Installation Operation Maintenance Manual

B Series Reverse Osmosis Systems With EWS 'OS3015' controller

Single phase version

Models
B2000
B4000
B5000

1.0 GENERAL NOTES

These instructions cover the B Series Range of Commercial Reverse Osmosis Systems, which includes models with nominal outputs ranging from 300 to 780 litres per hour.

It is recommended that these instructions are read throughout before commencing any work on the unit, particularly if you have no previous experience of installing and using a high pressure Reverse Osmosis System.

The instructions have been written in such a manner that the vast majority of the text applies to all the models in the range. However, in some cases, there are differences between different models, and when these result in a requirement to undertake a task in a different way, individual sections have been written to cover each case. These are clearly marked, and should be easy to identify.

2.0 THE REVERSE OSMOSIS PROCESS

2.1 Introduction

Osmosis is a natural process involving fluid flow across a semi-permeable membrane barrier. It is the process by which nutrients feed the cells in our bodies and how water gets to the leaves at the top of trees.

If you separate a solution of salts from pure water using a basic thin semi-permeable membrane like a sausage skin, the pure water passes through the membrane and tries to dilute the salt solution. If the salt solution is connected to a vertical pipe then the progressively diluted solution will fill the pipe until the 'osmotic pressure' drawing the pure water though the membrane is the same as the head of solution.

This process can be reversed - hence 'Reverse Osmosis' - by applying a higher pressure to the salt solution. Pure water will then pass the other way through the membrane in a process that is easy to visualise as 'filtration' where the filter will only let through the small water molecules and retain almost all of the other molecules.

The mechanism of water and salt separation by reverse osmosis is not fully understood at the 'atomic' level. Current scientific thinking suggests two transport models: porosity and diffusion. That is, transport of water through the membrane may be through physical pores present in the membrane (porosity), or by diffusion from one bonding site to another within the membrane. The theory suggests that the chemical nature of the membrane is such that it will absorb and pass water preferentially to dissolved salts at the solid/liquid interface. This may occur by weak chemical bonding of the water to the membrane surface or by dissolution of the water within the membrane structure. Either way, a salt

concentration gradient is formed across the solid/liquid interface. The chemical and physical nature of the membrane determines its ability to allow for preferential transport of solvent (water) over solute (salt ions).

2.2 Membrane construction

The semi-permeable membrane for reverse osmosis applications consists of a thin film of polymeric material a fraction of a millimetre thick cast on a fabric support. Commercial grade membranes have high water permeability and a high degree of semi-permeability; that is, the rate of water transport is much higher than the rate of transport of dissolved ions.

The membranes are stable over a wide range of pH and temperature, and have good mechanical integrity. The stability of these properties over a period of time at field conditions defines the commercially useful membrane life, which is in the range of 3 to 5 years. There are a number of different materials used for membranes and several ways of constructing them. This system uses a Composite polyamide spiral wound membrane.

In a spiral wound configuration two flat sheets of membrane are separated with a permeate collector channel material to form a leaf. This assembly is sealed on three sides with the fourth side left open for permeate to exit. A feed/brine spacer material sheet is added to the leaf assembly.

A number of these assemblies or leaves are wound around a central plastic permeate tube. This tube is perforated to collect the permeate from the multiple leaf assemblies. The feed/brine flow through the element is a straight axial path from the feed end to the opposite brine end, running parallel to the membrane surface. The feed channel spacer induces turbulence and reduces concentration polarisation.

The spiral membrane is then enclosed by wrapping with glass reinforced resin into which is bonded an adapter cap at each end. Water under pressure is introduced into one end of the membrane assembly so that it runs between the feed channel spacers, with the concentrate and permeate output piped away at the other

2.3 Pressure pump

In order to develop sufficient water pressure to overcome the Osmotic Pressure of the feed water and produce an acceptable volume of permeate, a vertical multistage pump is used to boost the supply pressure by approximately 100 -150 psi which results in the system running at 140 - 200 psi in normal service.

This type of pump is both quiet and reliable in continuous applications, requiring minimal maintenance.

2.4 Recirculation

Single membranes will normally recover only 10-15% permeate from the raw water without fouling. However by returning a proportion of the

concentrate exiting from the membrane to the inlet of the pressure pump, the flow across the surface of the membrane is dramatically increased allowing a recovery ratio of up to 75% to be achieved without significant fouling. Recirculation also allows a higher flow of water through the pump, reducing the load on its bearings and helping the pump to run cooler. The recirculation rate on the B Series is adjustable but will be factory set at 15 litres per minute.

