
<input type="checkbox"/>	V02 Feedwater bypass valve	CLOSED
<input type="checkbox"/>	V03 Product water outlet valve	OPENED
<input type="checkbox"/>	P1 HP Pump	OFF

Feedwater post filter pressure (PT02)

If the feedwater post filter pressure transducer (PT02) registers a high pressure measurement, the HMI alarm shall be raised and the following control actions will take place;

<input type="checkbox"/>	V01 Feedwater isolation valve	CLOSED
<input type="checkbox"/>	V02 Feedwater bypass valve	CLOSED
<input type="checkbox"/>	V03 Product water outlet valve	OPENED
<input type="checkbox"/>	P1 HP Pump	OFF

3. Installation

Note: Before actioning any installation observe the 'Safety information' in Section 1.

3.1 Water connections

It is important that the raw water supply is of softened water quality at all times. The supply water must have:

- A minimum pressure of 4 bar. Failure to achieve this could result in the plant tripping out on low pressure.
- A free chlorine (or total oxidant) level less than 0.1 mg/l.
- No abnormally high levels of iron, manganese or organics.
- Total Hardness levels <4mg/l.
- (SDI) <5
- Temperature <40°C maximum.

Pressure / temperature limits

Pump suction side	Maximum operating pressure	5 barg
	Maximum operating temperature	40°C
	Test pressure	6 .2 bar g @ 20°C
Pump delivery side	Maximum operating pressure	13 .6 bar g
	Maximum operating temperature	40°C
	Test pressure	15 bar g @ 20°C

Connections

Softened water inlet	RO water outlet	Drain	By-pass
All ¾"			

The water supply should comply to the statements above and water temperature should never exceed 40°C.

The water supply should always be maintained at the specified design pressure and temperature for the unit. The Spirax RO must not operate above the maximum pressure and temperatures indicated on the name-plate attached to the RO.

The installation of an appropriately sized non return valve on the permeate side is recommended if the permeate is connected directly to a boiler hotwell.

3.3 Electrical supply

All electrical wiring and connections should be carried out in accordance with National Regulations.

A lockable isolator / switch disconnect should be fitted adjacent to the unit.

Mains supply is directly connected to the primary side of the incoming control panel isolator as shown in the diagram below.

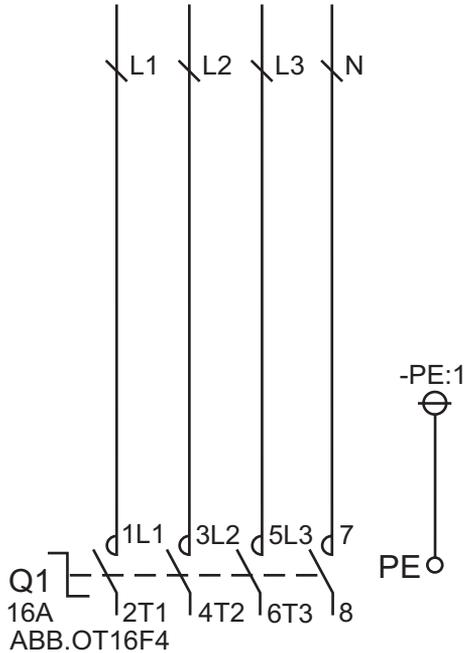


Fig. 2 400 V, 3 phase + N + E supply

Cable colours

L1	Brown	2.50 mm ² (minimum)
L2	Black	2.50 mm ² (minimum)
L3	Grey	2.50 mm ² (minimum)
N	Light blue	2.50 mm ² (minimum)
24 Vac	Red	0.50 mm ²
24 Vdc	Dark blue	0.50 mm ²
VFC	Orange	0.50 mm ²
Analogue signals		Grey screened

3.4 Electrical specifications

All control equipment is pre-wired and ready for connection to the power source (system activation via volt-free contact from level control in supply tank or hot well).

Electrical supply	Power supply	400 V, 3 phase, 50 Hz
	Supply fuse	20 A

3.5 Electrical connections

The following are available to customer connection to the Spirax Compact Reverse Osmosis (RO) System if required for general alarm;

