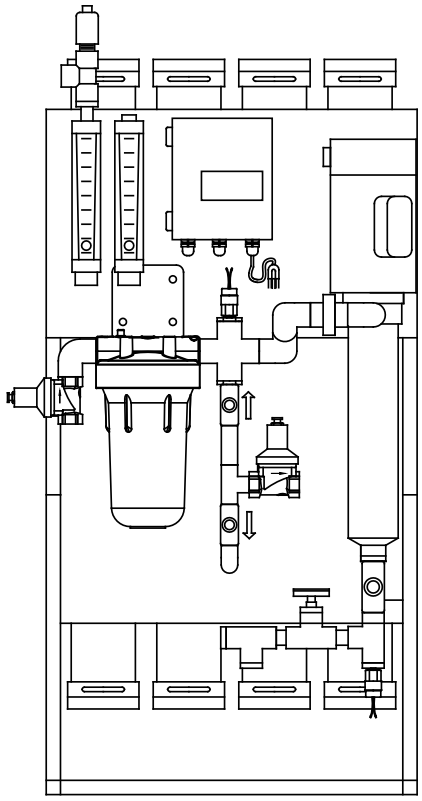
# *HVE Series*

## *Reverse Osmosis Systems*



## Installation & Operation Manual

Form No. 999365
Effective: 12-17-2014

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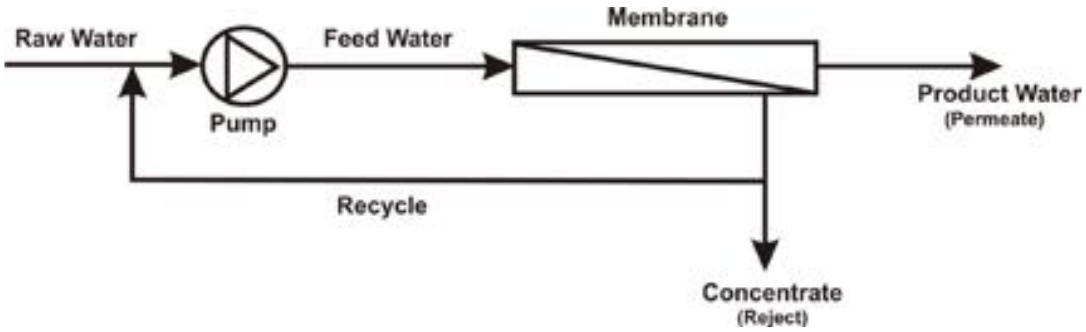
# PRINCIPLES OF REVERSE OSMOSIS

Reverse Osmosis is a process of rejecting dissolved mineral salts, organic molecules, and certain other impurities from water by forcing the water under increased pressure to pass through a semi-permeable membrane. This process is the reverse of the natural osmotic process in which fluids with low concentration of dissolved solids, pass through a membrane into an area of higher concentration. With reverse osmosis, water is made to pass from a state of high concentration to a state of low concentration.

Since reverse osmosis does not occur naturally, applying pressure to the high solids water in order to force it though the membrane must be done to create the process. Membranes must be strong and resistant enough to withstand the high pressures of RO operation – 150 to 300 PSI in most applications, or 1000 to 1200 psi for seawater desalination. High-pressure pumps are used to create the pressure required on the feed-water side of the membrane in order to produce product flow rates that are economically acceptable.

The product flow of an RO is mainly a function of temperature and pressure. System recovery is limited by the characteristics of the feed water and can be controlled through the use of a recycle stream. During operation, a portion of the feed water becomes product (permeate) and the rest becomes concentrate (reject) and is directed down the drain. A portion of the concentrate may be recycled and mixed with the raw water. The volume of product water divided by the volume of feed water is known as the recovery.




All HV Model RO systems utilize low energy elements for optimum performance. Low energy membranes are thin film composite (TFC) membranes. TFC membranes are three layers of material – a thin (0.25um) barrier coating on the surface of a microporous layer of polysulfone, both supported by a polyester web. Thin Film Composite (TFC) membranes have high salt rejection rates, usually operate at lower pressures than Cellulose Acetate (CA) membranes and have exhibited good performance under wide range pH and temperature conditions. TFC membranes are not degradable by micro-organisms, but have a low tolerance chlorine. TFC membranes are produced in a spiral wound module configuration.

Pretreatment of the water prior to the Reverse Osmosis System is almost always required. Chlorine removal required. High hardness minerals should also be controlled by a water softener or other suitable method of treatment. Hard water scale build-up on the membrane impairs the performance of the unit. Turbidity, iron, and other impurities must be removed for optimum RO performance.

# REVERSE OSMOSIS PRETREATMENT

Pretreatment is essential for the prevention of premature membrane fouling. As a rule of thumb, an RO will remove 90% of all contaminants in the raw water; therefore it can be fouled easily without the proper pretreatment. Dissolved ferrous iron and/or manganese will oxidize to insoluble ferric iron and manganese oxides, which will rapidly foul a membrane. The feed water should contain less than 0.05 ppm of iron and less than 0.02 ppm of manganese.

The membrane concentrates contaminants in the feed water. If this concentration exceeds the solubility limits of the compounds they will precipitate on the membrane surface, and will eventually foul the membrane. The compounds normally found in raw water, which could cause fouling are: calcium carbonate, calcium sulfate, barium sulfate, strontium sulfate, and silica. One way prevent scaling is to remove one of the ions which forms the compound. Another is to complex one of the ions by means of chemical dosage. Finally, the recovery could be reduced to the point where the solubility limits are not exceeded.

Suspended solids will plug the feed water channels of the membrane. They are normally impossible to remove because of their insolubility in the chemical cleaning solutions. The feed water should not contain suspended solids; therefore, there must be a 1 to 5 micron filter prior to the membrane(s). If turbidity exists in the raw water supply, then the proper multimedia or depth filter must be installed prior to the RO System.

Colloids are the most dangerous source of fouling for a membrane. Colloids are particles larger than molecules but can't be seen through a microscope. A standard water analysis will not reveal colloid contamination. Colloids consist of clay particles mixed with organic acids and microorganisms. The measurement of the amount of colloid contamination is called the *Silt Density Index (SDI).* Detailed procedures are provided with the SDI Test Kits. The procedures are detailed in the American Society for Testing and Materials (ASTM) under D 4189-82 "Standard Test Method for Silt Density Index (SDI) of Water" and is summarized in the technical service section of this manual.

Bacteria are capable of attachment and growth on membrane surfaces. The Polyamide Thin-Film Composite membranes are resistant to bacterial attack, but the slimy growth clogs the membrane surface. The bacterial growth will eventually penetrate the membrane and contaminate the product water.

## Types of Pretreatment:

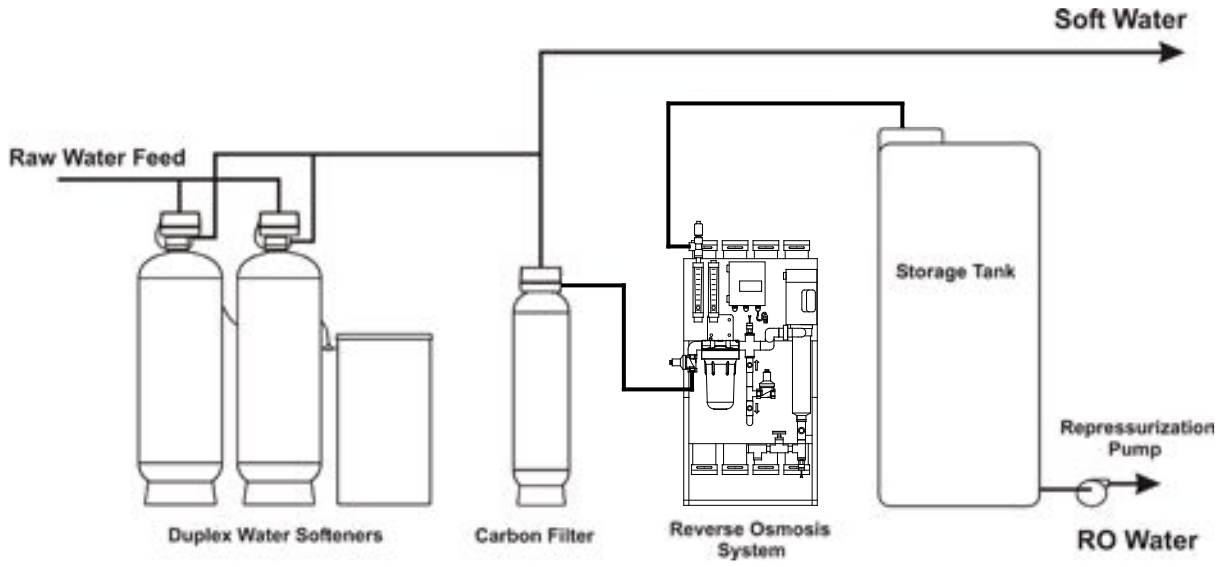
***Chlorination, Retention and De-chlorination*** **–** Chlorine feed with a 20 to 30 minute contact time is required to prevent bacterial contamination of the membrane. Bacteria will attack the Cellulose Acetate membrane and free chlorine in the feed water will shorten the life of a Polyamide Thin-Film Composite membrane. If bacteria is present in the feed water, it must be removed. Chlorine feed followed by retention and then by an activated carbon filter is the common acceptable method for treating the bacteria.

***Acid Feed*** **–** Adding acid to the feed water will limit the scaling problems associated with calcium salts. Bicarbonate associated with the calcium salts is converted to free carbon dioxide when acid is fed into the raw water. The carbon dioxide passes through the membrane but causes the product water to become very aggressive.

***Polyphosphate Feed*** **–** Polyphosphate (Sodium Hexametaphosphate) can be utilized to prevent calcium salts from scaling the membrane, by keeping them in solution. Use RO water when mixing the polyphosphate solution to prevent the calcium in the raw water from forming calcium phosphate and precipitating in the mixing tank. A fresh solution of polyphosphate should be mixed up daily. When the flow of water through the membrane is stopped, it should be rinsed with phosphate free water to prevent precipitation of the calcium salts onto the membrane surface. Calcium sulfate precipitation is normally not a problem in feed water containing less than 1500 mg/l of Total Dissolved Solids (TDS). Calcium bicarbonate requires free carbon dioxide in the water in order to remain dissolved. The polyphosphate should be fed at a dosage of 10 mg/l.

***Coagulation, Flocculation and Sedimentation*** **–** is commonly referred to as clarification. This is the only realistic way to remove colloids from the raw water. Colloids are gelatinous substances, which are finely divided particles suspended in water. They all have the same charge so they tend to repel each other, rather than form larger particles. Coagulation involves neutralizing the charges with a polyelectrolyte, so that the particles no longer repel each other. Once the charges are neutralized, the particles start colliding and growing in size forming wooly masses. This process is known as flocculation. The final clarification process is sedimentation, or mechanical filtration. Multimedia filters are ideal for removing sediment because they provide high flow rates with low pressure drops and remove particles down to 10 microns in size.

***Water Softening*** **–** Calcium, barium and strontium are exchanged for sodium in a water softener. By removing the calcium, barium and strontium the salt scaling characteristics of the raw water are reduced or eliminated. Softening the water will also stabilize colloids and prevents coagulation on the membrane. The sodium ions replace the other cations and tend to increase the protective layer on the membrane. SDI values are allowed to be higher with soft water than with untreated water.