2.5 Recovery

The recovery of a Reverse Osmosis System is a measure of the proportion of the total input water that is converted to high quality permeate. A recovery ratio of 10% means that only 1 part in ten of the input water is converted to permeate. At 50% recovery, half of the input water is converted. At 75% recovery, three quarters of the input water is converted to permeate.

The recovery ratio on the B Series is adjustable, and its setting will affect the final water quality. At high recovery ratios, the amount of solids in the concentrate water as it exits the membrane will be high which will result in a higher level of solids in the permeate. However by reducing the recovery, the operating pressure in the system will also be reduced, which in turn can also result in a raised level of solids in the permeate since rejection rates are better at higher pressures. The recovery is factory set at 75%.

2.6 Rejection

The rejection ratio is a measure of the amount of solids dissolved in the raw water that are rejected by the membrane. A rejection rate of 99% means that that only 1% of the dissolved solids will pass through the membrane, and these are usually of low molecular weight.

At 99% rejection on a raw water supply of 400 ppm, you would therefore expect a permeate quality of 4 ppm. However by running single membranes at high recovery levels with considerable recirculation will mean that the membrane actually sees a raw water of 1000-1500 ppm which could give a product water quality of 10-15 ppm. This is still a very pure water, but may need additional polishing through a mixed bed ion exchange resin if ultra-low TDS water is needed for process.

2.7 Flush

In order to remove fouling that accumulates during service it is essential to periodically flush the membrane at a high water flow.

The controller fitted will automatically flush the membrane at the end of a production run, and also flush it periodically during standby.

3.0 UNPACKING AND IDENTIFICATION

3.1 Basic Packages

The Reverse Osmosis unit will normally be delivered as a single item strapped to a small pallet. Additional items may also be supplied if ordered, such as a product water storage tank, pre-filter or water softener.

3.2 Unpacking notes

The unpacking of the system off of the pallet is straightforward and there are no 'hidden' items. It is advisable to keep the system on its pallet with any external wrapping until ready to complete installation to prevent dust or water ingress.

Care must be taken if carton slitters or hobby knives are used to remove any external wrapping since there are control cables and high pressure hoses routed around the system frame.

3.3 Lifting

Caution: The system will weigh between 85-100 kg depending on the model. It should be moved on its pallet using appropriate equipment to its point of installation. It can then be removed from the pallet by rocking and spinning on one edge of the base frame.

If the system must be lifted clear of the ground when off the pallet, suitable lifting straps must be used which will lift the system by the base without stressing components on the frame

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4.0 Temporary Storage

If installation is not to start immediately after delivery, the equipment should be stored in a clean dry area, where it will not be damaged, or be subjected to temperatures below freezing.

5.0 DESCRIPTION OF SYSTEM

Single B Series frame with one or two single length ESPA1 membranes, electronic controller, valves, Carbon filter, vertical multistage pressure pump and all interconnecting pipe work.

The inlet connection is positioned prior to the Carbon filter on a manifold with the inlet solenoid . After the filter is the low pressure switch and then a flexible hose takes the supply water to the inlet of the pressure pump, and the pump pressure gauge.

The control panel will not initiate service unless the water pressure is above the minimum set point, currently 1.0 bar. This level is set low since the high pressure pump draws water at a very high rate during flushing with the effect that the monitored inlet pressure will drop.

From the pump, high pressure water is piped to the inlet on the bottom of the first (or only) membrane housing. The permeate outlet from the housing is connected to the permeate outlet (1/2" John Guest fitting).

The concentrate outlet from the membrane housing is connected to a manifold with a tee to a recirculation flow regulating valve, tee to the flush line and tee to the concentrate flow valve. The concentrate flow valve is used to control the back pressure in the concentrate line and the flow of concentrate to drain.

The recirculation flow valve directs a proportion of the concentrate water back to the inlet of the high pressure pump which maintains the water velocity over the surface of the membrane. Water is recirculated to help give high recovery of permeate from the concentrate water, and also to keep up the flow across the surface of the membrane to prevent fouling.

The flows have been factory tested and set under working conditions.

Pressure gauges supplied are glycerine filled to minimise bounce and prolong the service life.

6.0 PRE INSTALLATION CHECKS

6.1 MECHANICAL

6.1.1 Foundations/Drainage

The Reverse Osmosis unit will not require any special foundations, provided that a firm, level area which is capable of supporting the working weight (see Engineering Data**)** is available.