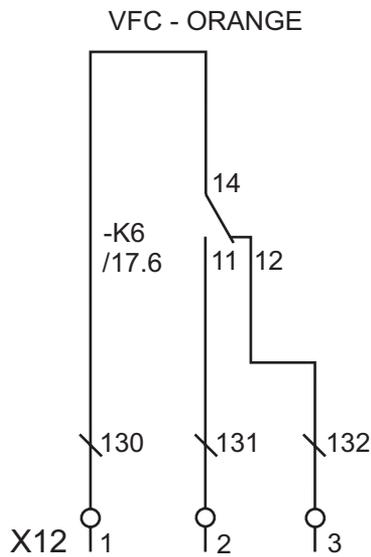


Fig. 3 General alarm

Terminal layout overview

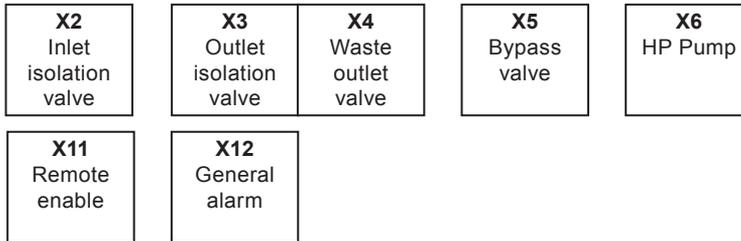


Fig. 4 Terminal layout

Terminal layout detailed

Note: for detailed wiring schematic please refer to the 'Operations manual'.

- X2 - Raw water inlet isolation valve
- X3 - Product water outlet isolation valve
- X4 - Waste water outlet isolation valve
- X5 - Raw waterfeed bypass isolation valve
- X6 - (P1) High pressure pump
- X11 - Remote enable
- X12 - General output alarm

4. Commissioning

Software copyright

Certain computer programs contained in this product [or device] were developed by Spirax-Sarco Limited ('the Work(s)').

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Spirax-Sarco Limited grants the legal user of this product (or device) the right to use the Work(s) solely within the scope of the legitimate operation of the product (or device). No other right is granted under this licence. In particular and without prejudice to the generality of the foregoing, the Work(s) may not be used, sold, licensed, transferred, copied or reproduced in whole or in part or in any manner or form other than as expressly granted here without the prior written consent of Spirax-Sarco Limited.

4.1 Commissioning requirements and tasks

We recommend that you use the service and support of a Spirax Sarco commissioning engineer. Details of this service can be found by contacting Spirax Sarco.

Note: Pre commissioning requirements:

- A minimum pressure of 4 bar. Failure to achieve this could result in the plant tripping out on low pressure.
- A free chlorine (or total oxidant) level less than 0.1 mg/l.
- No abnormally high levels of iron, manganese or organics.
- Total Hardness levels <4 mg/l.
- (SDI) <5
- Temperature <40°C maximum.
- Inspect all pipework, pumps and tanks for leaks and general condition.
- Test and prove all pump and level switch control systems.
- Test and prove the feed water to the RO plant for hardness and particulate matter.
- Check and calibrate any conductivity instruments and clean the conductivity cells.
- Test and prove all pressure switches and interlinks within the RO control system.
- Check filters have been loaded.
- Check all electrical connections are secure and as per the wiring diagram - Sections 3.3 and 3.4.
- **Complete a full RO performance tests and record the results.**

4.2 HMI quick start commissioning procedure:

The HMI display is a 7" touch screen, and the following procedures detail a basic set-up of the control system from initial power up. A more detailed description of each individual feature can be found in the full operation and maintenance manual.

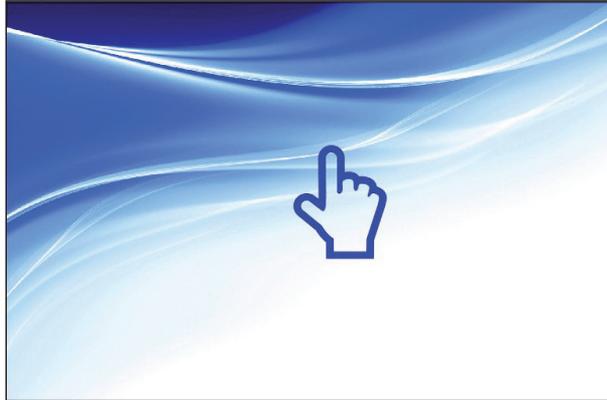


Fig. 5

When ready the above screen will appear, touch the screen.