**Typical Reverse Osmosis Installation with Softeners and Carbon Filter**

# HVE SERIES – SPECIFICATIONS AND DESIGN DATA

| Model | R1F40 | R2F40 | R3F40 | R4F40 | R5F40 | R6F40 |
|---|---|---|---|---|---|---|
| Product Flow Rate [1] [2] | | | | | | |
| GPM | 1.4 | 2.7 | 3.9 | 5.2 | 6.6 | 7.5 |
| GPD | 2,000 | 3,900 | 5,600 | 7,500 | 9,500 | 10,800 |
| Feed Flow (GPM) | 2.8 | 5.4 | 7.8 | 10.4 | 13.2 | 15 |
| Reject Flow (GPM) | 1.4 | 2.7 | 3.9 | 5.2 | 6.6 | 7.5 |
| Recycle (GPM) | 5.2 | 3.6 | 2.2 | 5.6 | 4.8 | 3.0 |
| Rejection | 98% | | | 98% | | |
| Design Recovery | 50% | | | 50% | | |
| Max. Recovery | 75% | | | 75% | | |
| Membrane Type | Low Energy | | | Low Energy | | |
| Membrane Size | 4” x 40” | | | 4” x 40” | | |
| Vessel Size | 1M | | | 1M | | |
| No. of Membranes | 1 | 2 | 3 | 4 | 5 | 6 |
| Array | 1 | 1:1 | 1:1:1 | 2:1:1 | 2:2:1 | 2:2:2 |
| Pre-Filter | 1 – 10” | 1 – 10” | 1 – 10” | 1 – 10” | 1 – 10” | 1 – 10” |
| Feed Pressure | 20 – 50 psi | | | 20 – 50 psi | | |
| Pump HP | ¾ HP | | | 2 HP | | |
| Voltage | 220 Volt – 60 Hz – 1 ph | | | 220 Volt – 60 Hz – 1 ph | | |
| Power | 6.9 Full Load Amps | | | 12.0 Full Load Amps | | |
| Dimensions (LxWxH)[3] | 26”x16”x54” | 26”x16”x54” | 26”x16”x54” | 26”x16”x54” | 38”x16”x54” | 38”x16”x54” |

Notes:

(1) Based on feed water: SDI < 3, free chlorine 0.0 mg/l, pH 2-11 and water temperature 38$^{O}$ F to 95$^{O}$ F.
(2) System flows are design parameters.
(3) All dimensions are approximate. Additional space required for maintenance.

# INLET WATER CRITERIA

Softened Water with SDI < 3
Design criteria based on 1000 ppm TDS, max.
Free Chlorine 0.0 mg/l maximum.
Feed Water Temperature – 35$^{O}$ F min. to 95$^{O}$ F max.
Feed Water Pressure – 20 psi min. to 50 psi max.
Feed Water pH – 2 to 11

## ELECTRICAL REQUIREMENTS

System is wired for 220 volt AC / 60 Hz / 1 ph. A standard 15 amp circuit is acceptable for proper operation. Refer to local electrical codes for proper installation of wiring.

*Caution: Do not rewire motor in the field for 120 volts. Electrical components other than the motor may be affected by voltage change and cause the system to overheat, which could cause a fire.*

## LOCATING THE REVERSE OSMOSIS SYSTEM

Locate the Reverse Osmosis System on a firm foundation near a 220-volt receptacle. A floor drain should be located within 10 feet of the system. The drain must be capable of handling a minimum of 10 gpm for the three smaller units and as much as 20 gpm for the three larger units. If pre-treatment equipment and RO System are discharged into the same drain floor drain, make sure the drain can handle the flow rates simultaneously. Be sure there is adequate clearance from walls and other equipment to enable servicing of the pump, motor, membranes, cartridge filters and other components.

## FEED, PRODUCT AND CONCENTRATE CONNECTIONS

***Feed Water Connection or Inlet -*** is a 1" connection. Installation of a manual valve and a 0 - 100 psi pressure gauge in front of the Reverse Osmosis System is recommended to assist in servicing the system when required.

***Concentrate Connection or waste line –*** is an NPT connection, which must be directed to a floor drain. It is connected to the top of the concentrate flow meter. An air gap must be maintained between the drain line and the floor drain in accordance with the local and state plumbing codes.

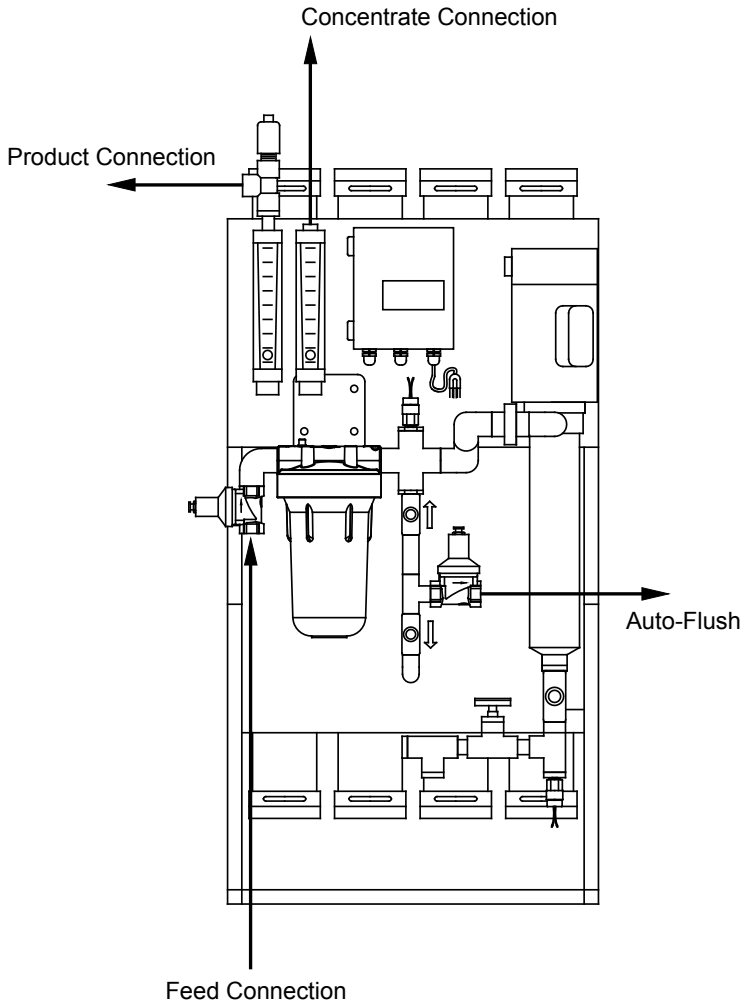
***Product Connection –*** is connected to the top of the Product Flow meter on the Better models. There is a tee with a conductivity cell installed on the outlet of the Product Flow meter on all Best models and the Product Line connects to the tee.

The Product Line must be made of a corrosion resistant material, non-conducive to Product Water contamination. Product Line piping may be PVC, Stainless Steel, Polypropylene, PVDF etc. It is recommended that the Product Line be ran to an atmospheric storage tank. A check valve must be installed between the RO and the storage tank to prevent backflow through the membrane then the system is not in operation. **Do not install a shut-off valve in the Product Line!** If the valve is closed during operation damage to the membrane will occur.

***Auto Flush Connection (Optional) –*** There is an additional connection that must be run to drain when this option is chosen. A tee is installed above the Concentrate Valve with an electric solenoid valve attached to it. The outlet of the solenoid valve must be connected to the floor drain where an air gap must be maintained in accordance with the local and state plumbing codes.

**CONNECTION SIZES:**

| Number of Membranes | Feed | Product | Concentrate | Auto Flush |
|---|---|---|---|---|
| 1, 2, 3 | 1” | 1/2” NPT | 1/2” NPT | 1/2” NPT |
| 4, 5, 6 | 1” | 3/4” NPT | 3/4” NPT | 1/2” NPT |



# REVERSE OSMOSIS CONTROL – BETTER

The control used on better Reverse Osmosis systems is called the ESDI Model 258 RO Controller. The control has an ON / OFF rocker switch and six LED indicators. The control is equipped with 3 inputs and 3 outputs.

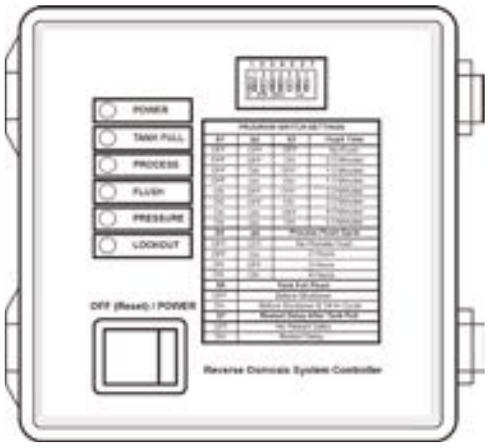
***Inputs:***

- Pretreatment Lockout
- Inlet Pressure
- Storage Tank Level

***Outputs:***

- Inlet Solenoid
- Flush Solenoid (optional)
- RO Pressure Pump

The location of the inputs and outputs are shown on the PC Board assembly on the wiring diagram at the end of this section. The Power required is 115/230 Volts AC, 50/60 Hz, 20 Amps max.




***ESDI Model 258 RO CONTROLLER***

**NORMAL OPERATION –** Turn on the power switch and the LEDs will indicate the status, the inlet valve will OPEN and after a delay, the RO Pump will start. The RO will run until the storage tank is full or the pretreatment lockout has been activated. If the level in the storage tank drops the RO will start after a time delay and shut off when the storage tank is refilled. Should the RO be running when the pretreatment lockout is activated, it will shut down. The RO will return to operation after a time delay takes place, after the pretreatment lockout is deactivated.

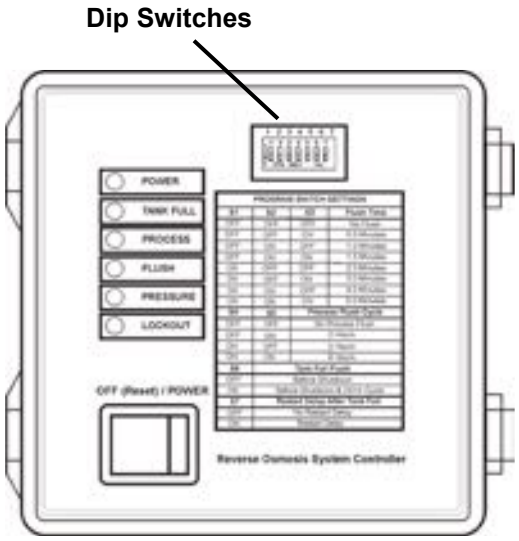
If the inlet pressure drops below 20 psi, the pressure switch will drop out causing the RO pump to shut down. When pressure returns the RO will restart after a preset delay.

The LEDs provide an indication of the status of the reverse osmosis system. The LEDs glow steady based on the operating status.

| *LED COLOR – Action* | *OPERATING STATUS* |
|---|---|
| *Green – Power* | *Indicates that Power is being supplied to the control.* |
| *Blue – Tank Full* | *Indicates when permeate water storage tank is full.* |
| *Green – Process* | *Steady indicates that the system is producing water. Flashing indicates system is pauses and in a restart time out.* |
| *Amber – Flush* | *Indicates Auto Flush is activated.* |
| *Red – Lockout* | *Steady indicates that the system is in lockout. Flashing indicates the system lockout has been reset and system will soon restart.* |
| *Red – Pressure* | *Steady indicates inlet water pressure is low. Flashing indicates pressure is good and system is waiting to restart.* |

**PROGRAMMING THE FLUSH FUNCTIONS OF THE CONTROL -** The various flush functions of the control can be programmed by activating the seven dip switches located on the main face plate of the control. In an effort to extend the life of the membranes, this controller has several programmable Auto Flush cycles. These Flush cycles can be enabled or disabled as desired.

