ENGINEERING YOUR SUCCESS.

Sea Recovery

Tasman Sea (T3)
Owner's Manual

Tasman Sea T-3

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TM-A600 (Rev. A)

REVISION HISTORY

REVISION	DESCRIPTION	DATE
0	Document Release	20-Sep-2019
A	Update entire manual	Jan 18, 2020

The following are the types of flags used in this technical manual. They designate safety related items and important operational instructions and should be given special attention when they appear in the text:

WARNING	Text formatted in this manner concerns an operating procedure or practice that, if not strictly observed, can result in injury to personnel or loss of life.
CAUTION	Text formatted in this manner concerns an operating procedure or practice that, if not strictly observed, can result in damage to or destruction of equipment.
NOTE	Text formatted in this manner concerns an operating procedure or condition that warrants special attention.

Contents

SECTION 1

SYSTEM DESCRIPTION

1 SYSTEM DESCRIPTION

Tasman Sea is a potable water reverse osmosis system designed to take seawater and make freshwater.

1.1. FLOW:

Model	Feed Water Inlet**	Feed Water Inlet	Reject Outlet	Reject Outlet	Product Water Outlet*	Product Water Outlet*	Product Water Outlet*	Product Water Outlet*
A600	**GPM**	**LPM**	**GPM**	**LPM**	**GPM**	**LPM**	**GPD**	**M3/Day**
-30	43.2	163.5	30.5	115.5	5.5	20.8	7920	30
-31	43.2	163.5	30.5	115.5	5.5	20.8	7920	30
-38	43.2	163.5	29	109.8	7	26.5	10080	38
-39	43.2	163.5	29	109.8	7	26.5	10080	38
-44	43.2	163.5	27.7	104.9	8.3	31.4	11952	45
-45	43.2	163.5	27.7	104.9	8.3	31.4	11952	45
-61	43.2	163.5	24.8	93.9	11.2	42.4	16128	61
-62	43.2	163.5	24.8	93.9	11.2	42.4	16128	61
-67	43.2	163.5	23.5	89	12.5	47.3	18000	68
-68	43.2	163.5	23.5	89	12.5	47.3	18000	68

Table 1.0 System Flow Rates

Note

Flow based on the following conditions @ 25°C (77° F) seawater @ 35,000 PPM TDS. Temperature will affect the production rate of the system.

CAUTION

Reverse osmosis membrane element susceptibility to chemical attack. Any chemical, not approved in writing by Parker Hannifin, use of non-authorized or misuse of authorized chemicals voids system warranty. See Table 1.2 Damaging Chemicals:

Chlorine in excess of 0.1 PPM	Chloramines-T
Chlorine dioxide	Hydrogen peroxide
Bromine	Phenolic disinfectants
Chloramines	N-chlorioisocyanurates
Hypochlorite	Iodine
Bromide	Petroleum products

Table 1.1 Damaging Chemicals

1.2. STANDARD CONNECTIONS:

Description	Pressure Range	Size	Type*
Feed Water Inlet:	0-2 BAR (30 psi)	1-1/2”	FNPT or ANSI Flange
Product Water Outlet:	0-2 BAR (30 psi)	0.1”	FNPT or ANSI Flange
Reject Outlet:	0-2 BAR (30 psi)	1-1/2”	FNPT or ANSI Flange
Outlet- Prefilter Drain:	NA	1”	FNPT or ANSI Flange
Fresh water flush:	0-4.5 BAR (65 psi)	0.75”	FNPT or ANSI Flange

*Alternate connection types available.

Table 1.2 Standard Connection

1.3. DIMENSIONS & WEIGHT:

Note

System gross shipping weight add approximately 160 lbs. / 68 Kg

Note

Modular systems see drawings

Model	**Length**	**Width in(cm)**	**Height in(cm)**	**Wet Weight**
A600 - Vertical	**in(cm)**	**in(cm)**	**in(cm)**	**Lbs. (KG)**
-30	137 (348)	39.4 (100)	60.1 (155)	1478 (670)
-31	137 (348)	39.4 (100)	60.1 (155)	2142 (972)
-38	137 (348)	39.4 (100)	60.1 (155)	1641 (744)
-39	137 (348)	39.4 (100)	60.1 (155)	2305 (1045)
-44	137 (348)	39.4 (100)	60.1 (155)	1641 (744)
-45	137 (348)	39.4 (100)	60.1 (155)	2305 (1045)
-61	137 (348)	39.4 (100)	60.1 (155)	1800 (816)
-62	137 (348)	39.4 (100)	60.1 (155)	2464 (1118)
-67	137 (348)	39.4 (100)	60.1 (155)	1800 (816)
-68	137 (348)	39.4 (100)	60.1 (155)	2464 (1118)

Table 1.3 System Dimensions

1.4. ELECTRICAL:

The system comes in a variety of voltages – check name plate for actual voltage and frequency of the system.

Total system power required for system is 12 kW.

CAUTION

Do not operate power or frequency other than what is specified on the name plate. Damage to the system can occur.

Model	TASMAN - T3
A600	Voltage/Frequency/Hz
-30	440-480/3/60
-31	380-410/3/50
-38	440-480/3/60
-39	380-410/3/50
-44	440-480/3/60
-45	380-410/3/50
-61	440-480/3/60
-62	380-410/3/50
-67	440-480/3/60
-68	380-410/3/50

Table 1.4 System Voltage

1.5. ENVIRONMENTAL PARAMETERS

If the system will be used outside of the following parameters, please contact the factory for recommendations on system performance.