This main screen will appear. Configuration occurs from here

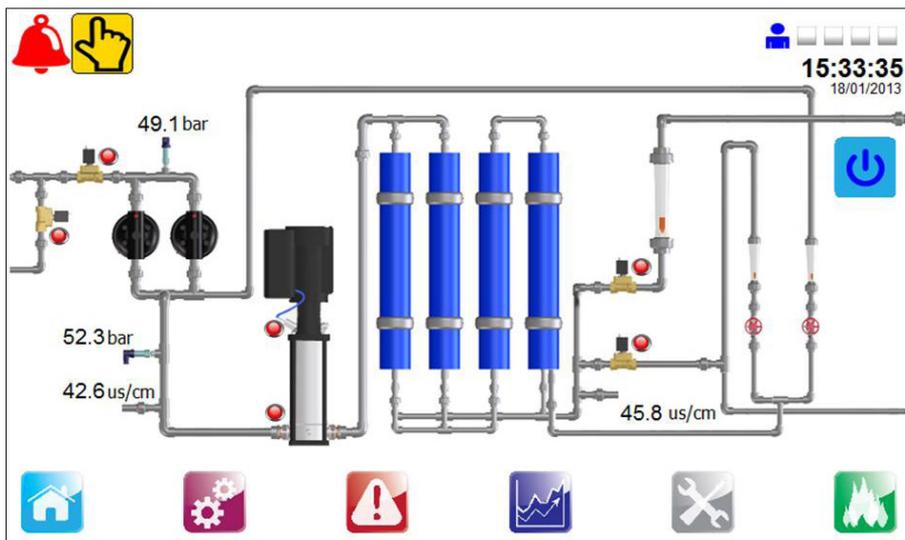


Fig. 6

Press this button



to configure Year / Month / Day / Hour / Min / Secs

15:32:59
18/01/2013

		PLC	HMI	
YYYY	<input type="text" value="2013"/>	2013	2013	U P D A T E
MM	<input type="text" value="01"/>	1	1	
DD	<input type="text" value="01"/>	18	18	
HH	<input type="text" value="12"/>	15	15	
MM	<input type="text" value="00"/>	33	33	
SS	<input type="text" value="00"/>	44	52	

Fig. 7

Press this button



to continue

	<input type="text" value="4 mA"/>	<input type="text" value="20 mA"/>
<u>ANALOG INPUT SCALING</u>		
RAW Water Feed Line Conductivity	<input type="text" value="10.00"/> $\mu\text{S/cm}$	<input type="text" value="100.00"/> $\mu\text{S/cm}$
Permeate Conductivity	<input type="text" value="10.00"/> $\mu\text{S/cm}$	<input type="text" value="100.00"/> $\mu\text{S/cm}$
RAW Water Feed Line High Pressure	<input type="text" value="10.00"/> bar	<input type="text" value="100.00"/> bar
RAW Water Feed Line Low Pressure	<input type="text" value="10.00"/> bar	<input type="text" value="100.00"/> bar
<u>ALARMS LOW/HIGH SET POINTS</u>	<input type="text" value="LOW"/>	<input type="text" value="HIGH"/>
RAW Water Feed Line Conductivity	<input type="text" value="20.00"/> $\mu\text{S/cm}$	<input type="text" value="80.00"/> $\mu\text{S/cm}$
Permeate Conductivity	<input type="text" value="20.00"/> $\mu\text{S/cm}$	<input type="text" value="80.00"/> $\mu\text{S/cm}$
RAW Water Feed Line High Pressure	<input type="text" value="20.00"/> bar	<input type="text" value="80.00"/> bar
RAW Water Feed Line Low Pressure	<input type="text" value="20.00"/> bar	<input type="text" value="80.00"/> bar

Fig. 8

This menu gives access to the analogue scaling 4-20 mA settings and alarm set points. The analogue settings will be factory set for the specific site and should not be adjusted. The Low/High alarms will be factory set, but may need to be adjusted for bespoke control.

Continuing with first operation requires further inputs

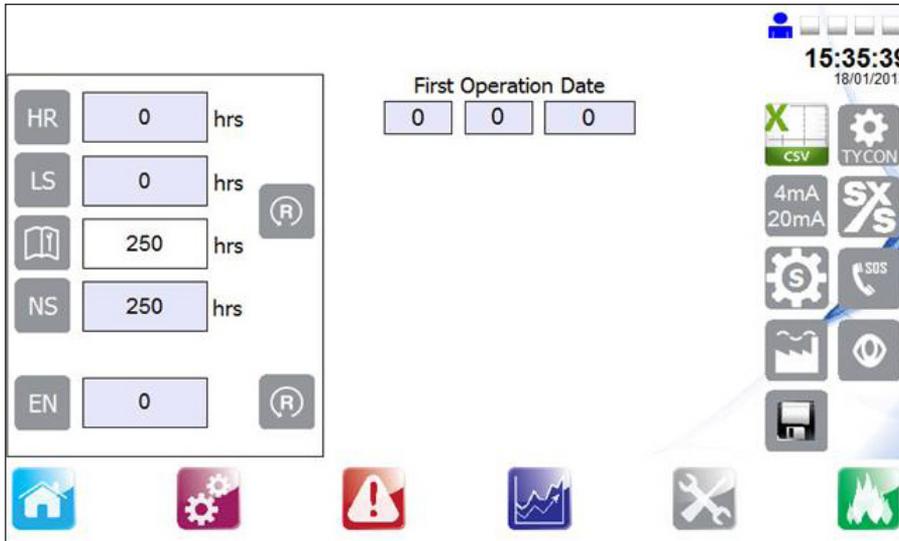


Fig. 9

This screen also shows the data logging function keys, help function and save data.