*FLUSH TIME* – Dip Switches S1, S2 and S3 control the Auto Flush cycle length of time. There can be No Flush, or up to 5.0 minutes dependent on which Dip Switches are activated. During this time, the Auto Flush and Inlet valves are opened and raw water is allowed to flow through the membranes and out the Flush Valve to drain.




| S1 | S2 | S3 | Flush Time |
|---|---|---|---|
| Off | Off | Off | No Flush |
| Off | Off | On | 0.5 minute |
| Off | On | Off | 1.0 minute |
| Off | On | On | 1.5 minutes |
| On | Off | Off | 2.0 minutes |
| On | Off | On | 3.0 minutes |
| On | On | Off | 4.0 minutes |
| On | On | On | 5.0 minutes |

*PROCESS FLUSH CYCLE* – It is important to flush the membrane periodically when the RO has been process water for an extended length of time. This helps clean the membrane(s) and improve efficiency. Dip Switches S4 and S5 control the Process Flush cycle time. This is the amount of time between Auto Flushes. If both switches are Off, then there is No Process Auto Flush. If S4 is Off and S5 is On then the Process Flush occurs every 2 hours. If S4 is On and S5 is Off, then the Process Flush occurs every 3 hours. If both are On then Process Flush occurs every 4 hours. See chart below.

| S4 | S5 | Time Interval |
|---|---|---|
| Off | Off | No Process Flush |
| Off | On | 2.0 Hours |
| On | Off | 3.0 Hours |
| On | On | 4.0 Hours |

| S6 | Tank Full Flush |
|---|---|
| Off | Flush Before |
| On | Flush Before and every 24 hours |

| S7 | Restart Delay |
|---|---|
| Off | No Restart Delay |
| On | 10 Minutes Restart Delay |

*TANK FULL FLUSH* – Each time the tank is filled, the control will activate a flush cycle prior to shut down. Dip Switch S6 controls the Tank Full Flush. If Switch S6 is Off, then Auto Flush will occur every time the tank is filled. If Switch S6 is On then Auto Flush will occur every time the tank is filled, and every 24 hours. See Chart above.

*RESTART DELAY* – Dip Switch S7 controls the Restart Delay after the permeate tank is full. Once a signal that the tank is full is received and the RO is shutdown, it cannot restart for 10 minutes if switch S7 on turned on. If switch S7 is turned off – there is not delay upon Restart of the RO System.

*ADDITIONAL FLUSH CYCLES* – When Auto Flush is enabled, additional auto flushes will occur in the following instances. The Flush Time will be what is programmed with switches S1, S2 and S3.

POWER-UP FLUSH – An auto flush will occur each time power is turned on.

LOCKOUT FLUSH – An auto flush will occur after each lockout condition.

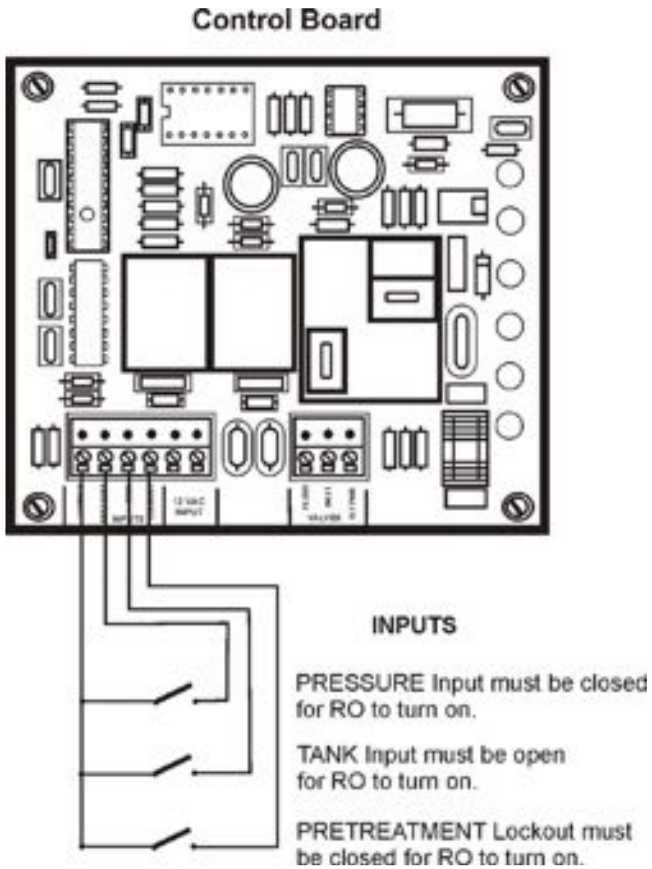
**PRESET CONTROLLER DELAYS -** The controller has preset delays built in to help the performance of the RO System and reduce strain on the pump. The delays are listed below.

| | | |
|---|---|---|
| 1) | Time delay between inlet valve opens and pump starts | 10 minutes |
| 2) | Time delay between inlet valve opens and flush starts | No Delay |
| 3) | Time delay between Pump Off and Inlet Valve Closes | 5 seconds |
| 4) | Time delay between Flush On and Pump starts | 10 seconds |
| 5) | Time delay between Restart after Tank Full | 10 minutes |
| 6) | Time delay from Low Pressure Shutdown to Restart | 5 Minutes/6 times & 30 minutes thereafter |

**INPUTS and OUTPUTS –** The Controller has three inputs and three outputs. Operation of the inputs and outputs are detailed below. Wiring connections are shown on the wiring diagram at the end of this section.

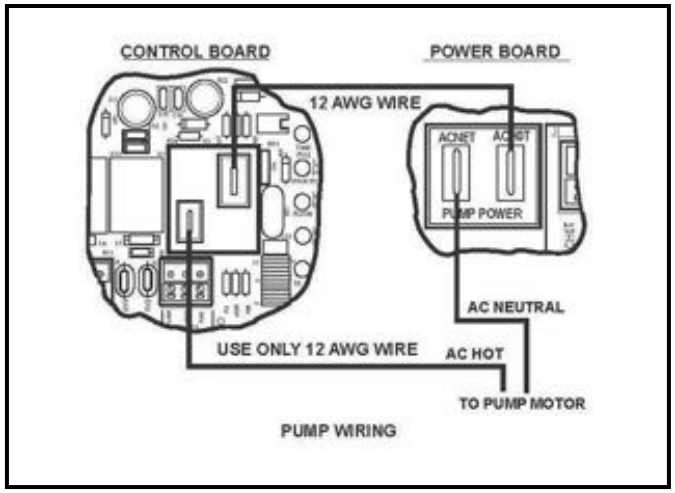
*TANK LEVEL INPUT* – The Tank Level Input signals when the Permeate Tank is full. A Float or Level Switch with isolated or dry contacts is used for this purpose. The contact must be “open” when the tank is full and “closed” when the tank is low. A built in 10 minute delay helps prevent excessive recycling of the RO Pump. This input is connected in the field. Refer to wiring diagram on the right.

*PRETREATMENT LOCKOUT INPUT* – The Pretreatment in a form of a filter and/or softener is connected in series to this input. When the filter or softener goes into regeneration the circuit is opened thus shutting down the RO system. In Lockout the pump will stop, and all the valves will close. When the pretreatment completes regeneration returns to service and the contact is maintained for 10 seconds, a Power up Reset and an Auto Flush will occur, provided the Flushes are enabled. This Input is connected in the field. Refer to wiring diagram on the right.



*LOW PRESSURE INPUT* – The Inlet Pressure Switch closes its contacts when minimum pressure is reached. When the inlet pressure is low, the contacts are opened and the RO is shut down, this means the pump will shut off and the valves will close. There is a 5 minute delay before the system will reset and try again. This 5 minute delay will occur 6 times and then it will change to a 30 minute delay until the pump pressure remains good. This Input is prewired at the factory. Refer to the wiring diagram on the previous page.

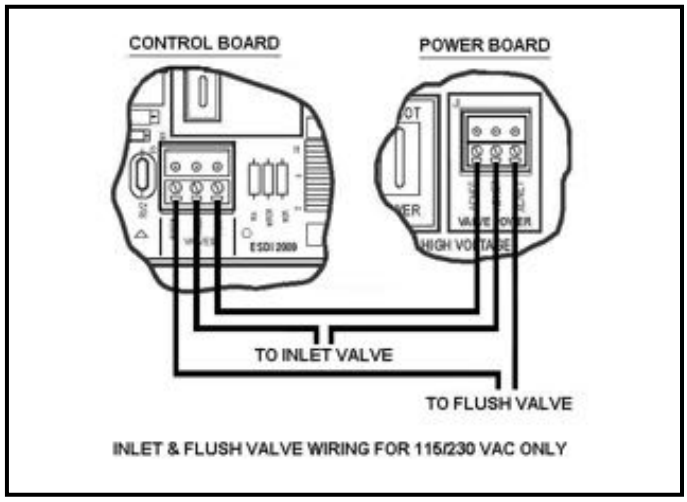
*PUMP RELAY OUTPUT* – The Pump Relay turns the pump on and off. The contacts are rated for a maximum of 30 amps. If 240 Volts AC is being supplied to the control then the pump can be up to 2 HP. If 120 Volts AC is being supplied the pump can be no larger than 1 HP. The Flush Valve and the Inlet Valve must be the same voltage as the pump. When the storage tank calls for water, the control will open the inlet valve, delay 10 seconds, and check for good pressure before starting the pump. This insures that the pump does not run dry. The RO System comes from the factory with pump prewired to the control relay.



PUMP WIRING

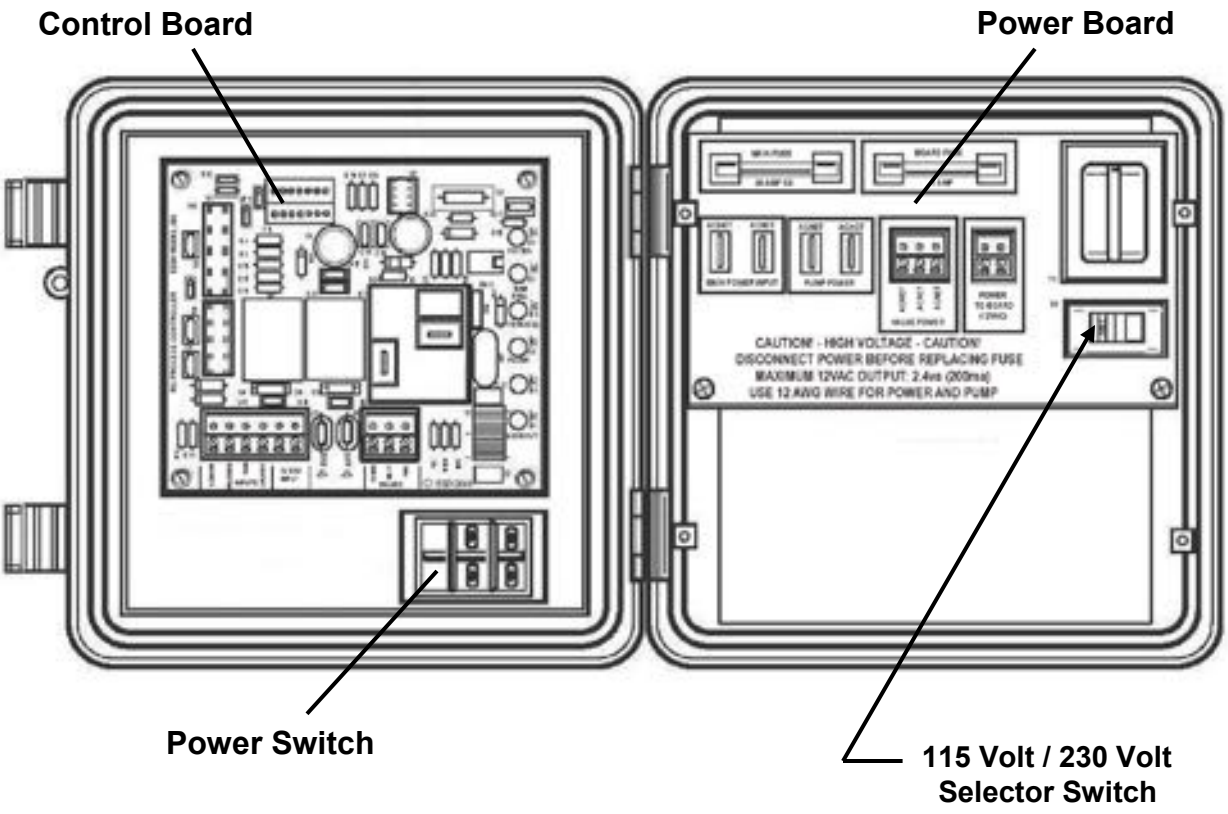
*FLUSH VALVE OUTPUT* – The Flush Valve is controlled by this output. When a Flush is called for based on the programming, this output is activated. The voltage must be the same as the pump and the contacts are rated for a maximum of 3 Amps. The Flush Valve is prewired at the factory. Refer to wiring diagram to the right.