Reject/concentrate water from the process must flow to drain, or to a nearby storage tank where it can be utilised for other processes that do not require high quality water, such as washdown or lavatories.

If the system is simply run to waste this must be to an open drain or gully, capable of passing the necessary flow as required (see Process and Operating Data for relevant flows). The total flow of water to drain depends on site conditions, but will typically be between 50-100% of the product water flow. The drain must not be at a level higher than the Reverse Osmosis unit and preferably should be installed with an air break at the same height as the drain outlet.

6.1.2 Operating Space

It is difficult to be precise with regard to the floor space which will be occupied by the assembled unit, since there will usually be associated pre-treatment and product water storage. However, an idea can be gained from reference to the Engineering Data**.** The RO frame has a 400mm W x 575mm D footprint

Access will be required to monitor the operating pressure and permeate conductivity. Access will also be needed to carry out adjustments or maintenance on the equipment. It is therefore recommended that a minimum of 500mm clearance be allowed around the base for this purpose.

6.1.3 Incoming Water

The raw water to be fed to the Reverse Osmosis unit must comply with the following:

(a) Available at all times at a flow equal to the required maximum service flow or greater.
(b) At a pressure between 2.0 and 5.0. bar at the service flow required.
(c) Temperature between 10^{q}C and 40^{q}C.
(d) Pre-filtered to below 5 micron nominal.
(e) Iron less than 0.2 p.p.m., Manganese less than 0.1 p.p.m.
(f) Free Chlorine less than 0.2 ppm
(g) Softened to no greater than 1 0ppm hardness as CaCO3.

6.1.4 Pipework

Pipework to be connected to the Reverse Osmosis Unit should not have an excessive amount of Iron or hardness scale deposit. Piping that is heavily built up with scale or Iron deposits should be replaced.

Make sure that the pipework can be connected to the Reverse Osmosis Unit in such a way as to impose no stresses on the inlet connection, and so that it is properly aligned and supported. Excessive vibration can cause erratic operation of the solenoid valves, so, if required, a suitable vibration damper should also be installed. Final connections to the Unit should be made where possible using flexible connections to avoid stresses during operational cycles.

6.1.5 Water Supply Company Requirements

It is essential that the equipment is connected to a pressurised water supply. If connected to a mains supply the local bye laws must be adhered to. These cover both plumbing and the prevention of back flow into the mains. If there is any doubt, the local water inspector should be consulted, but in general, the installation of a 'Double check valve assembly' conforming to BS.6282 part 2 will be required in the supply pipework to the

system.

6.2 ELECTRICAL

6.2.1 Single phase system

A continuous single phase supply of 230v, 50 Hz with a rating of 13 Amps is required by the Reverse Osmosis Unit.

7.0 INSTALLATION

7.1 MECHANICAL

A flow diagram showing the suggested overall layout of the system is included as Fig 14.1 ,and should be referred to for guidance.

Check all the items against the parts list and shipping documents, and ensure you have them all before starting work. In addition to the components you will require basic tools, (i.e. spanners, screwdrivers etc., and P.T.F.E. tape).

7.1.1 Inlet Pipework

Pipework should be assembled incorporating the features shown in the Flow Diagram, Fig 14.4. It is essential that an inlet isolating valve is provided, and that the water main is protected by a double check valve where appropriate (see Local Water Bye laws).

Pipework can be constructed from any normally acceptable material (Copper, Galvanised, Plastic), provided it is properly supported and aligned. Ensure that the pipe is sufficiently large to accommodate the flow of water required.

NOTE: IF BRAZED OR SOLDERED FITTINGS ARE TO BE USED, THE PIPE WORK MUST BE DISCONNECTED FROM THE SYSTEM CONNECTIONS DURING HEATING AND COOLING. EXCESS HEAT CAN CAUSE PERMANENT DAMAGE TO SOME OF THE SYSTEM COMPONENTS.

The inlet pipework should be connected to the upper left hand piping supplying the filter (3/4" BSPM.) See Drawings Section 14

7.1.2 Drain Connection

The drain pipework should be connected to the port on the lower manifold The drain outlet connection is 3/4" BSPM.

This should be run to a drain or concentrate storage tank capable of taking the maximum flow during flushing**,** using flexible tube if at all possible An air gap is necessary on the drain line from the system to prevent negative pressures acting on the membrane, which can result in

membrane failure.

7.1.3 Permeate Connection

The permeate connection is made to the outlet John Guest fitting. This will accept 1/2" OD tube.