Parameter	**Specification**
Seawater System Salinity Range	Up to 36,000 PPM TDS
Seawater TEMPERATURE RANGE	1-30 °C (33-90°F)
pH RANGE	3-11 (typical seawater pH is 8)
Ambient temperature:	1-40°C (33-108°F)
List (permanent)	15°
Trim (fore and aft):	+ 30°
Pitch:	± 10° (6 sec cycle)
Roll	± 30° (12 sec cycle)

Table 1.5 Environmental Parameters

SECTION 2

SPARE PARTS LIST

TASMAN SEA

RECOMMENDED SPARE PARTS LIST

1 YEAR

Part Number	Description	QTY
33-5105	20 MICRON CARTRIDGE FILTER ELEMENT	12
33-5104	5 MICRON CARTRIDGE FILTER ELEMENT	12
40012008	CIP CLEANING ELEMENT #1	5
40012009	CIP CLEANING ELEMENT #2	5
40012021	PRESERVATION CHEMICAL ELEMENT #3	3
0803005173	FWF ELEMENT CHARCOAL	6
20-4096	PROBE, CONDUCTIVITY, 5-WIRE, 5’	1
2317100701	TRANSDUCER, 300 PSIA, ABSOLUTE	1
2317102001	TRANSDUCER, 0-2000 PSIG 1/4NPT	2

Table 2-0 Recommended Spare Parts

SPECIAL TOOLS

Part Number	Description	QTY
91-3557	HANDHELD WATER QUALITY METER	1
90-1301	SOLUTION, CALIBRATION, 30,000 PPM	1
90-1300	CALIBRATION SOLUTION, TDS, 300	1

Table 2-1 Special Tools

SECTION 3

PRE-INSTALLATION NOTES

3 PRE-INSTALLATION NOTES

3.1 PRECAUTIONS

1. Storage prior to uncrating:

CAUTION

DO NOT store in direct sunlight.

DO NOT store above 103 degrees F (39 degrees C).

DO NOT freeze.

CAUTION

If the RO system has been shipped new with Reverse Osmosis Membrane Elements installed, the System must be commissioned within 3 months. This is to avoid drying out or biological fouling of the RO membranes.

2. When system is unpacked inspect for damage:

3.2 RO SYSTEM LOCATION

The RO unit should be installed in a dry, sheltered location protected from direct weather. Some type of drainage should be provided beneath the RO unit to allow standing water to drain when performing maintenance or repair (see drawings for skid size, interface locations and minimum maintenance envelope requirements).

The following two diagrams that show the RO System located relative to the seawater level. The first shows the RO System installation below water line and the second shows the RO System installation above water line.