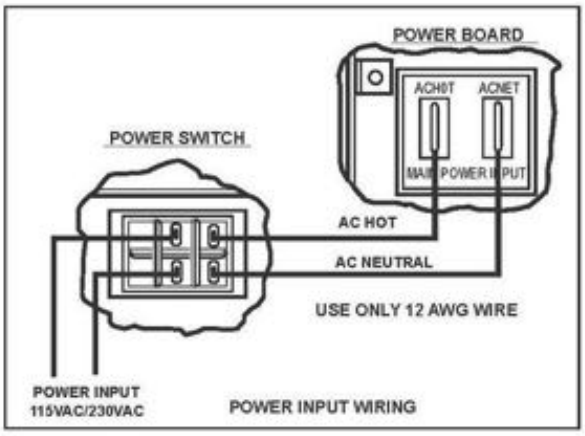
*INLET VALVE OUTPUT* – The Inlet valve is controlled by this output. When the storage tank calls for water, the control will open the inlet valve, delay 10 seconds, and check for good pressure before starting the pump. The Inlet Valve will remain open for 5 seconds after the pump stops. The Inlet Valve must be the same voltage as the Pump and Flush Valve. The Inlet Valve contacts are rated for a maximum of 3 amps. The Inlet Valve is prewired at the factory. Refer to wiring diagram to the right.

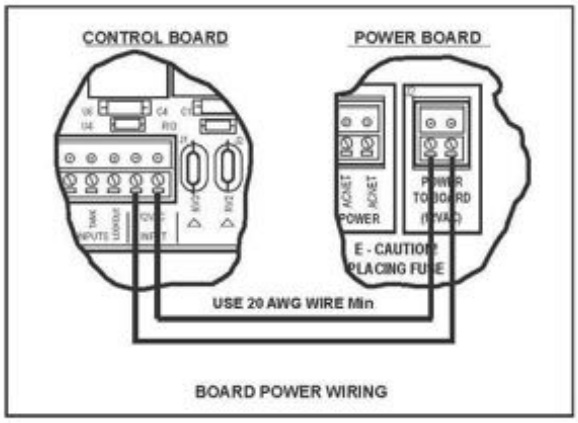


INLET & FLUSH VALVE WIRING FOR 115/230 VAC ONLY

## ESDI CONTROL PC BOARDS and POWER WIRING



## REVERSE OSMOSIS CONTROL – BEST

# ROC-2

# Reverse Osmosis System Controller Documentation

## Table 1. Specifications

### *Inputs*

| | |
|---|---|
| Tank level switches | (2) Normally-Closed. Can be used with a single level switch. |
| Inlet pressure switch | Normally-Open. |
| Pretreat lockout switch | Normally-Open. |
| Controller Power | 120/240 VAC, 60/50Hz (Range: 90-145 VAC at 120VAC setting, 180-290 VAC at 240 VAC setting |
| Permeate Conductivity | 0-1500* PPM, 0-3000 µs (Resistivity to 20M ohm available with Resitivity Cell) |
| Feed Conductivity (opt) | 0-3000* PPM, 0-6000 µs |
| | *These ranges are provided with the standard conductivity cell constant of 1.0. Higher ranges can be obtainned by using a cell with a di?erent constant. |

### *Output Relay Ratings*

| | |
|---|---|
| Feed Solenoid | 12A Resistive, 6A (Inductive). Voltage is the same as motor/supply voltage. |
| Flush Solenoid | 12A Resistive, 6A (Inductive). Voltage is the same as motor/supply voltage. |
| Motor | 30A Resistive, .75 HP/110V, 1.5 HP/220V. |

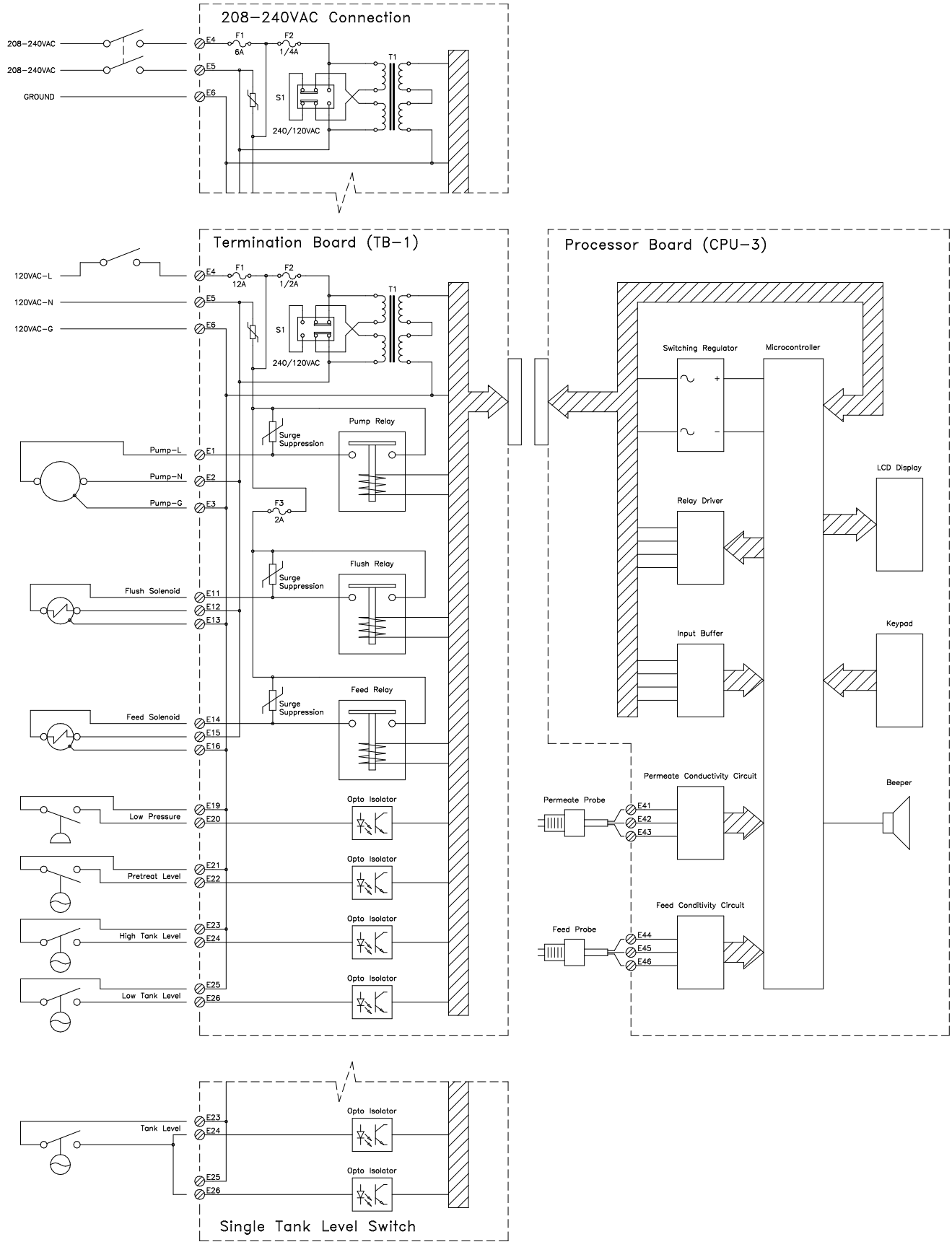
### *Circuit Protection*

| | | | |
|---|---|---|---|
| Main Power Fuse (110V) | F1 3AG | 20 Amp | LittleFuse 314.020(P) (For up to .75 HP motor) |
| | F1 3AG | 4 Amp | LittleFuse 312.004(P) (Motor contactor coil) |
| Main Power Fuse (208/240V) | F1 3AG | 12 Amp | LittleFuse 314.012(P) (For up to 1.5 HP) |
| Transformer Fuse | F2 3AG | 1/8 Amp | LittleFuse 312.125(P) |
| Relay Fuse | F3 3AG | 2 Amp | LittleFuse 312.002(P) |

### *Other*

| | |
|---|---|
| Dimensions | 6.5” tall, 6.5” wide, 4.5” deep. Nema 6P non-metallic. |
| Weight | 2.3 lb. (Basic Configuration, not including optional wire harness, etc..) |
| Environment | 0-50°C, 10-90%RH (non-condensing) |