Install a suitable overflow in the permeate storage tank. This must be below the level of the permeate inlet and must also make allowance for permeate production during flushing.

The top of the permeate storage tank should be no higher than 500mm above the outlet fitting on the top of the membrane to prevent operating back pressure on the membrane during production or static pressure on the membrane during standby. Back pressure during production reduces the output of the system. Static pressure on the membrane from a column of water can de-laminate the membranes during standby.

The permeate inlet to the tank must be open with no restriction. Under no circumstances must a float shut off valve be used to close off the permeate delivery line.

The permeate inlet must be at least 100 mm above the overflow level in the storage tank to prevent permeate being drawn back through the membrane by osmosis during standby.

Prior to making the permeate connection final, make a temporary pipe connection from the permeate outlet to drain so that the system can be fully flushed during commissioning.

7.2 ELECTRICAL

Electrical installation is very straightforward, but should still be carried out by a competent electrician, and must conform to the appropriate standards of safety.

7.2.1 Mains Supply

The mains supply connection should be made through a separate, switched supply, fused and earthed in accordance with Institute of Electrical Engineers Regulations. Current rating should be 13 amps.

7.2.2 Level sensor installation

The system is shipped without a remote start switch or tank level sensor, and the control connections in the controller looped out. It is recommended that a tank level sensor is installed to give fully automatic control and interval flushing, and this should be a volt free contact across controller terminals 16 & 17 that close when RO water is required. The control voltage on these terminals is below 12v.

Install a level switch on the treated water storage tank and connect to the controller as shown in section 14.3

Important: When installing the level sensor in the permeate tank, the top of the sensor must be at least 100 mm below the overflow since permeate will flow to the tank during the post-service flush.

8.0 COMMISSIONING

The membrane(s) are shipped in preservative which will need to be flushed prior to putting permeate water to service. Commissioning and flushing should take place immediately before the system is put into service

8.1 Pre Service Flush

Do not turn on the power at this point

After connecting the water inlet, run a line to drain from the concentrate and permeate outlets. Turn on the water supply to the system and check the inlet side for leaks up to the inlet solenoid.

Turn on the power supply, and press the system 'On'

switch. The controller should default to Service.

The inlet solenoid will then open allowing water to flush through the system but the pump will not operate for one minute which will allow the pump to prime under feedwater pressure.

Check for leaks with low pressure running in the system and turn off the power supply before the pump starts is any leaks are seen.

8.2 Pressure flush

After one minute the pump will power up and the system will run up to pressure.

The concentrate and recirculation flows have been set up and balanced in the factory, and the regular knobs removed to prevent adjustment by unqualified personnel.

This should give a back pressure on the pump (centre) pressure gauge of 140-200 psi depending on the raw water pressure.

Do not adjust the concentrate valve so that the pump pressure exceeds 200 psi.

Leave to run to drain for 30-60 minutes to flush the preservative out of the

membranes. If the permeate is then to the correct quality, the system can

be put into service.

8.3 Service connections and checks

With the system switched off, connect the permeate tube to the storage tank. Turn the system on and leave to run to service.

Test the flush circuitry by lifting the permeate float switch. This will initiate a 'post service' flush. The pressure pump will cut out as the float switch is operated. Shortly afterwards the flush solenoid will open and then the pump will start up again. This will flush the membranes at a high flow rate for the time set in the controller. Lowering the floats will immediately switch the system back to service.

If the pump draws a massive amount of water during flushing it may be necessary to adjust down the low pressure threshold. Monitor the inlet pressure during flushing.

The system is now commissioned.

9.0 Operation

The B Series Reverse Osmosis systems are designed to run and flush automatically and should not be turned off at the mains after a production run of permeate.

For the first few days of use, the operating pressure, permeate and concentrate flows should be monitored every few hours and the system fine tuned as the membrane settles down to its working environment.

Thereafter the flows, pressure and permeate conductivity should be monitored daily at a regular time when production is taking place. These readings will vary slightly due to variations in incoming water temperature and pressure. An example data recording sheet can be found in section 9.3

If a variation of more than 15% is noted in the permeate flow at usual operating pressures then the system should be cleaned with an appropriate recirculating cleaner. This must be done by a service technician with a thorough understanding of reverse osmosis systems and their cleaning regimes

9.1 Routine maintenance.

Daily Monitor permeate and concentrate flow, inlet, pump and back pressures, and product water conductivity.