Press this button



to configure energy and membrane fouling constants

The screenshot shows a control panel interface with a top navigation bar containing a bell icon, a hand cursor icon, a fuel pump icon, and a user profile icon. The date and time are displayed as 15:33:20 on 18/01/2013. A dropdown menu is open, listing fuel types: Gas, LPG, Oil Gas, Diesel, Coal, and Wood Pellets. The main area contains several parameter fields with values in green boxes:

Condensate Conductivity		Deliverable	2000.00	l/hr	
Boiler Inlet Conductivity			24.00	hr	
Steam Rate		um Hardness	24.00	dGH	
Boiler Return Conductivity	16.00	uS/cm	Input Water Total Alkalinity	22.00	mEq/L
Original Boiler Blowdown	32.00	kg/hr	Input Water Temperature	28.00	°C
Boiler No. of bars	14.00	bar	Input Water PH	26.00	pH
Fuel Cost	0.10	£/kWh	Membrane Surface	24.00	m2

At the bottom of the screen, there are six navigation icons: a home icon, a gear icon, a warning icon, a line graph icon, a wrench and screwdriver icon, and a flame icon.

Fig. 10

Accurately enter the specific energy data to ensure that the valid energy data can be calculated.

Press this button to configure fuel type



Fuel cost £ / kWh

Work through the menu inputting accurate data

Upon completion of the above data all of the other global navigation buttons that are displayed in Figure 11 (along the base of the screen) are available for use.

4.3 Global navigation buttons



Fig. 11

The 'Home mimic' button (Figure 12) will always navigate you back to the overview of the Spirax Compact Reverse Osmosis (RO) System that has been selected and configured.



Fig. 12

From the home screen (Figure 13) the overall status and control of the Spirax RO system operation can be performed.

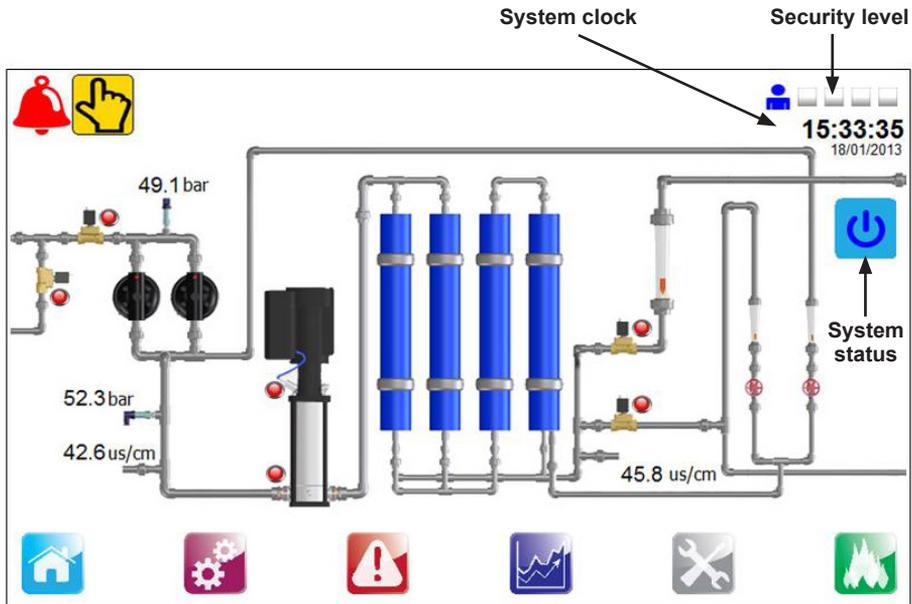


Fig. 13

Press this button



This page shows all active alarms. An active alarm is indicated on all the mimic screens via the alarm bell in the top left hand corner of the screen.