## Figure 1. Simplified Schematic

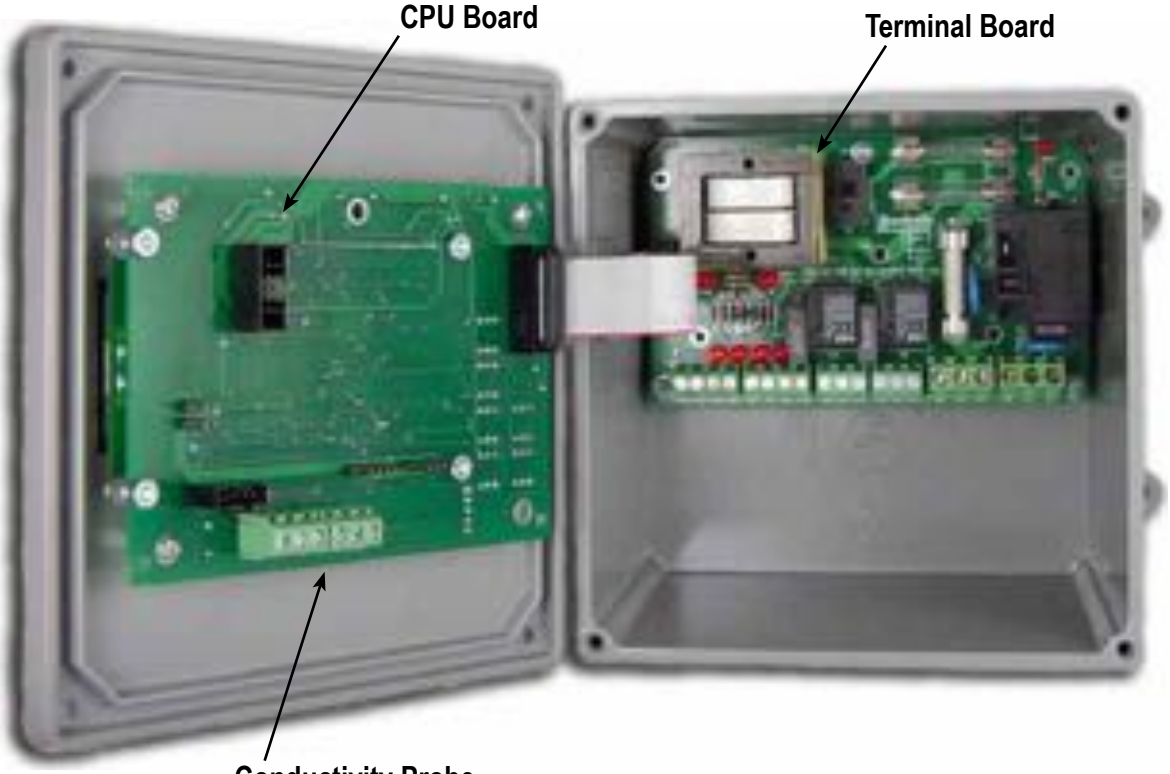


## Figure 2. Controller Overview


**Keypad.**
System ON/OFF,
Up Arrow
Down Arrow
Manual Run, Manual Flush

**Display.** (4 line, 20 character) Clear, concise feedback on the RO's status.

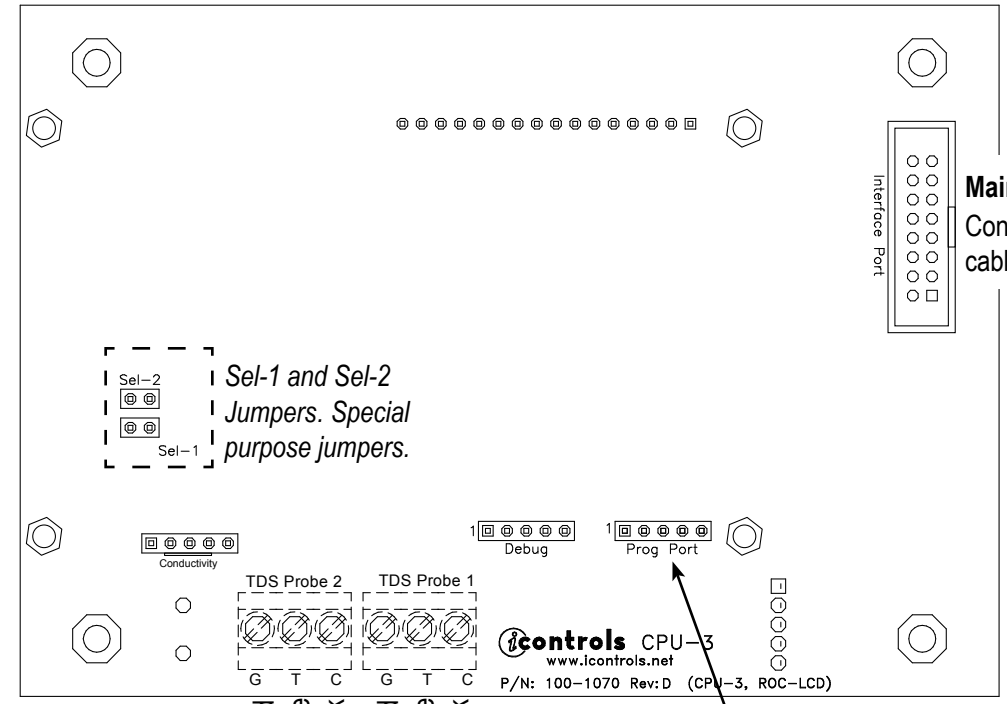
**Alarm.**
Display backlight flashes along with audible beeper to indicate alarm condition.



## Figure 3. Controller Detail: CPU-3

### Typical Configuration


### Detailed View



## Figure 4. Controller Detail: Terminal Board, TB-1 (See Fig. 1 for schematic)


**Pump LED**
Illuminates when the motor relay is energized.

**Inlet Power Switch**

**Feed and Flush Solenoid LEDs**
Illuminate when the relay is energized.

**Switch LEDs**
Illuminate when switches close.

Transformer
120 VAC
240 VAC
120V/240V
**F2** Controller Power Fuse
**F3** Solenoid Power Fuse
Pump
DS5
R1
CR1
K1
Motor Relay
(.75HP 120VAC)
(1.5HP 240VAC)
icontrols
www.icontrols.net
TB-1
E35
Z1
**F1** Main Power Fuse
P/N: 100-1001 Rev: N/C (Terminal Board -1)
CPU Interface
J1
R2
R3
Feed
Flush
CR4 CR3 CR2 CR6
CR5
CR7
C3
C2
C1
Z2
Inlet Valve Relay
Flush Valve Relay
K3
K2
DS4 Hi Tank
DS3 Pretreat
DS2
DS1 Press
Lo Tank
E26 E25 E24 E23
E22 E21 E20 E19
G N L
E16 E15 E14
E13 E12 E11
E6 E5 E4
E3 E2 E1

Alternate wiring for single level switch.
Tank Lo Tank Hi

Tank Lo Switch
Tank Hi Switch
Pretreat Switch
Pressure Switch
**Dry Contacts. Do not apply external voltage**

**Inlet Valve** 120/240 VAC
**Flush Valve** 120/240 VAC
**Supply Power** 120/240 VAC
**Pump/ Motor** 120/240 VAC

**Figure 6. Controller Programming. Accessing the hidden menus.**


1. With the System ON, Press and Hold the UP and Down Arrows.

2. With the UP and Down Arrows depressed, press the System On/ Off Switch. The menu will switch to the RO Presets menu shown in Figure 7.

## Table 2. Controller Programming: ROC-2 Program Selections

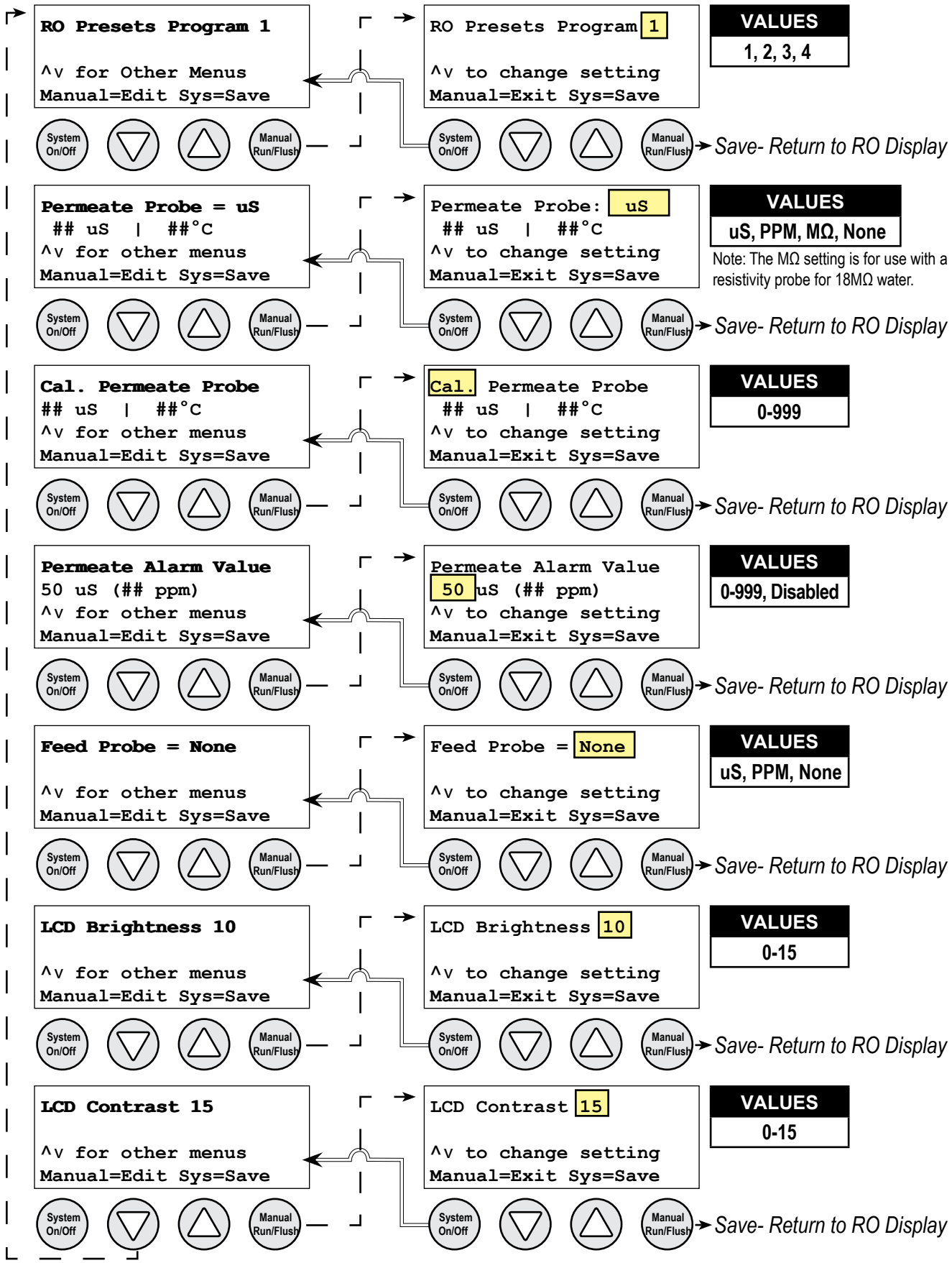
The controller has 4 separate, field-selectable sets of settings for configuring the RO. The factory default settings are shown below. The settings are identical except for variations in the flush behavior.

- **For "Normal" operation use Program 1.**
- **For No Flush, use Program 2.**
- **For higher frequency and longer duration flush see Programs 3 & 4.**
- See the following page for instructions on how to access the menu for selecting these programs.
- See Appendix A for a detailed explanation of the Parameters and their effect on the RO's operation.
- See Appendix B for information on the programming interface.

| Parameter | Value | Program 1 | Program 2 | Program 3 | Program 4 |
|---|---|---|---|---|---|
| Tank Level Switch delay (actuation and de-actuation) | Seconds | 2 | 2 | 2 | 2 |
| Pressure Switch delay (actuation and de-actuation) | Seconds | 3 | 3 | 3 | 3 |
| Pretreat Switch delay (actuation and de-actuation) | Seconds | 2 | 2 | 2 | 2 |
| Pump start delay | Seconds | 10 | 10 | 10 | 10 |
| Inlet Solenid stop delay | Seconds | 1 | 1 | 1 | 1 |
| Pump start retry interval (restart delay after LP fault) | Seconds | 60 | 60 | 60 | 60 |
| Low pressure fault shutdown, # of faults | Faults | 5 | 5 | 5 | 5 |
| Low pressure fault shutdown, time period to count faults | Minutes | 10 | 10 | 10 | 10 |
| Low pressure fault shutdown, reset after shutdown | Minutes | 60 | 60 | 60 | 60 |
| Low pressure fault alarm relay output (TB-2 ONLY) * | Off/On | Off | Off | Off | Off |
| Low pressure timeout fault | Seconds | 60 | 60 | 60 | 60 |
| **Flush Behavior** | | Normal | No Flush | Extra Flush | Maximum Flush |
| Time from last flush before Flush on Shutdown | Minutes | 10 | 0 | 10 | 10 |
| Minumum operation before Flush on Shutdown | Minutes | 30 | 0 | 30 | 1 |
| Flush duration on Shutdown | Seconds | 60 | 0 | 120 | 300 |
| Periodic Flush interval | Minutes | 60 | 0 | 60 | 30 |
| Periodic Flush duration | Seconds | 30 | 0 | 60 | 30 |
| Unit Idle Flush interval * | Minutes | 0 | 0 | 0 | 0 |
| Unit Idle Flush duration * | Seconds | 0 | 0 | 0 | 0 |
| Timed Manual Run | Minutes | 5 | 5 | 5 | 9 |
| Timed Manual Flush | Minutes | 5 | 0 | 5 | 9 |
| Conductivity Probe Sample Rate | Seconds | 2 | 2 | 2 | 2 |
| Conductivity Shutdown * | Minutes | 0 | 0 | 0 | 0 |

* These features are disabled by default due to the potential for confusion on the part of end-users in the field. They can be enabled when needed via the OEM PC programming interface which allows changes to all of the values shown above.