Weekly Monitor raw water temperature

Monthly Inspect system for leaks and tighten fittings where necessary

3 Monthly Replace inlet filter cartridges

Annually Clean membrane with a recirculating cleaner if normalised output has
fallen by greater than 15%

9.2 Temporary Shutdown

If permeate is not required for up to five days then the system should be left with the permeate tank empty, the level probes disconnected and the water and power supplies turned on. The controller will automatically flush the system every 24 hours and a small amount of permeate will flow to the tank.

If the permeate tank must remain empty, then disconnect the level probe and route the permeate production line to drain.

If the system needs to be powered down for more than 7 days, then the membrane housing should be filled with an appropriate preservative. The system should then be recommissioned prior to putting back into service. See Section 8.0

9.3 Example Data Recording Sheet

Model

Date installed .....

Membrane serial no(s) .....

Date	Pump Pressure (PSI)	Conc Flow (lpm) CF	Perm Flow (lpm) PF	Total Flow (lpm) TF=CF+PF	Recovery R=(PF/TF)* 100	Temp (^{O}C)	Initials

10.0 FAULT FINDING AND RECTIFICATION

Problem	Possible cause
No Power	Main fuse or supply cabling fault
Power on controller Motor does not run	High level probe jammed or failed Motor failure
Pump motor runs Low or no production	Pump motor drive loose Concentrate valve fully open Inlet filter blocked Membrane fouled Concentrate valve fully closed
Pump cuts out during Flush	Inlet filter blocked Low pressure threshold too high
Pump cuts out during service	Inlet filter blocked Water supply failure
Permeate quality Poor	Membrane fouled Concentrate valve fully closed. Permeate storage tank too small
Pump Pressure	Inlet pressure greater than 5 bar

11.0 WARRANTY AND SERVICE

11.1 AFTER SALE WARRANTY

Your Reverse Osmosis unit is covered by a parts warranty for a period of one year from installation on all mechanical and electrical components. Filters cartridges and membranes are excluded from this warranty since they can deteriorate due to operational or site conditions.

Should you have any problems with your Reverse Osmosis unit or require routine service, please contact your supplier.

12 Data

12.1 PROCESS AND OPERATING DATA

Model Parameter	Units	2000	4000	5000
Max. Output Flow*	Lit/hr	300	600	780
Max Inlet Flow*	Lit/hr	400	800	1040
Concentrate To drain*	Lit/hr	100	200	260
Max flow to Drain during Flush	Lit/hr	1500 all		
Min salt rejection		99% all		
Max. Recovery		75% all		

Important Notes

The data quoted in the above table is affected by the inlet pressure, raw water quality and period of usage, and so should be regarded as nominal only. * Total inlet flow and flow to drain will depend on the recovery settings chosen for the Reverse osmosis unit. Figures shown are based on typical UK mains softened water at 50 PSI and 12 Degrees Celcius

12.2 ENGINEERING DATA

Model		2000	4000	5000
Parameter	Units			
Width	mm	400 all		
Depth	mm	575 all		
Height	mm	1475 all		
Inlet Conn.	Ins BSPM	¾" all		
Permeate Conn	Ins O/D	½"		
Drain Conn	Ins BSPM	¾"		
Delivered Wt.	Kg	90	100	110
Working Wt.	Kg	100	115	125
Power	V	230 all		
	Hz	50 all		
	kW	0.75	1.1	1.1
	A	4.7	6.8	6.8
No. of Membrane		1	2	2
Membrane ref		4040	4040	4641
Pump ref		1-15	1-23	1-23
Controller		EWS 3015 all		
Flush	lpm	15 all		
Carbon Filter		20" Radial Flow all		
Drain	lpm	1.5	3	4
Re-cric	lpm	15 all		

MAXIMUM INLET PRESSURE 5 Bar MINIMUM INLET PRESSURE 2.0 Bar MAXIMUM OPERATING TEMPERATURE 40.0C HEADROOM - Allow 1000 mm greater than overall height.

13.0 EWS OS3015

CONTROLLER 13.1

Manufacturers Manual

A manufacturers manual for the EWS OS3015 controller is enclosed with the system. Please refer to this for information operation and programming of the controller.

13.2 Factory programming notes

The controller has been set up with a typical operating program suitable for a reverse osmosis system of this size and type.