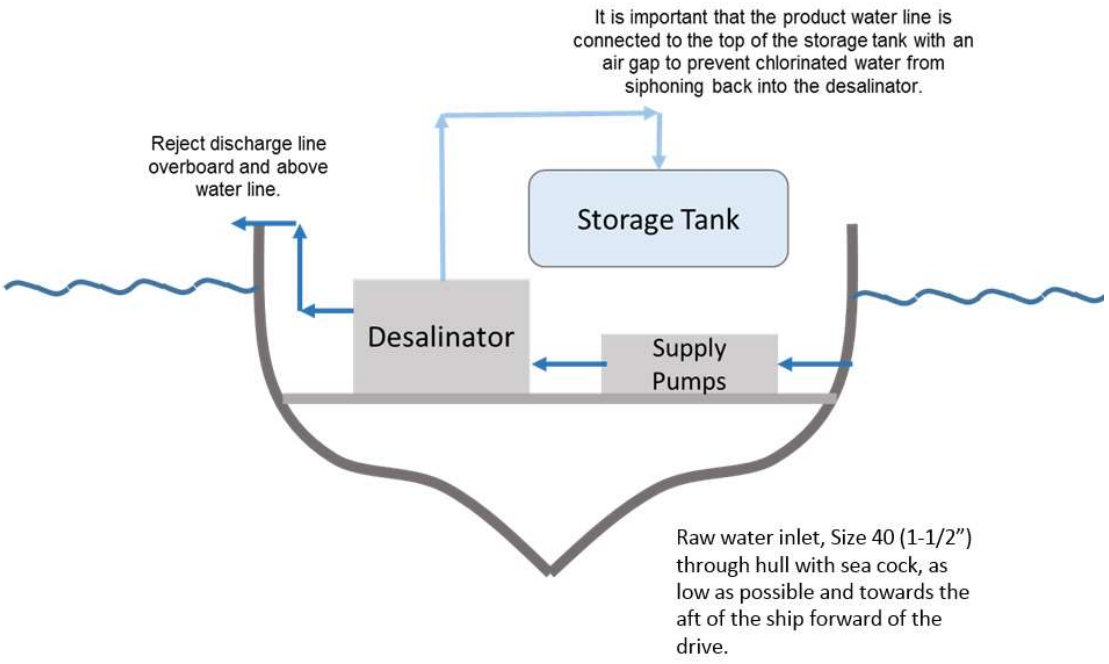


Figure 3.0 – RO Below Water Line

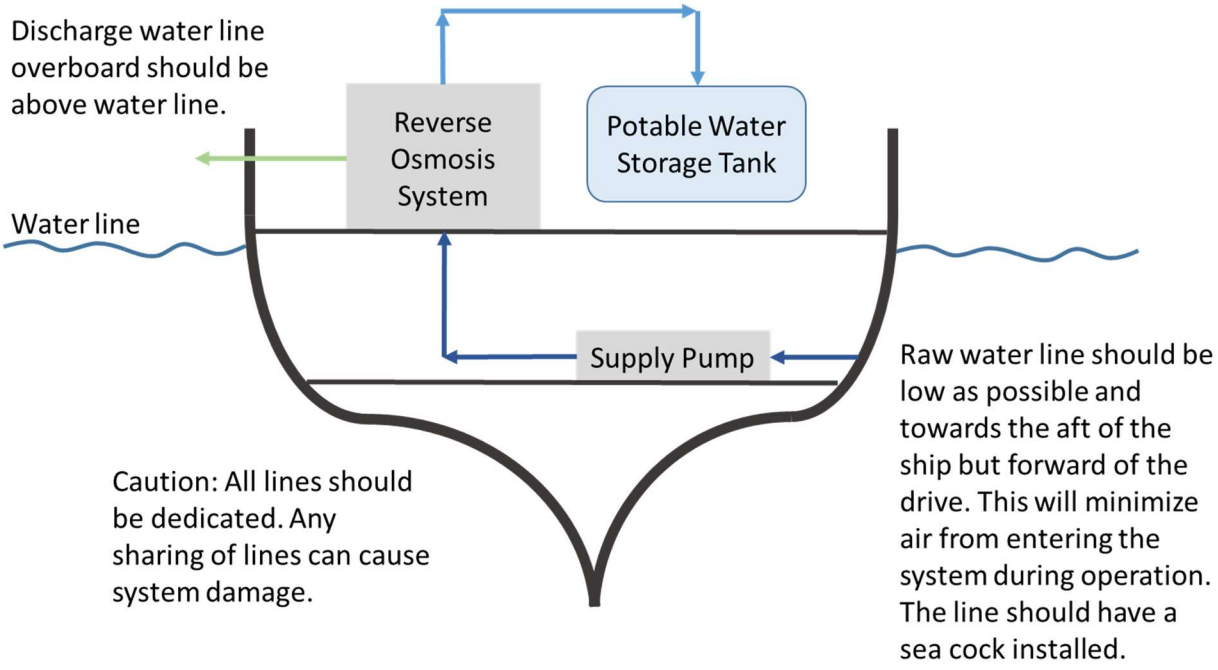


Figure 3.1 – RO System Above Water Line

3.3 INSTALLING THE UNIT

Since every installation is unique, the mounting instructions are provided for guidance only. It is recommended that you use your own discretion as to the exact method of mounting and placement of any mounting bolts.

1) Mount the RO unit securely. Secure each skid in place using vibration isolators as required. Follow the maintenance envelope provided in the General Arrangement drawing.

CAUTION

All mounting surfaces must be flat to avoid warping of brackets and frames. Grind flat or use of appropriate shims on uneven surfaces to ensure that mounting of the system components does not cause bending or warping. Any damage caused by attaching the system or its components to an uneven surface is attributed to improper installation, is the liability of the installer, and is not covered by the Parker Hannifin warranty.

2) Make the following plumbing connections to the RO unit's piping interfaces provided on the General Arrangement drawing.

CAUTION

Inlet and discharge interconnecting lines must be constructed of a NON-FERROUS material. Examples of some suitable materials are PVC, copper-nickel, 316 stainless steel pipe or a reinforced non-collapsing hose. Ferrous piping produces rust that will irreversibly foul the membrane and void the RO unit warranty.

a) Connect the sea water supply to a clean seawater source using a flexible connection to the unit.

CAUTION

Avoid connecting the inlet piping to any water line that services any other piece of equipment. Air could be drawn through the RO unit causing damage to the RO unit's pumps. Any air suction leaks coming into the system feed line may cause the system to shut down due to low feed pressure. If possible plumb the feed line at the bottom of the Sea Chest. This ensures an uninterrupted supply of air free seawater.

b) Connect the reject discharge (concentrate flow), to an unobstructed line using a flexible connection. The reject should be discharged overboard above the waterline.

CAUTION

The use of galvanized steel for product piping should be avoided as small

amounts of rust may form that can be drawn back into the RO when the system is off.

c) Connect the product water discharge using a flexible connection to an unobstructed line that is connected to the TOP of the product water storage tank. If the storage tank water is chlorinated, a check valve or air gap should be installed in the product line as a precaution to prevent chlorine damage of the RO membranes. The air gap is often accomplished by teeing the product connection to a tank vent or tank fill line of suitable size.

CAUTION

Exposing the membranes to chlorinated water may cause irreversible damage and will void the RO unit warranty.

3) Connect the following RO unit's electrical interfaces:

CAUTION

Strictly observe all applicable electrical codes and regulations governing the installation and wiring of electrical equipment. Never connect the RO unit to a line that services another electrical device. The RO unit should have its own dedicated power supply and breaker.

WARNING

DISCONNECT ELECTRICAL POWER TO RO UNIT AND THE POWER SOURCE BEFORE CONNECTING TO RO UNIT INTERFACE. FAILURE TO DO SO CAN CAUSE SERIOUS INJURY OR DEATH TO PERSONNEL.

4) Motor rotation. The Booster Pump uses a VFD and automatically rotates in the correct direction. The High-Pressure Pump has proper markings to determine rotation.

CAUTION

Do not run high-pressure pump without water adequate flow and pressure. High-pressure pump will be damaged.

Note

Three phase power supply will spin the motors and pumps either rotation direction, depending on the phase sequence of the three hot power legs. The high-pressure pump will not be damaged from running momentarily backwards.

5) Connect a suitable ground to the RO unit skid, as determined by the specifics of your installation.