## Figure 7. Controller Programming: Menu Navigation



## Appendix A. Controller Programming: Parameters Explained

| Parameter | Value | Range | Example |
|---|---|---|---|
| **Input Switch Behaviors** | | | |
| Tank Level Switch delay (actuation and de-actuation) | Seconds | | 2.0 |
| *This specifies the time that the tank switch must be closed or open before the controller accepts it as a valid condition. The function is to prevent nuisance tripping of the RO especially in small tanks or turbulent tanks* | | | |
| Pressure Switch delay (actuation and de-actuation) | Seconds | | 3 |
| *This specifies the time that the pressure switch must be closed or open before the controller accepts it as a valid condition. Since pressure switches usually have built-in hysteresis this value is set at 0.* | | | |
| Pretreat Switch delay (actuation and de-actuation) | Seconds | | 2 |
| *This is the time that the pretreat switch must be OPEN before the controller accepts it as a valid condition.* | | | |
| | | | |
| **Pump/Inlet Solenoid Behaviors** | | | |
| Pump start delay | Seconds | | 10 |
| *On RO start-up, after the tank switch opens, the inlet solenoid valve is energized. When the inlet pressure switch closes this begins the "Pump start delay". If the pressure switch remains closed, the pump will start after 10 seconds.* | | | |
| Inlet Solenid stop delay | Seconds | | 1 |
| *This value sets the delay for the inlet solenoid valve to be deenergized following the deenrgizing of the motor on RO shut down. The purpose is to prevent the pump from operating against a closed suction as the pump spins down.* | | | |
| | | | |
| **Low Inlet Pressure Behaviors** | | | |
| Pump start retry interval (restart delay after LP fault) | Seconds | | 60 |
| *When the inlet pressure swith opens, the controller deenergizes the motor and the inlet solenoid valve remains open. The controller will continure to monitor the inlet pressure switch. After the switch is closed for the duration of the "Pump start retry interval" the motor is reenergized.* | | | |
| Low pressure fault shutdown, # of faults | Faults | | 5 |
| Low pressure fault shutdown, time period to count faults | Minutes | | 10 |
| Low pressure fault shutdown, reset after shutdown | Minutes | | 60 |
| *These three values work together to determine how the RO handles Low Pressure conditions. The first two values, "# of faults" and "time period to count faults", sets the limit for the number of low fault conditions over time that are required to place the RO in "Low Pressure Fault Shutdown". The third value sets the duration of the "Low Pressure Fault Shutdown" which is the period that the RO will remain idle before trying to restart. The purpose of the Low Pressure Fault Shutdown is to prevent an RO from turning OFF/ON repeatedly without any limit.* | | | |
| Low pressure timeout fault | Seconds | | 60 |
| *If the inlet valve is open, but the pressure isn't sufficient to close the inlet pressure switch, the RO would run indefinitely on line pressure. This value sets the time limit for the RO to operate with the inlet valve open with Low Pressure as indicated by an Open inlet pressure switch before a Low Pressure Fault is added to the counter above* | | | |

## Appendix A. Controller Programming: Parameters Explained

| **Flush Behavior** | | | |
|---|---|---|---|
| Time from last flush before Flush on Shutdown | Minutes | | 15 |
| Minimum operation before Flush on Shutdown | Minutes | | 60 |
| Flush duration on Shutdown | Seconds | | 60 |
| Periodic Flush interval | Minutes | | 60 |
| Periodic Flush duration | Seconds | | 30 |
| Unit Idle Flush interval * | Minutes | | 0 |
| *The Unit Idle Flush Interval sets a time after which the RO will start-up and run in the flush mode. This is disabled by default because of the danger of over-flowing a tank if not properly implemented. It is intended for environments where leaving the RO idle for long periods would invite bio-fouling. (0)=disabled* | | | |
| Unit Idle Flush duration * | Seconds | | 0 |
| *Sets the duration of the Idle Flush. (0)=disabled* | | | |
| | | | |
| Timed Manual Run - Duration of Manual Run | Minutes | | 5 |
| Timed Manual Flush - Duration of Manual Flush | Minutes | | 5 |
| Conductivity Probe Sample Rate | Seconds | | 2 |
| Conductivity Shutdown * *(0)=disabled* | Minutes | | 0 |

## START-UP AND MEMBRANE FLUSHING

All Reverse Osmosis units are shipped with the Membranes installed. Please follow these directions when preparing the system for service.

- Install the pre-filter cartridge(s) at this time.
- Make sure there is no power to the unit.
- Turn on the water supply and check for leaks.
- Make fitting adjustment as necessary to eliminate any leaks that may have developed during shipping.
- Open the waste valve fully (counter clockwise).
- Disable Pump by disconnecting wiring at RO Pump Control terminals in control. See appropriate control section for wiring terminals.
- Disconnect the product line and direct it to drain.
- Connect power to the control by plugging in the power cord. Turn on the power. The inlet solenoid will open and water will flow into the RO. The pump should not come “on” at this time because it was disconnected. Allow water to completely fill the unit and run to drain for 5 minutes.
- Turn the power “off”.
- Reconnect the wiring at the RO Pump Control terminals.
- Determine the product and waste flow rates from the Specifications on page 4.
- Open the waste and pump discharge valves fully.
- Close the recycle valve.
- Turn “on” the RO and set the Waste (reject) flow rate by closing the Waste control valve until the desired flow rate is obtained. ***Caution – do not let the membrane feed pressure exceed 200 psi, open recycle valve to decrease membrane pressure if necessary.***
- Upon completion of setting the Waste flow rate, adjust the Recycle valve until the Product flow rate is set.

  *Note: Observe and record the membrane feed pressure after the product flow rate has been set.*

- Open the Waste valve to reset the Waste flow rate.
- Close the Recycle valve until the membrane feed pressure matches the recorded pressure from above.
- After the flow rates have been set, allow the unit to operate to drain for a minimum of 30 minutes. After the 30-minute period begin monitoring the Product TDS. When the percent rejection rises to 95% or greater, turn the RO off and reconnect the product line. The RO is ready for normal operation turn on the power.

$$\%\ \text{Recovery} = \frac{\text{Product Flow}}{\text{Feed Flow}}$$

$$\%\ \text{Rejection} = \frac{\text{Feed TDS} - \text{Product TDS}}{\text{Feed TDS}} \times 100$$

# TECHNICAL INFORMATION

## RO SYSTEM SHUTDOWN

To shutdown the RO simply turn off the power switch and unplug. If the shutdown is going to be longer than 48 hours, the following steps must be taken to prevent microbiological growth in the membranes. A biocide must be recirculated through the membranes for this purpose. It is recommended that the following equipment be used to facilitate the procedure.

- Progard SPC ™ - A combination biocide and antifreeze – p/n 704056
- Poly holding tank for biocide
- Pump (if required) see step 5 below.
- ½" or ¾" flexible hose.

1. Collect sufficient product water in the biocide tank to create a 4 to 1 solution (4 parts RO water to 1 part Progard SPC™) equal to or greater than the volume of water in the RO membranes, filter housings, and piping and hoses.
2. Add the required quantity of Progard SPC™ to the biocide solution tank to make the 4 to 1 solution. Mix thoroughly. Read all safety precautions and instructions supplied with the preservative before handling.
3. If the RO feed water is being chemically treated, determine the chemical dosage.
4. Turn on the RO system. Open the waste valve slowly until the membrane feed pressure decreases to approximately 40 psi. If the RO is equipped with a feed pressure-throttling valve, close it slowly while simultaneously opening the waste valve until the pressure decreases to 40 psi. This will create a high flow, low-pressure flush of the membranes. Flush the membranes for 20 minutes then turn off the RO.
5. Connect a hose from the solution tank to the RO pump inlet. If the solution in the solution tank is above the pump inlet proceed to step 7. If not, a repressurization pump is required to recirculate the solution.
6. Disconnect the power leads to the RO pump to keep it from running when using a repressurization pump for the biocide solution.
7. Temporarily direct the product and waste lines into the solution tank.
8. Turn on the RO, then, turn on the repressurization pump if used. Recirculate the solution through the RO and back to the solution tank.
9. After recirculating for 30 minutes, turn off the recirculation pump if used and the RO. Plug the product and waste ports on the RO. When plugging ports be careful not to spill the preservative.
10. Reconnect the RO pump wiring and the inlet feed line.
11. Label the RO with a warning sign not to use while out of service.
12. Dispose of the remaining biocide solution per local codes. Flush the solution tank; hoses and recirculation pump if used.
13. Prior to returning the RO back to service it should be flushed for approximately 30 minutes.

The RO System has been designed to operate with a minimum of operator attention. Longer operation and fewer problems will arise, when operator maintenance is performed regularly. Operator maintenance for a RO system is limited to maintaining performance logs, proper membrane cleaning and disinfection when needed, periodic lubrication, and timely prefilter cartridge replacement.

## RO SYSTEM PERFORMANCE LOG

| **Date** | Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|---|
| Prefilter Inlet PSI | | | | | | | |
| Prefilter Outlet PSI | | | | | | | |
| Prefilter ΔP (<10psi) | | | | | | | |
| Product Flow GPM | | | | | | | |
| Waste Flow GPM | | | | | | | |
| Recycle Flow GPM | | | | | | | |
| Water Temperature | | | | | | | |
| RO Pump Pressure | | | | | | | |
| Feed Water TDS | | | | | | | |
| Product Water TDS | | | | | | | |
| % Rejection | | | | | | | |
| Free Chlorine - ppm | | | | | | | |
| Antiscalant - ppm | | | | | | | |
| RO Feed Pressure | | | | | | | |
| Softener Effluent Hardness - ppm | | | | | | | |
| Brine Tank Salt Level | | | | | | | |
| | | | | | | | |
| Inspected by - | | | | | | | |
| Comments | | | | | | | |

## PREFILTER CARTRIDGE REPLACEMENT

Visually inspect the prefilter every 30 days. If the core of the cartridge is discolored, replace it. The discoloration is an indication that the filter has been in service too long. This also means that a more frequent filter inspection and replacement should be considered.

- Turn off the power to the RO System and close the inlet feed valve.
- Place both hands tightly around the bowl and unscrew counter clockwise until it is free from the head.
- Remove the cartridge filter and empty the water remaining in the bowl. Rinse the inside of the bowl. Clean the inside of the bowl with a mild detergent and rinse thoroughly, if necessary.
- Inspect the bowl o-ring seal and lubricate with glycerin if required. ***Do not use petroleum-based lubricants****.* Make sure the o-ring is seated and completely inside the groove.
- Insert the replacement cartridge inside the bowl and fill the bowl with RO feed water. The cartridge will float slightly inside the bowl and the top will protrude above the bowl rim.
- Align the top filter core opening with the center guide molded into the filter housing head and screw on the filter bowl. Hand-tighten the bowl. ***Do not use a wrench! Using a wrench could damage the o-ring seal and cause difficulty in unscrewing the bowl during the next removal.***
- Open the feed water valve and turn on the power.

## PUMP IMPELLER STACK REPLACEMENT

Remove pump from RO frame and mount it vertically in vise – motor side down. Hold at center of motor. It may be desirable to wrap motor with a shop rag to protect outside surface.

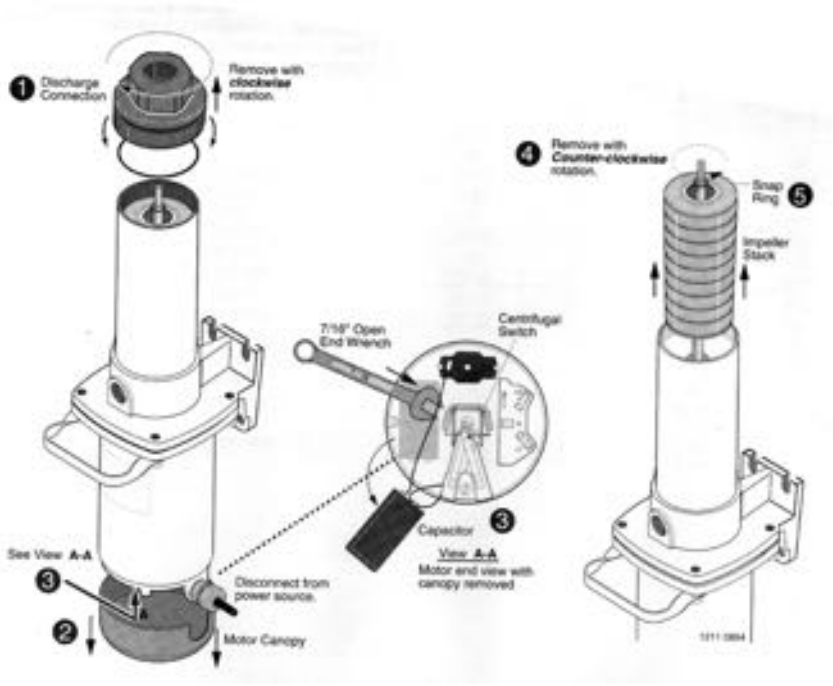
1) Attach pipe wrench to flats on discharge connection and turn clockwise to remove (left hand threads).
2) Remove screws holding motor canopy and remove canopy. Pull straight off. Leave switch wires attached. Warning – capacitor voltage may be hazardous. To discharge capacitor hold insulated screwdriver by the handle and short capacitor terminals together. Do not touch screwdriver blade or capacitor terminals.
3) Unscrew capacitor clamp and remove capacitor. Do not disconnect capacitor wires. Slide 7/16” open-end wrench in behind spring loaded centrifugal switch. Place on motor shaft flats to hold shaft stationary.
4) Place a second 7/16” wrench on shaft hex at pump end and unscrew impeller stack by turning counter-clockwise.
5) Once loose from motor shaft, hold shaft by snap ring using a pliers or similar tool, and pull stack from shell. Apply back and forth motion as needed to break stack loose from shell.