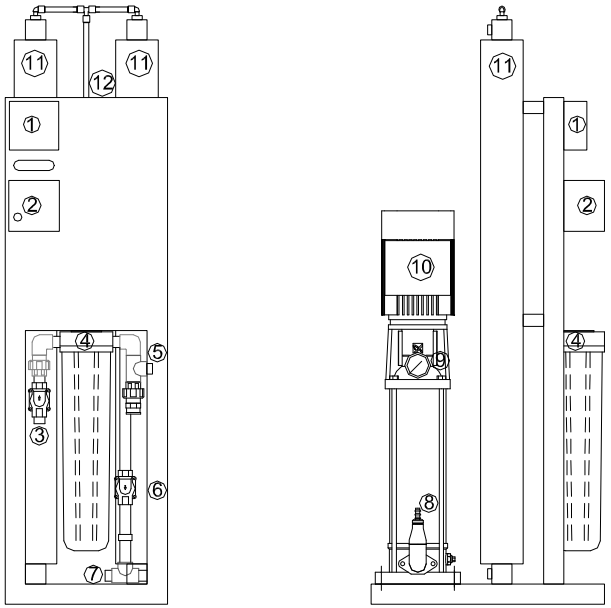
The programming includes a post service flush, flush during service and flush during standby.

13.3 Factory programming

Program Step	Setting	Function
1.1	E	Language
5.1	1	1 level switch on permeate
5.2	1s	Delay for permeate high level switch
6.1	10s	Delay for low water pressure switch activation
6.2	ST	Stop function chosen for input (looped out)
6.4	1s	Delay for stop signal
6.5	300s	Delay for retrying after low water pressure failure
7.1	CV	Concentrate Valve chosen for relay 3
8.1	60s	Pump Delay
10.1	Y	Rinse after production activated
10.2	180s	Duration of rinse
10.3	IVI PUI	Functions activated during rinse
11.1	Y	Interval Rinse Activated
11.2	24h	Time between intervals
11.3	180s	Duration of Interval Rinse
11.4	IVI PUI	Functions activated during rinse