CAUTION

The pumps may be isolated from the ship's bonding system because of the protective coating applied to the pumps and their attached motor. As such, there may be no continuity between the pumps and the ship's bonding system. The path of stray current from the electric motors may be through the Feedwater Line. This is especially true if the electric motor grounding wire is insufficient. If left unbonded, the pumps become sacrificial and corrosion by electrolysis takes effect and destroys the pump manifolds, chambers and impellers. Such destruction can render these pumps inoperable within just a few short months. The System Warranty does not cover damage resulting from electrolysis or improper or inadequate grounding.

SECTION 4

THEORY OF OPERATION AND GENERAL DESCRIPTION

4 THEORY OF OPERATION AND GENERAL DESCRIPTION

4.1 REVERSE OSMOSIS THEORY

Reverse osmosis, like many other practical scientific methods, has been developed from processes first observed in nature. Osmosis is a naturally occurring phenomenon in which a semi-permeable membrane separates a pure and a concentrated solution (a semi-permeable membrane is defined as one that preferentially passes a substance). Every fluid has an inherent potential that is directly related to the type and number of solids in solution. This potential, referred to as osmotic pressure, increases in proportion to relative concentration of a solution. A concentrated solution, therefore, has an osmotic pressure that is higher than that of a pure solution.

In a desalination system, the less concentrated solution will equalize the concentrations of both solutions by migrating across the membrane. When enough pure solution migrates across the membrane such that the inherent potential difference between the solutions is no longer higher than the osmotic pressure of the membrane, the purer solution will stop flowing. If the pressure on the concentrated solution is increased to above the osmotic pressure, fluid flow will be reversed. This condition, called Reverse Osmosis, can be established by artificially pressurizing the more concentrated solution using a high-pressure pump. In this type of system, the concentrated solution (normally referred to as feedwater) will become more concentrated as pure water flows out of the solution and across the membrane to the permeate side. Discounting the effects of feedwater temperature and salinity, the operating pressure normally required to produce significant amounts of pure water is at least twice the osmotic pressure of the membrane being used.

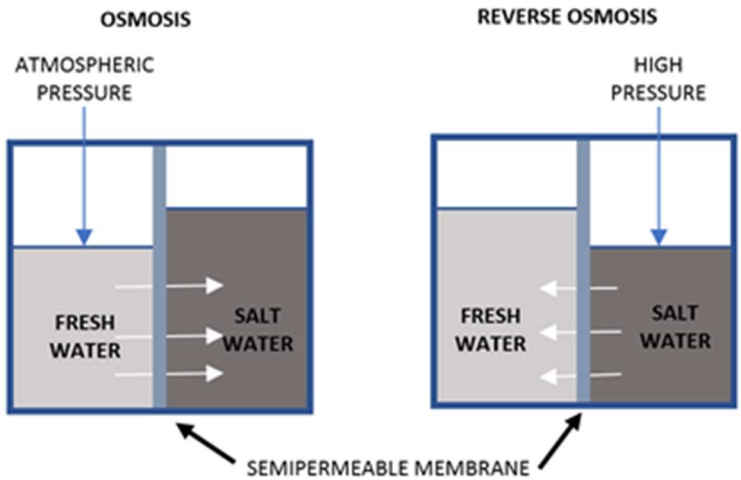


Figure 4.0 - Simple (Reverse) Osmotic System

Seawater contains many kinds of solids dissolved in solution. The most prevalent is common table salt (sodium chloride). Other minerals that may be present in solution are substances that usually contain various compounds of calcium and sulfate. The sum of all of the solids dissolved in a particular sample of water is referred to as *Total Dissolved Solids* or TDS. Seawater normally averages 32,000 to 35,000 ppm (parts per million) TDS; although variations of 5000 ppm are common in various parts of the world. The fundamental goal any desalination process is a significant reduction in the number of dissolved solids in water.

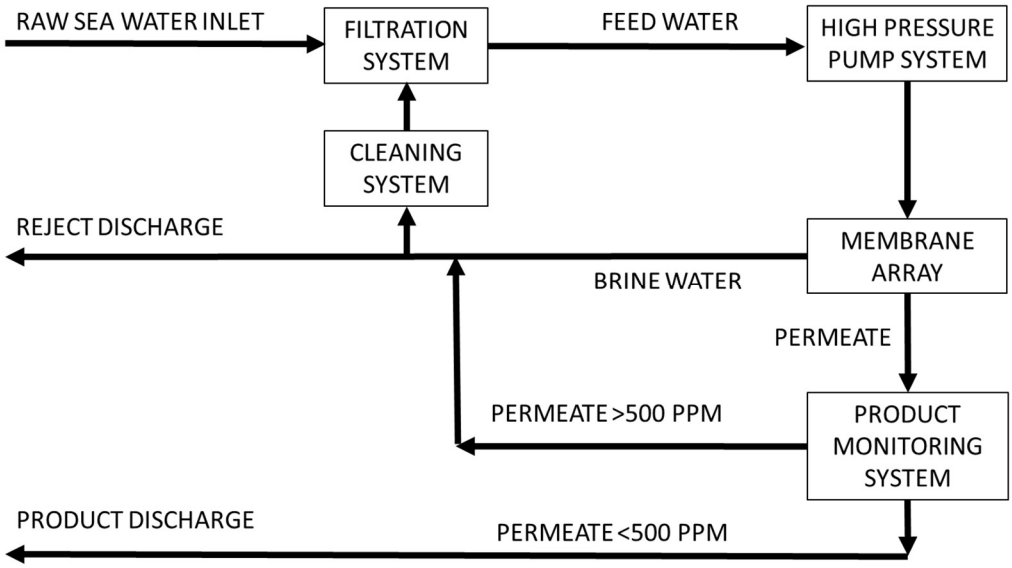


Figure 4.1 – Simplified Schematic of an RO System

It should be noted that no system can remove all the dissolved solids from seawater. The system is designed to reject approximately 99% of the TDS or, in other words, to allow 1% of the 35,000 ppm TDS in the seawater to pass into the product water. This yields water of less than 500 ppm, the recommended TDS for drinking water. A system such as this is said to have a salt passage percentage of 1% or a salt rejection of 99%.