Fig. 14

From : 01/18/13 - 15:29:57 Duration : 5 Mins Refresh

To : 01/18/13 - 15:34:57

18/01/2013 15:34:59

Alarm Time	Description	Event Type	Alarm Sta
18/01/2013 15:30:02	Isolation Solenoid Valve 'V1' Manual Mode Selected	Triggered	Triggered
18/01/2013 15:30:02	RAW Water Feed Line High Pressure Under Range	Triggered	Triggered
18/01/2013 15:30:02	RAW Water Feed Line Low Pressure Under Range	Triggered	Triggered
18/01/2013 15:30:02	RO System is Due for Service	Triggered	Triggered
18/01/2013 15:30:02	RAW Water Feed Line Conductivity High	Triggered	Triggered
18/01/2013 15:30:02	Product Water Outlet Solenoid Valve 'V2' Manual Mo...	Triggered	Triggered
18/01/2013 15:30:02	RAW Water Feed Line Conductivity Low	Triggered	Triggered
18/01/2013 15:30:02	Permeate Conductivity High	Triggered	Triggered

Navigation icons: Home, Settings, Alarm, Trend, Tools, Fire.

Press this button



to configure high and low adjustments to alarms. These alarms will already be factory set but can be further tuned if required.

Fig. 15

18/01/2013 15:35:07

ALARMS LOW/HIGH SET POINTS

	LOW	HIGH
RAW Water Feed Line Conductivity	20.00 $\mu\text{S/cm}$	80.00 $\mu\text{S/cm}$
Permeate Conductivity	20.00 $\mu\text{S/cm}$	80.00 $\mu\text{S/cm}$
RAW Water Feed Line High Pressure	20.00 bar	80.00 bar
RAW Water Feed Line Low Pressure	20.00 bar	80.00 bar
Prolonged High Outlet Conductivity - Alarm Delay Time		10 sec

Navigation icons: Home, Settings, Alarm, Trend, Tools, Fire.

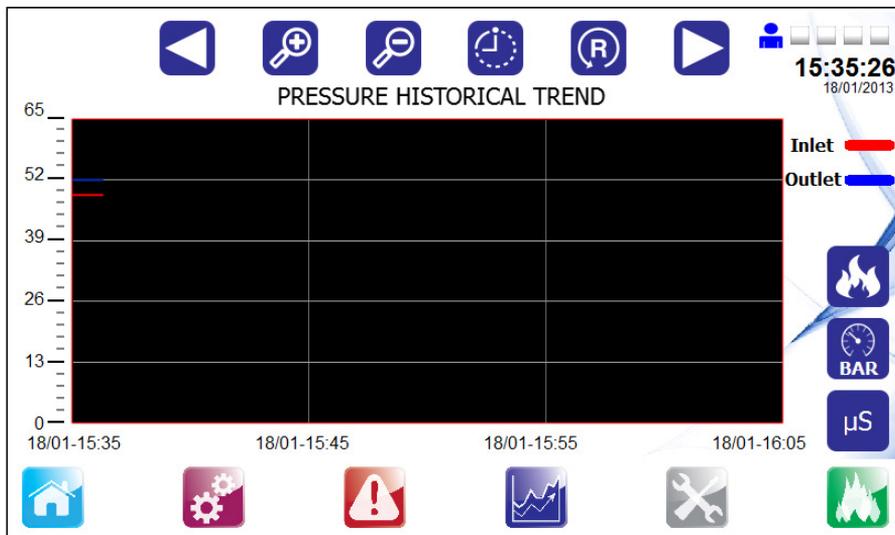


Reset general latch



Navigation to historical alarm page

Trend menu



Press this button to view current trend data

This menu provides historical trend monitoring of the process values. useful for analysing the historical reactions of the Spirax Compact Reverse Osmosis (RO) System to process conditions.



Press this button to view service information for your Spirax Compact Reverse Osmosis (RO) system

This page provides key servicing information as well as the following:

- Contact details of Spirax Sarco local office.
- Facility to monitor the inputs and outputs of the Spirax Compact Reverse Osmosis (RO) system.
- Reset the system set points back to those at the time of commissioning.

To finalise the mechanical commissioning of the system:

- Open all RO drain valves.
- Monitor the process conductivity to ensure that it is within the acceptable limits.

**The Spirax Compact Reverse Osmosis (RO) System
is now ready to be turned on**

6. Maintenance

Note: Before actioning any maintenance observe the 'Safety information' in Section 1.

6.1 General

For maintenance of the individual components that make up the system, please see the relevant product specific IMI's for the components concerned.

RO feed requirements

The RO should only be fed with a good reliable supply of softened water and adequate treated water storage facilities downstream.

The RO plant requires:

- Total hardness <4 mg/l
- Free chlorine <0.1 mg/l
- SDI <5
- Minimum of 4 bar pressure
- No abnormally high levels of iron, manganese or organics.
- Failure to remove organics and particulates of >5 SDI will result in membrane and filter fouling.