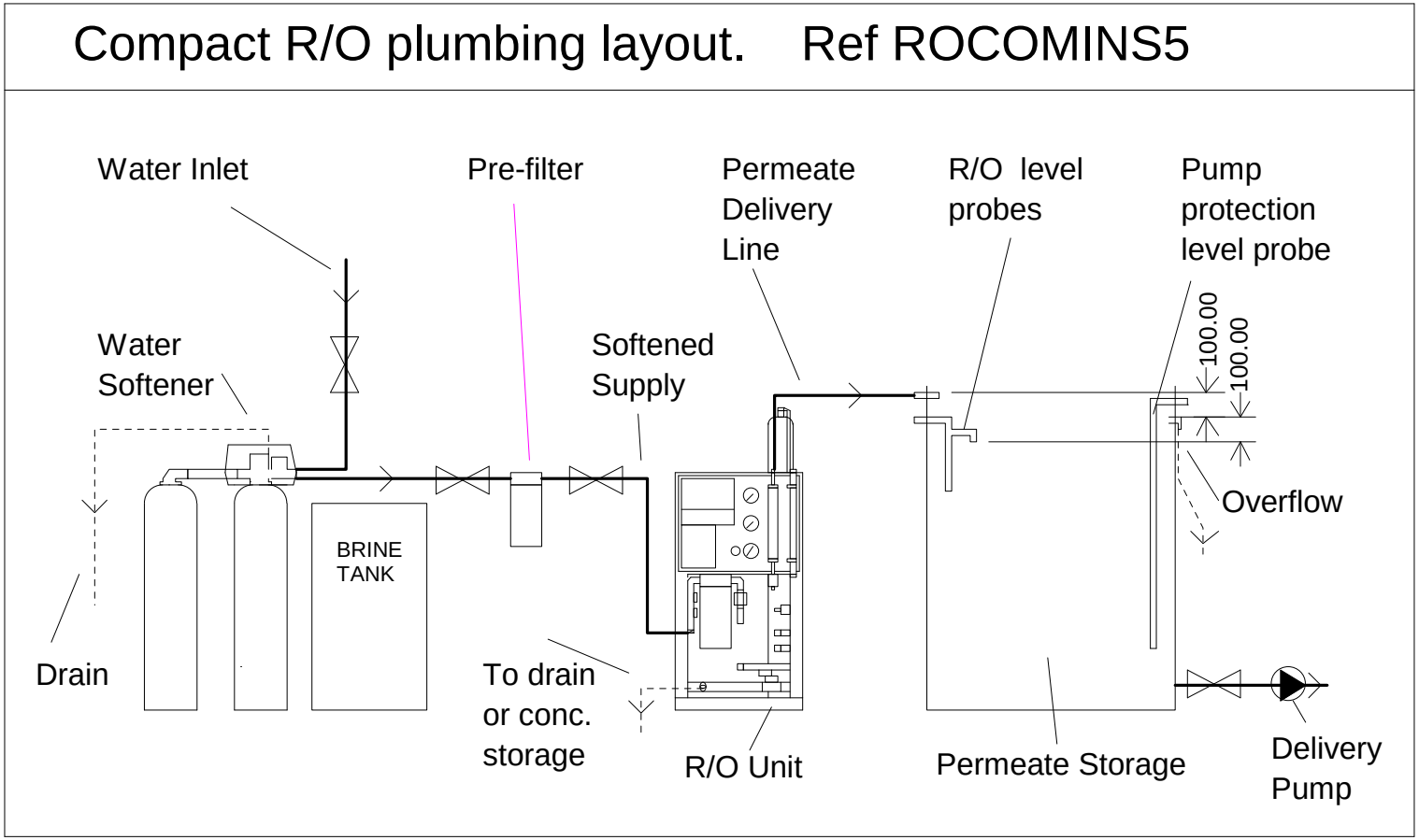
14.0 Drawings

14.1 Dimensions and Parts Identification



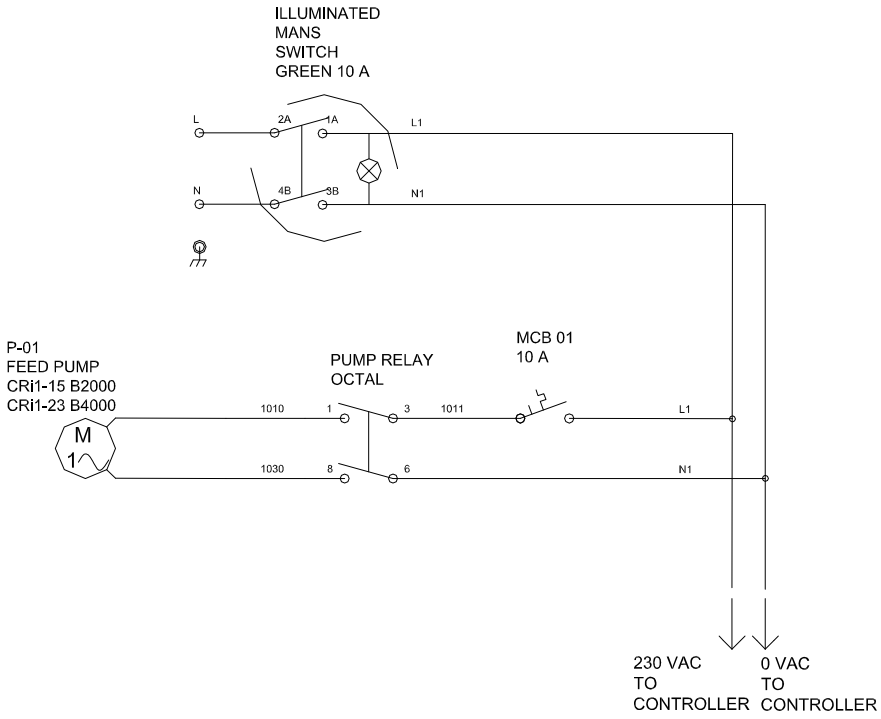
1	CONTROLLER
2	PUMP CONTROLS
3	INLET 3/4" BSPM
4	GAC FILTER
5	LOW PRESSURE SWITCH
6	FLUSH SOLENOID & DRAIN FLOW CONTROLLER
7	DRAIN 3/4" BSPM
8	RE-CIRC FLOW CONTROL
9	PUMP PRESSURE
10	HIGH PRESSURE PUMP
11	MEMBRANES
12	PERMEATE OUTLET 1/2" PUSH FIT