4.2 PRODUCT WATER QUALITY STANDARDS

This RO unit will produce permeate (product water) with a quality of < 500 ppm TDS and in accordance with World Health Organization (WHO) standards for drinking water. General specifications for acceptable drinking water quality are as follows:

Constituent Ion/Molecule	Maximum Limits (ppm)
Nitrate	10
Fluorine	.1
Sulfate	100
Magnesium	30
Calcium	75
Calcium Carbonate	100
Iron	.1
Manganese	.05
Total Dissolved Solids	500
Turbidity	5
Oil	.1
Detergents (anionic)	.2
Phenols	.001
Bacteria - E Coli (per 100 ml)	0

Table 4.0 - Drinking Water Standards

4.3 FACTORS AFFECTING PERMEATE PRODUCTION

4.3.1 VARIATIONS IN TEMPERATURE, PRESSURE AND SALINITY

The following table illustrates how the quality and quantity of permeate produced by the RO system is affected by changes in temperature, salinity and pressure:

With constant....	And increasing....	Permeate	
		TDS	Capacity
Salinity and Pressure	Temperature	Increases	Increases
Temperature and Pressure	Salinity	Increases	Decreases
Temperature and Salinity	Pressure	Decreases	Increases

Table 4.1 - Factors Affecting Permeate Quality

Note

If feedwater salt concentration decreases, the product water flow rate should not be allowed to increase more than 20% above rated flow. Membrane Reject pressure will need to be lowered to maintain rated flow in brackish water or fresh water applications.

The RO system can be adjusted to maintain a constant permeate output when feedwater salinity is below nominal (near river mouths or in estuaries). The operator can do this by controlling system pressure manually via the back-pressure regulator valve, located in the system brine piping. For long pump life and low membrane fouling, Parker recommends that 800 psi is not exceeded except in situations of extreme low temperature feed water.

CAUTION

Operating the unit at more than 120% of rated capacity in low salinity water can damage the membranes and will void the RO unit warranty.

4.3.2 TEMPERATURE CORRECTION FACTOR

As previously described, the output capacity of any RO unit is highly dependent on feedwater temperature. To quantify this relationship, theoretical data has been utilized to develop Temperature Correction Factors (TCF) to compensate measured flowrate to calculated flowrate at 25°C/77°F. This allows the operator to establish the baseline flow for a given temperature, allowing more accurate troubleshooting. The procedure for calculating the temperature compensated flow is as follows:

1) Measure raw water temperature and determine the corresponding correction factor from Table 4.2 based on the measured temperature.
2) Note the actual product flow rate at the *Product Flow* meter. Multiply the actual product flow meter flow rate by the correction factor from Table 4.2 to give theoretical temperature compensated flow under standard conditions (25°C).

Example:

Raw Water Temperature:	15°C
TCF:	1.47
Actual Product Flow:	113.5 (gph)
Calculation:	113.5 x 1.47 = 167 (gph)
Temperature Corrected Flow:	167 (gph)

°C	Factor	°C	Factor	°F	Factor	°F	Factor
1	3.64	26	0.97	34	3.47	84	0.88
2	3.23	26	0.94	36	3.18	86	0.82
3	3.03	28	0.91	38	3.18	88	0.79
4	2.78	29	0.88	40	2.68	90	0.79
5	2.58	30	0.85	42	2.47	92	0.77
6	2.38	31	0.83	44	2.29	94	0.75
7	2.22	32	0.80	46	2.14	96	0.73
8	2.11	33	0.77	48	2.01	98	0.70
9	2.00	34	0.75	50	1.88	100	0.68
10	1.89	35	0.73	52	1.77	102	0.65
11	1.78	36	0.71	54	1.68	104	0.63
12	1.68	37	0.69	56	1.59	106	0.61
13	1.61	38	0.67	58	1.51	108	0.59
14	1.54	39	0.65	60	1.44	110	0.57
15	1.47	40	0.63	62	1.36	112	0.55
16	1.39	41	0.61	64	1.30	114	0.53
17	1.34	42	0.60	66	1.24	116	0.51
18	1.29	43	0.58	68	1.17	118	0.49
19	1.24	44	0.56	70	1.12	120	0.47
20	1.19	45	0.54	72	1.08	122	0.45
21	1.15	46	0.53	74	1.05		
22	1.11	47	0.51	76	1.02		
23	1.08	48	0.49	78	1.00		
24	1.04	49	0.47	80	0.93		
25	1.00	50	0.46	82	0.90		

Table 4.2 - Temperature Correction Factors (TCF)