To reassemble with replacement impeller stack, keep pump in vertical position, motor down, and reverse the removal steps.

**Assembly Hints**

a) Apply soapy water to o-rings to ease assembly of shell.
b) Make sure mechanical shaft seal spring is in proper position on motor shaft.

***Impeller Stack Replacement Illustration***




## MECHANICAL SEAL REPLACEMENT

Remove pump from service and mount in a vise. Vise should hold pump in a vertical position with the motor down, as shown in the illustration on the following page.

First completely disassemble pump and motor as outlined in steps 1 thru 5 under ***Impeller Stack Replacement.***

6) Remove the 4 cap screws holding the pump body to the motor.
7) Unscrew the pump shell from the pump body, turning clockwise (left hand threads).
8) Remove mechanical shaft seal spring and rotating half of mechanical seal from the motor shaft. Use care not to scratch motor shaft when removing the rotating half of mechanical seal.
9) Remove pump body from the motor and place it on a flat surface, face down. Again, use care not to scratch the motor shaft.
10) Use a screwdriver to push the ceramic seat out from the seal cavity as shown in the illustration on the following page.
11) Installation of ceramic seat:
    a) Turn pump body over so seal cavity is up; clean cavity thoroughly.
    b) Clean polished surface of ceramic seat with a clean cloth.

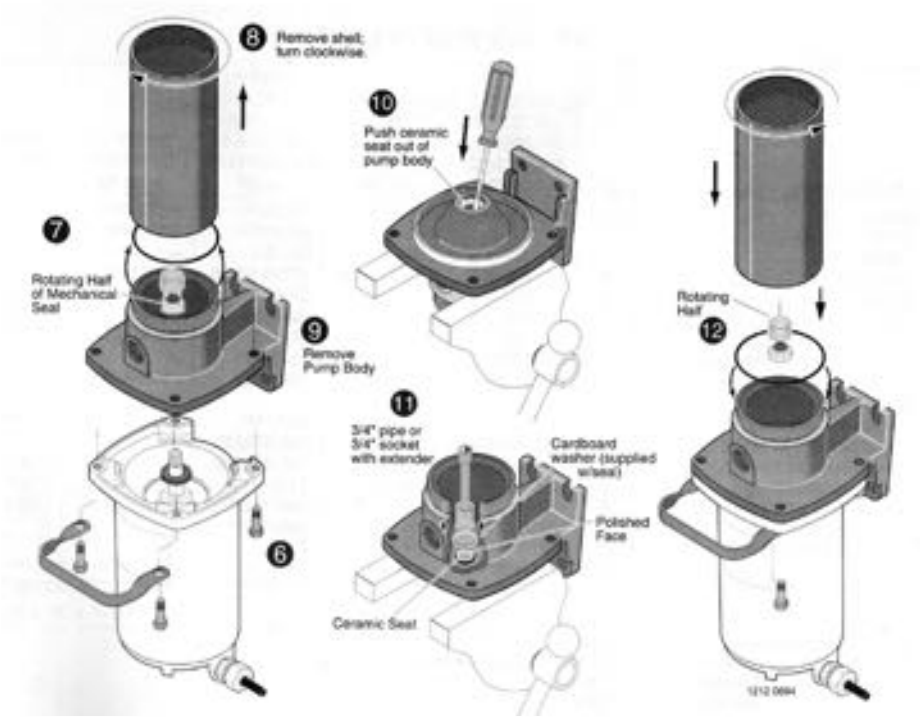
c) Lubricate outside rubber surface of seat with soapy water. Place cardboard washer over polished face of seat and press into seal cavity using a ¾" socket or a piece of ¾" standard pipe.
d) Be sure polished service of seat is free of dirt and has not been damaged by insertion. Remove excess soapy water. Dispose of cardboard washer.

12) Installation of rotating half and spring:
a) Reinstall pump body on motor using extreme caution not to hit ceramic portion of seal on motor shaft. Reattach pump body to motor using cap screws.
b) Inspect shaft to make sure it is clean.
c) Clean face of rotating half of seal with a clean cloth.
d) Lubricate inside diameter of rotating half of seal with soapy water and slide onto motor shaft (sealing face first).
e) Place spring over motor shaft so it rests on the rotating half.

13) To complete reassembly from this point, reverse instructions 1 through 5 under "Impeller Stack Replacement".

NOTICE: Lubricate suction and discharge O-rings with soapy water for easier installation of shell.

***Mechanical Seal Replacement Illustration***



## MEMBRANE CLEANING

There are a number of indicators that signal when a membrane must be cleaned. The most common indicator is a reduction in product flow by at least 10%. A second indicator is an increase in differential pressure between the feed and waste streams. An increase in product water TDS may also indicate that membrane cleaning is required.

Membrane cleanings are categorized as either Low pH or High pH. Low pH cleaning will remove metal hydroxides, calcium carbonate, and similar scales from the membrane. High pH cleaning will remove organics, silt and other particulates from the membrane. The best results are obtained when a high pH cleaning follows a low pH cleaning.

**MEMBRANE CLEANING CHEMICALS**

| Chemical | Mixing Instructions | Contaminant |
|---|---|---|
| *Citric Acid (0.5 – 1.0%)* | Adjust pH to 4.0 with sodium hydroxide (NaOH) – Mix 17.0 lbs of Citric Acid with 0.45 quarts of liquid non-ionic detergent concentrate and 100 gallons of RO permeate. | ***Inorganic Salts*** – Carbonates and Phosphates<br>***Metal Oxides*** – Iron, copper, or nickel. |
| *Sodium Tripolyphosphate + Sodium EDTA* | Adjust pH to 7.5 with sulfuric acid ($H_2SO_4$) – Mix 17.0 lbs of Sodium Tripolyphosphate with 7.0 lbs of Sodium EDTA, 0.43 quarts of liquid non-ionic detergent concentrate and 100 gallons of RO permeate. | ***Mixed Colloids*** – Iron, organics and silicates.<br>***Calcium Sulfate*** – $CaSO_4$<br>***Biological films*** – organics |
| *Sodium Tripolyphosphate + Sodium Dodecylbenzene-sulfonate* | Adjust pH to 7.5 with sulfuric acid ($H_2SO_4$) – Mix 17.0 lbs of sodium Tripolyphosphate and 2.13 lbs of Sodium Dodecylbenzene-sulfonate and 100 gallons of RO permeate. | ***Bacteria*** |
| *Sodium Hydroxide + Sodium EDTA* | Mix 0.1% by weight of Sodium Hydroxide with 0.1% by weight of Sodium EDTA. Correct pH to 12.0 – Max temp. $86^{O}$ F. | ***Silica***<br>***Biological Films*** - organics |
| *Hydrochloric Acid* | Mix 0.3 – 0.5% by volume of HCl. Dilute with RO permeate, then adjust pH to 4.0 with sodium hydroxide. | ***Inorganic Salts*** – Carbonates and Phosphates, Calcium Carbonate, Barium Sulfate or Calcium Sulfate. |
| *Phosphoric Acid* | Mix 0.1 – 0.5% by volume of Phosphoric Acid. Dilute with permeate, and then adjust pH to 4.0 with sodium hydroxide. | ***Inorganic Salts*** – Carbonates and Phosphates, Calcium Carbonate, Barium Sulfate or Calcium Sulfate.<br>***Metal Oxides*** – Iron, copper, or nickel. |
| *Sodium Hydrosulfite* | Mix 2.0 – 4.0% by weight of Sodium Hydrosulfite and RO Permeate. | ***Metal Oxides*** – Iron, copper, or nickel. |

Note: The criteria above were taken from information supplied by Filmtec, Desal and Hydranautics. When attempting to clean a membrane, the membrane manufacturer should be consulted and cleaning procedures for that particular membrane should be followed. The above list is not meant to be complete, there are numerous cleaning agents available, but the majorities are some form of the above chemicals.

The chemicals should be pumped into the membranes at the following flow rates – 1.5 to 2.5 for 2.5" membranes, 4 to 5 gpm for 4" membranes and 15 to 20 gpm for 8" membranes. These flow rates are half the recirculation rates utilized during the cleaning process. The pressure should be reduced to the point that no permeate is produced during the filling process. The chemical solution should be warm for best results.

Fill the vessels until the chemical shows up at the drain. Switch to recirculation until the temperature stabilizes. The maximum solution temperature is based on the pH of the chemical cleaning solution (see chart). Turn off the pump and allow the membrane(s) to soak over night. The temperature can be maintained by slow recirculation (0.5 gpm for 2.5" membranes, 1.0 gpm for 4" membranes and 4.0 gpm for 8" membranes).

| Maximum Temperature of Solution | |
|---|---|
| pH | Temperature |
| 2 – 10 | 122$^{O}$ F |
| 10 – 11 | 98$^{O}$ F |
| 11 – 12 | 86$^{O}$ F |

After allowing the membranes to soak for 10 to 15 hours, increase the recirculation rate of the cleaning solution through the membrane to a flow of 3 – 5 gpm for 2.5" diameter membranes, 8 – 10 gpm for 4" diameter membranes, and 30 – 40 gpm for 8" diameter membranes for a period of 30 to 60 minutes. The pressure during cleaning should be maintained between 20 and 60 psi.

The membrane should be rinsed with RO permeate water until the water runs clear or for at least 10 minutes after cleaning. Pretreatment water can be used as long as there is no corrosion in the piping. The permeate should be directed down the drain until the membrane is completely rinsed. Operate the system at reduced pressures and flows initially to insure all the cleaning chemicals are rinsed from the membrane before resuming normal operation.

## TEMPERATURE CORRECTION FACTORS

The water temperature is one of the key factors in the performance of the Reverse Osmosis System. The higher the temperature, the more the product flow and vise versa. All RO Systems are rated at 77$^{O}$ F (25$^{O}$ C). To find the permeate rate at a different temperature – divide the rated flow rate by the temperature correction factor in the table.

| TEMPERATURE | | CORRECTION FACTOR |
|---|---|---|
| $^{O}$F | $^{O}$C | |
| 33.8 | 1 | 3.64 |
| 35.6 | 2 | 3.23 |
| 37.4 | 3 | 3.03 |
| 39.2 | 4 | 2.73 |
| 41.0 | 5 | 2.58 |
| 42.8 | 6 | 2.38 |
| 44.6 | 7 | 2.22 |
| 46.4 | 8 | 2.11 |
| 48.2 | 9 | 2.00 |
| 50.0 | 10 | 1.89 |
| 51.8 | 11 | 1.78 |
| 53.6 | 12 | 1.68 |
| 55.4 | 13 | 1.61 |
| 57.2 | 14 | 1.54 |
| 59.0 | 15 | 1.47 |

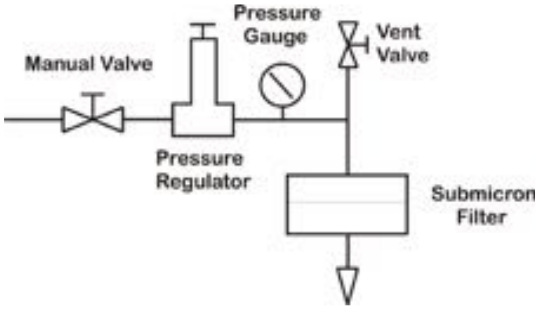
| TEMPERATURE | | CORRECTION FACTOR |
|---|---|---|
| $^{O}$F | $^{O}$C | |
| 60.8 | 16 | 1.39 |
| 62.6 | 17 | 1.34 |
| 64.4 | 18 | 1.29 |
| 66.2 | 19 | 1.24 |
| 68.0 | 20 | 1.19 |
| 69.8 | 21 | 1.15 |
| 71.6 | 22 | 1.11 |
| 73.4 | 23 | 1.08 |
| 75.2 | 24 | 1.04 |
| **77.0** | **25** | **1.00** |
| 78.8 | 26 | 0.97 |
| 80.6 | 27 | 0.94 |
| 82.4 | 28 | 0.91 |
| 84.2 | 29 | 0.88 |
| 86.0 | 30 | 0.85 |

## SDI STANDARD TEST METHOD

The test method outlined here was taken from the ASTM Standards D 4189-82, and covers the determination of the silt density index (SDI) of water. An SDI Test is utilized to determine the amount of particulate matter in the water. It only applies to low turbidity waters such as well water, filtered water, or clarified water. This test method is not applicable for Reagent Grade Water Types I, II, and III or effluents from reverse osmosis and ultra-filtration systems. The SDI is calculated based on the amount of time it takes to plug a .45-micron filter at a constant pressure of 30 psi.