14.2 RO Plumbing Layout

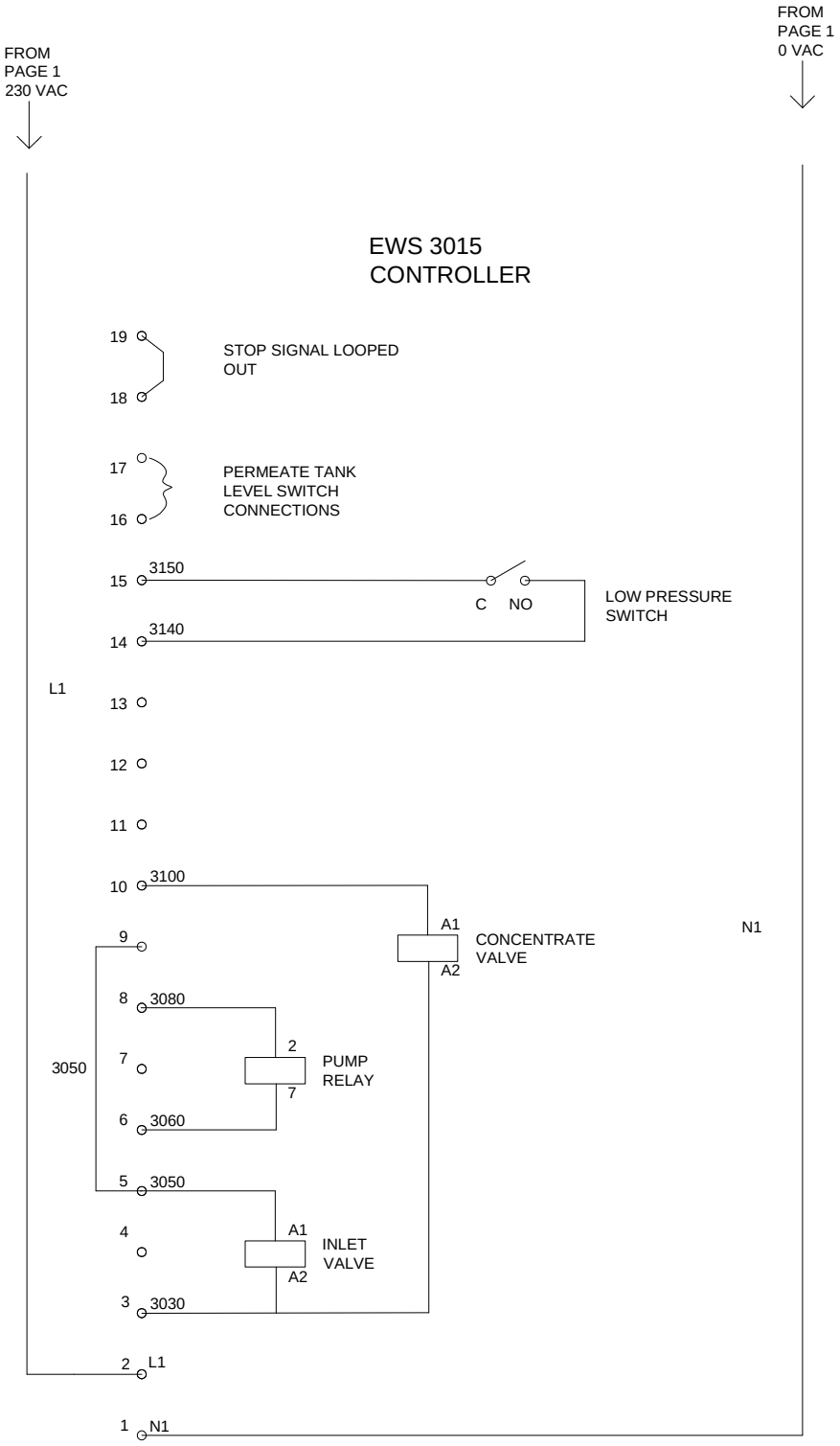


14.3 Cabling Diagram

14.3.1 Mains Box



14.3.2 EWS Controller



15.0 CE Cert

Manufacturer's Declaration of Conformity

We the undersigned

EURAQUA UK, HITCHIN, ENGLAND

Certify that the product

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type: Budget Automatic Series Reverse Osmosis Unit
Models B2000, B4000 B5000 with EWS 'OS3015' controller

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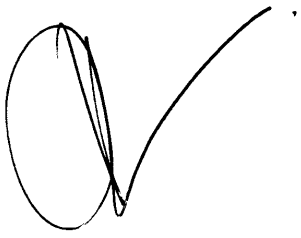
has been designed and manufactured in accordance with the specifications of the following:

Directive	**Standard**
Machinery Directive 89/392/EEC	EN 292-1, EN 292-2
Low Voltage Directive 73/23/EEC	EN 60 335-1
EMC-Directive 89/336/EEC	EN 55 014



RT Adam
Director

Hitchin, England 04/08/10
Issue place & date