4.4 OPERATIONAL DESCRIPTION

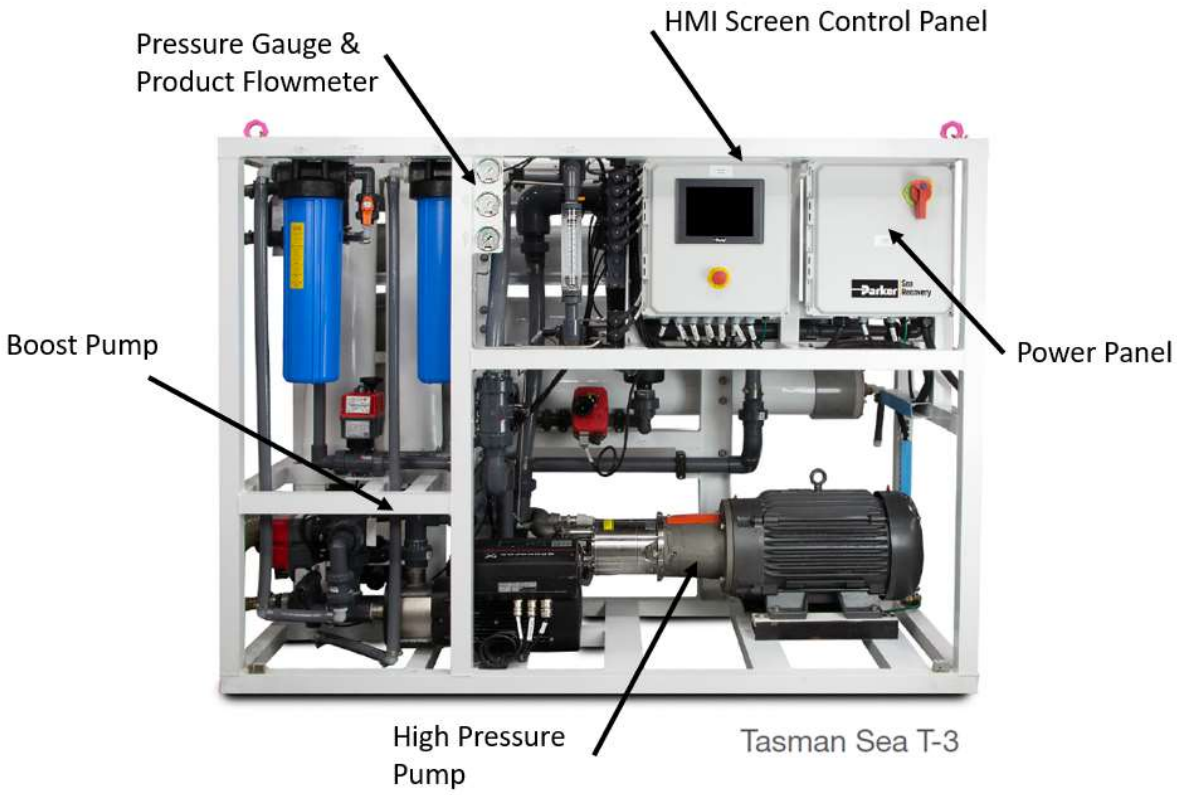


Figure 4.2 – Major Components of RO System

4.4.1 CONTROLS AND INSTRUMENTATION

The following table provides a brief description of each individual component along with an explanation of its function. It is intended as a supplement to the more detailed information contained in the System/Equipment Drawings and Diagrams.

Call Out	Description	Function
AE-1001	Product Conductivity	Indicates the product conductivity/TDS to the HMI.
AIT-1001	Product Conductivity Transmitter	Transmit the product conductivity/TDS to the HMI.
BPRV-1002	Back Pressure Regulator Valve	Allows operator to regulate pressure on the RO membrane array.
BV-1006	FWF Valve (3/4”)	Allows operator to open fresh water flow to automatic fresh water flush system.
BV-1011	Reject/Chem Diversion Valve (1-1/2”)	Allows operator to direct reject and cleaning flow.
BV-1014	Pre-Filter Drain Valve (1-1/2”)	Allows operator to purge water after filter replacement.
CL-95	Cleaning Cartridge Housing	Housing contains membrane cleaning cartridges.
CV-1000	Check Valve (1”)	Prevents back flow into the hydrocyclone.
CV-1003	Check Valve (1”)	Prevents flow from going reverse through the high-pressure pump
CV-1004	Check Valve (1”)	Prevents product water back flow.
CV-1006	Check Valve (1”)	Prevents back flow into the fresh water feed.
CV-1009	Check Valve (1”)	Prevents back flow in the reject line.
CV-1010	Check Valve (1”)	Prevents reject back flow into product water.
CV-102	Check Valve (1-1/2”)	Prevents flow from going reverse through the high-pressure pump
CV-95	Check Valve (1”)	Prevents back flow into cleaning system.
FE-1002	Product Flow Probe	Indicates the product flow to the HMI.

FI-1002	Product Flow Meter	Allows operator to see the product flow rate.
FIL-1000	20-Micron Pre-Filter	Filters the water to below 20 microns.
FIL-1001	5-Micron Pre-Filter	Filters the water to below 5 microns.
FIL-1006	Fresh Water Flush Cartridge Housing	Housing contains the carbon filter to remove harmful chlorine from the fresh water flush
FIT-1002	Flow Indicating Transmitter	Transmits the product flow to the HMI.
HC-1001/2/3	Hydrocyclones	Removes particles from feed water.
MV-1001	Feed Inlet Valve (1-1/2”)	Controls feedwater and fresh water inlet to the system.
MV-1009	High Pressure Bypass	Automatic valve which is opened by the HMI during fresh water flush.
MV-1010	Product Diversion Valve (1”)	Diverts the product to the product storage tank when signaled by the HMI.
MVA1-4	Membrane Pressure Vessel(s)	Pressure vessel that holds the RO membrane (double).
NV-1000	Hydrocyclone Control Valve (1”)	Controls the under flow from the hydrocyclone.
P-101	Booster Pump	Provides pressure to the high-pressure pump.
P-102	High Pressure Pump	Provides pressure to the RO membranes.
PI-1002	Pre-Filter Inlet Pressure Gauge (0-160psi)	Indicates pre-filter inlet pressure.
PI-1004	High-Pressure Pump Inlet Gauge	Indicates inlet pressure to the high-pressure pump.
PI-1005	High-Pressure Pump Outlet Pressure Gauge (0-2000psi)	Indicates outlet pressure from the high-pressure pump
PIT-1000	Booster Pump Inlet Pressure Transmitter (0-	Transmits booster pump inlet pressure to HMI.
PIT-1001	Booster Pump Outlet Pressure Transmitter (0-	Transmits booster pump outlet pressure to HMI
PIT-1002	Pre-Filter Inlet Pressure Transmitter (0-300psi)	Transmits pre-filter inlet pressure to HMI.
PIT-1003	Pre-Filter Outlet Pressure Transmitter	Transmits 20-micron pre-filter outlet pressure to HMI.
PIT-1004	High-Pressure Pump Inlet Pressure Transmitter	Indicates the inlet pressure to the high-pressure pump to the HMI.