***SDI Test Kit Components -***

- SDI Testing Assembly – This apparatus is depicted in the diagram. It is composed of a manual valve, a pressure regulator, a pressure gauge, and a 0.45-micron filter assembly. All parts must be free of corrosion, or contamination. Do not use carbon steel or cast iron components.
- Membrane Filter – Filters to be used in the filter housing are 47 mm in diameter with a mean pore size of 0.45 +/- 0.02 micron.
- Graduated Cylinder – 500 ml capacity is required.




**SDI APPARATUS ASSEMBLY**

- Stopwatch – Graduated in hundredths of a minute.
- Thermometer – Liquid in glass, suitable for measuring the temperature of the water sample, and capable of being read within +/- 1$^{O}$C.

***Procedure -***

- Assemble the apparatus as shown in the illustration above. Set the pressure regulator to 30 psi (207 kPa).
- Before installing the 0.45-micron filter, flush the apparatus with water to be tested to remove any contaminants.
- Measure the temperature of the water.
- Open the filter housing and place a 0.45-micron filter disc on the support plate. Handle the filter paper only with dull tweezers to avoid puncturing. Avoid touching the filter disc with the fingers.
- Check the o-ring for proper position and condition. Replace the top half of the filter housing and screw together loosely, do not tighten.
- Bleed out trapped air by opening the valve. Close the valve and tighten the filter housing.
- Open the valve. Using a stopwatch, measure the time required to flow 500 ml of sample water. Record the lapsed time. Leave the valve open and allow the water to continue to flow.
- Collect additional samples at 5 minutes, 10 minutes, and 15 minutes. Each time, use the stopwatch to measure the time it takes to collect a 500 ml sample. Measure the water temperature and check the pressure as each sample is collected. The pressure must remain at 30 psi and the temperature must remain constant throughout the testing.
- After completion of the test, remove the filter and retain for future reference.

***SDI Calculation –***
Calculate the Silt Density Index ($SDI_T$) as follows:

$$SDI_T = \frac{\%P_{30}}{T} = \frac{\left[1 - \frac{t_1}{t_2}\right] 100}{T}$$

Where:

| | | |
|---|---|---|
| $\%P_{30}$ | = | percentage of time difference to collect 500 ml |
| T | = | total elapsed time in minutes – usually 15 |
| $t_1$ | = | initial time to collect 500 ml sample of water |
| $t_2$ | = | time required to collect 500 ml sample after test time T |

*Note: When utilizing this test method, if $\%P_{30}$ exceeds 75%, use a shorter time for T; that is 5 or 10 minute measurements instead of 15 minutes as outlined in the procedure. If $\%P_{30}$ exceeds 75% after 5 minutes, the sample should be analyzed for particulate matter.*

***The SDI Report –***

The report should contain the following information:

- The SDI, with a subscript indicating the total elapsed time (T) in minutes.
  Example: $SDI_{15}$ = 1.8
- The water temperature before and after the test.
- The manufacturer of the 0.45 micron membrane filter used for the test, as well as, the manufacturer's identification for the membrane filter,

## PERIODIC MEMBRANE DISINFECTION

If bacteria free product water is required, the system should be flushed periodically with a disinfectant. The disinfectants used for long-term storage differ from those used for periodic disinfection. See "RO System Shutdown" located at the beginning of this technical section, for long-term storage requirements.

The most suitable chemical for periodic disinfection is 0.1% hydrogen peroxide. It is recommended that the hydrogen peroxide be used once a week for disinfection. The maximum temperature should be $77^{O}$F, and the maximum contact time should be 20 minutes. However, if the disinfection is only once a month then the contact time should be increased by a factor of four, to 80 minutes. It should be noted that continuous use of hydrogen peroxide in the above concentration will decompose the membrane.

Formaldehyde can also be used as a periodic disinfectant, however it should not be used until the membrane is completely saturated with water, which usually takes 6 to 24 hours of operation. Use 0.5 to 3.0% formaldehyde for disinfection of the membrane. Initially a 5% to 10% reduction in productivity will be experienced, and is a permanent loss. A temporary 5% to 10% loss will be experienced each time the formaldehyde is used thereafter.

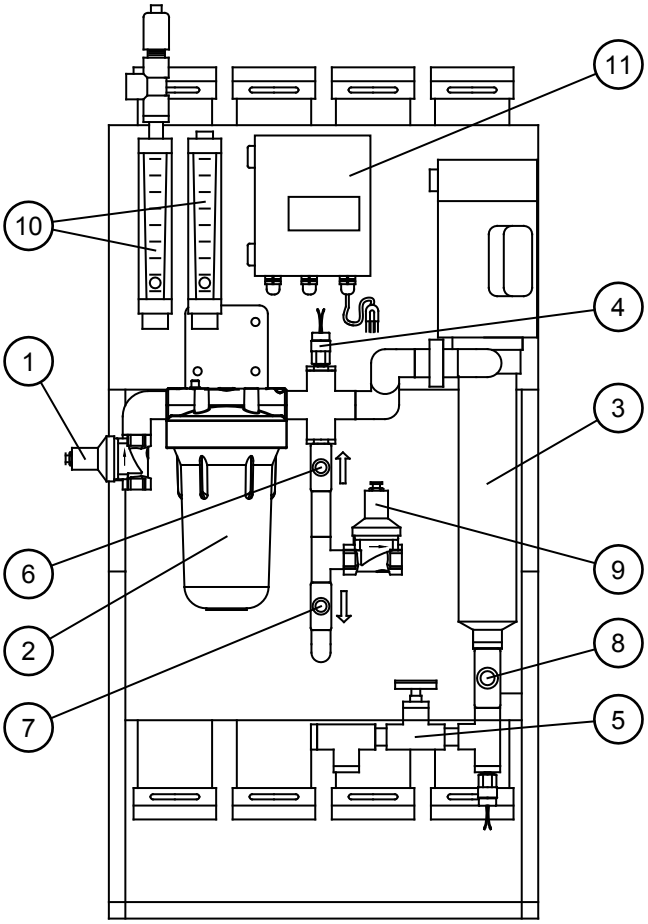
*Do not use chlorine or compounds containing chlorine on TFC membranes.*

## MEMBRANE REPLACEMENT

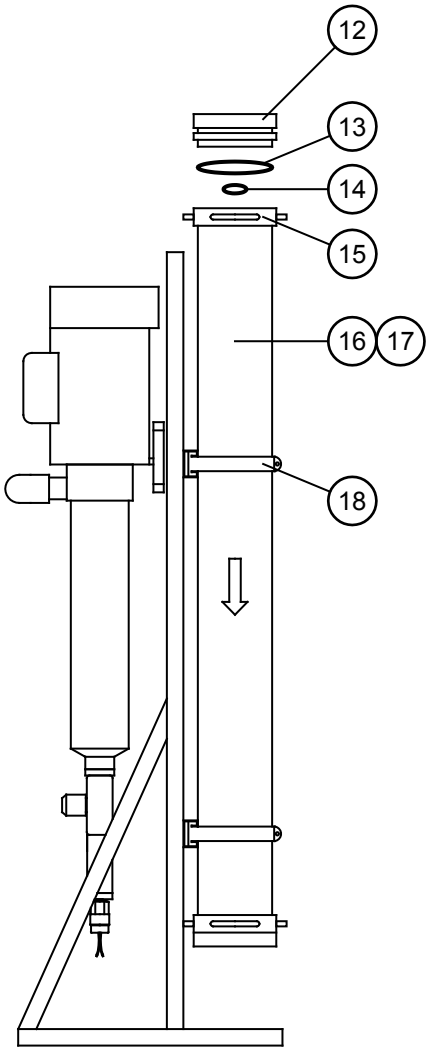
The life of a membrane is normally 3 to 5 years. Membrane life can be shortened if the proper pretreatment is not installed or contaminants in the influent water have been added since the system was installed. At some point in time, the membranes will need to be replaced. The following procedure details how to go about replacing the membranes.

- Turn OFF the RO System and unplug the power cord.
- Make sure all the pressure vessels have been depressurized, then, disconnect all the lines from the feed end of the pressure vessel(s) being serviced.
- Remove the clamps from both ends of the housing and remove the end plugs by carefully pulling on the plug connector.
- Pull the membrane out of the vessel or if necessary, remove the end plug from the waste end of the pressure vessel and push the membrane out of the vessel.
- Insert the replacement membrane into the feed end of the vessel. Make sure the brine seal is on the feed end of the vessel. If lubrication is needed – use glycerin on the brine seal. Do not use silicone lubricants on membrane.
- Inspect all o-rings on the end plugs and adapters and replace if necessary.
- Lubricate the end plug o-rings and insert the plugs into the appropriate end of the pressure vessel.
- Reconnect all the lines to the proper ports on the pressure vessel.
- Plug in power cord and turn ON the RO System. Follow the Start-Up and Flushing Procedures in Section 5 of this manual.

## HVE SERIES PARTS LIST




FRONT VIEW




SIDE VIEW

| ITEM | DESCRIPTION | PART NO. | SPARE PART |
|---|---|---|---|
| **1** | Inlet solenoid valve<br>1" Valve | <br>207028 | |
| **2** | Prefilter Housing<br>10” Housing<br>10” 5-Micron Cartridge Polyspun | <br>235023<br>235024 | <br><br>√ |
| **3** | Pressure Pump<br>3/4 HP Sta-rite Pump (R1, R2 & R3)<br>2 HP Sta-rite Pump (R4, R5 & R6) | <br>201057<br>201058 | |
| **4** | Pressure Switch – 15 PSI | 236050 | |
| **5** | Pressure Gauge – 2.5” Liquid filled – 0 to 300 PSI | 236026 | |
| **6** | Recycle Valve<br>Needle Valve 1/2” NPT (all models) | 233035 | |
| **7** | Waste Valve<br>Needle Valve 1/2” NPT (all models) | <br>233035 | |
| **8** | Pump Throttling Valve – 3/4” | 233034 | |
| **9** | Flush Solenoid Valve (optional) – 1/2” NPT (all models) | 207029 | |
| **10** | Permeate & Concentrate Flow Meters<br>5 GPM – 1/2” Female NPT<br>10 GPM – 1” Female NPT | <br>202128<br>202129 | |
| **11** | Controls<br>Better – ESDI 258<br>Best – ROC-2 (includes permeate TDS sensor) | <br>920302<br>920301 | |
| **12 - 15** | Replacement RO End Cap Kit (includes Items 12 - 15) | 653109 | √ |
| **12** | Membrane Housing End Cap for SST Housing | 653100 | √ |
| **13** | O-ring for Membrane Housing End Cap | 653102 | √ |
| **14** | Membrane Permeate O-ring | 508020 | √ |
| **15** | End Cap Clamp Kit – SST Membrane Housing | 653101 | |
| **16** | Stainless Steel Membrane Housing Complete for 4 x 40 Membranes – includes O-rings & Clamp Kits | 653047 | |
| **17** | 4 x 40 Low Energy Membrane | 650188 | |
| **18** | Uni-strut Clamp for 4” Stainless Housing | 509036-10 | |