PIT-1005	High-Pressure Pump Outlet Pressure Transmitter	Indicates the outlet pressure from the high-pressure pump to the HMI.
PIT-1006	Reject Pressure Transmitter (0-2000psi)	Indicates the reject pressure from the RO membrane array to the HMI.
PIT-1007	Product Outlet Pressure Transmitter (0-300psi)	Indicates the product pressure to the HMI.
PRV-1003	Pressure Relief Valve	Protects the product line from over-pressurization.
PSL-1001	Low Pressure Switch	Protects the high-pressure pump from low pressure.
SV-1000	Sample Valve (1” x ¼”)	Bleeds air from filter housing.
SV-1001	Sample Valve (1” x ¼”)	Bleeds air from filter housing
SV-1003/4/5/6	Sample Valve (3/8” x ¼”)	Bleeds air from membrane housing
SV-1010	Product Water Sample Port	Allows operator to sample each membrane

Table 4.3 – System Component and Function

4.4.2 RO FILTRATION SYSTEM DESCRIPTION

Seawater supplied to the intake of the Parker RO desalination unit will initially flow through the Feed Inlet Valve. This valve controls the sea water or freshwater supply to the reverse osmosis system. Next the water flows to the booster pump were the pressure is increased to flow through the filtration section of the system.

Once through the booster pump, the raw water is supplied to the hydrocyclone. The hydrocyclone is installed in the watermaker and will remove particles as small as 25 microns in diameter with a specific gravity greater than 2.3. The hydrocyclone is a self- cleaning system which requires no maintenance. The performance of the hydrocyclone is manually controlled by the hydrocylone control valve. The benefit is to significantly reduce the cleaning and replacement frequency for the micron filters. The inlet and discharge pressure from the hydrocyclone can be viewed on the HMI and allows the operator to see the differential pressure.

Next the raw sea water passes through the 20-micron pre-filter, which is designed to reduce raw water turbidity to a nominal 20-microns in diameter. The micron filter consists of one 20-micron filter cartridge. The filter also has a manual air bleed valve on the top of the filter housing. The inlet and discharge pressure from the filter housing is monitored by the pressure transmitters, which allows the operator to determine when the filter element require replacement.

Next the raw sea water passes through the 5-micron pre-filter, which is designed to reduce raw water turbidity to a nominal 5-microns in diameter. The micron filter consists of one 5-micron filter cartridge. The filter also has a manual air bleed valve on the top of the filter housing. The inlet and discharge pressure from the filter housing is monitored by the pressure transmitters, which allows the operator to determine when the filter element require replacement.

Next the filtered seawater pass through the **Pre-filter Drain Valve.** This valve is used to drain the system after the filter change out to reduce particle contamination to the High-Pressure Pump.

4.4.3 REVERSE OSMOSIS SYSTEM

The clean and filtered raw water (now referred to as feedwater) is supplied to the inlet of the high-pressure pump. This pump raises feedwater pressure to 56-75 BAR (800 - 1000 psi), the nominal pressure required for optimal system recovery. The pressurized feedwater then flows directly into the membrane pressure vessels (array)**.** The membrane array is an arrangement of fiberglass pressure vessels each containing RO membrane elements.

The pressurized feedwater flows along the membrane elements where reverse osmosis takes place. The feedwater flow is divided into two streams - the high purity product stream (referred to as the *product)* and the increasingly concentrated reject stream (referred to as the *reject).*

After exiting the membrane array, the reject (which contains higher concentrations of salts) flows through the **back pressure regulating valve.** This manually adjustable valve is used to control the back pressure through the membrane array. The pressure is read on the **HMI or the High-Pressure Outlet Pressure Gauge**. After passing through the **back pressure regulating valve**, the reject exits the RO unit.

4.4.4 PRODUCT MONITORING SYSTEM

The product water stream flows past a conductivity sensor, which provides a signal to the water quality monitor. Depending on the concentration of total of dissolved solids (TDS) in the permeate stream, the following occurs:

If permeate TDS is> 500 ppm, indicating poor quality water, a signal is sent to divert the product water to the reject line.

If permeate TDS is<500 ppm, indicating good quality water, a signal is sent to divert the product water to the product line.

Pressure relief valve is installed in the product water line to protect the product water line from over-pressurization.

In addition, there is a product water flow meter and transmitter to allow the operator to determine how much water is being made.

4.4.5 MEMBRANE CLEANING SYSTEM

This RO unit includes a membrane cleaning system which provides a means for removing performance degrading organic foulants and scale deposits from the RO membranes (occurs approximately every 30 – 90 days during constant use). By using the cleaning cartridge housing as a cleaning solution tank, the booster pump and reject/chem diversion valve and the high-pressure bypass valve, the membranes can be chemically cleaned in place. Complete information and cleaning procedures can be found in Section 7.5.

4.4.6 FRESH WATER FLUSH SYSTEM

This RO unit includes a fresh water flush system which provides a means for removing the sea water from the RO system. By using the fresh water flush cartridge housing with carbon filter installed and the automatic feed inlet valve the system will automatically fresh water flush upon system shutdown. Complete information of the fresh water flush procedures can be found in Section 6.4.

4.4.7 HUMAN INTERFACE (HMI)

The HMI monitors and displays system health and conditions like permeate salinity, temperature and accumulated unit operating hours. It also provides operational mode control of the system.

Pressures, flows, valve position and pump status are shown on the P&ID.

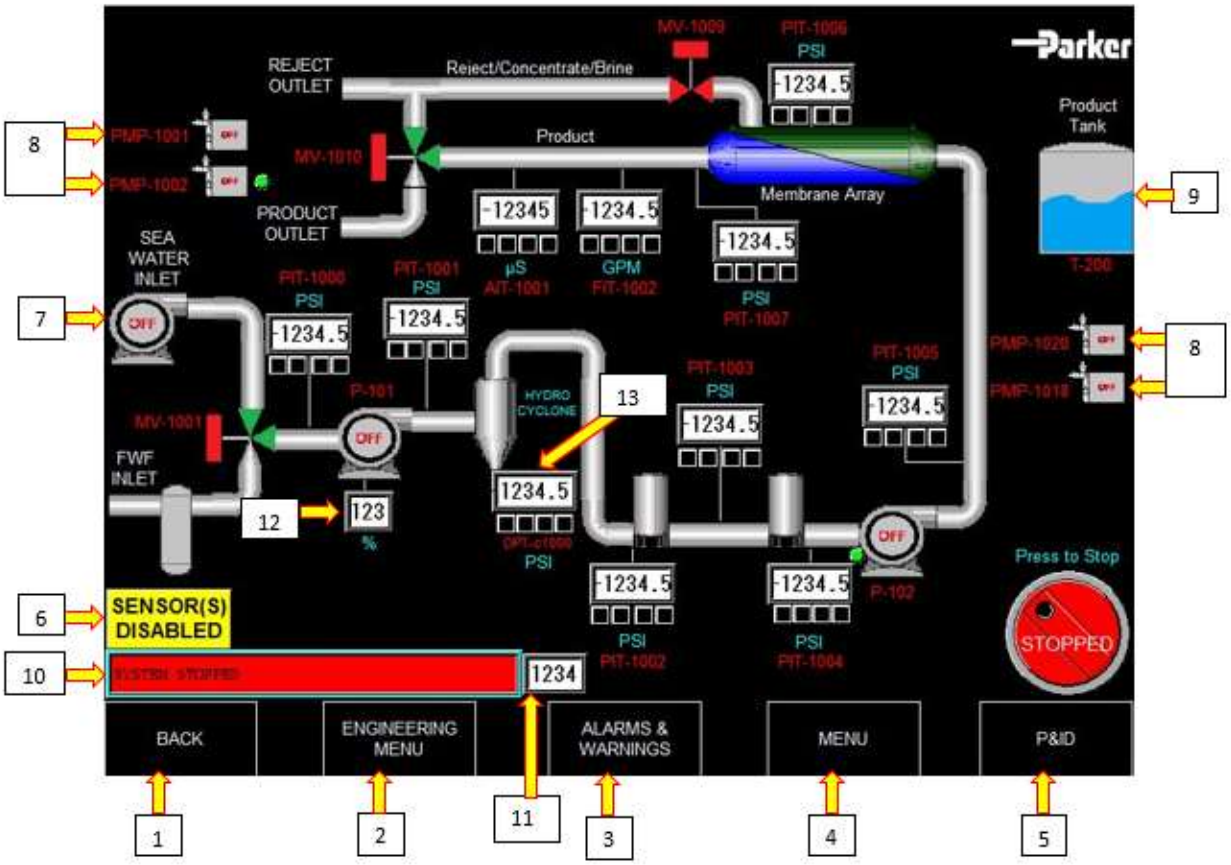


Figure 4.3 – Human Interface (HMI)

1) The Back button will jump to the previous screen.
2) The Engineering Menu button will open up the popup Engineering Menu.
3) The Alarms and Warning button will open the Alarm and Warning screen. This button will be yellow if there is an active alarm.
4) The Menu button will open the popup Main Menu.
5) The P&ID button will return to this P&ID screen.
6) The “Sensor(s) Disabled” indicator will appear if one or more of the sensors are disabled. During normal operation, all sensors should be enabled.
7) If enabled, the optional Feed Pump (P-100) will be shown here. The image will be green when the pump is running.
8) Any optional metering pump that is enabled will appear on the left or right side of this screen. The image will be green when the pump is running.
9) If the optional tank level switches are installed and enabled, the level of the product tank will be shown here.
10) The current status of the RO will be displayed on the status bar.
11) If there is an active countdown timer, the value will be displayed here.
12) The current speed setting of the Booster pump.
13) DPT-c1000 Differential pressure across the HydroCyclone

4.4.8 SAFETY SET POINT SUMMARY

The following table provides a list of shutdown and alarm set points for more details

consult the System/Equipment Drawings and Diagrams.

Call Out	Description	Set Point
PIT-1000	Booster Pump Inlet Pressure Sensor	LOLO/HIHI Pressure shut down alarm set @ -15PSI (-1 BAR) / 80PSI (5.5 BAR) LO/HI Pressure alarm set @ -10PSI (-.7 BAR) / 65PSI (4.5 BAR)
PIT-1001	Booster Pump Discharge Pressure Sensor	LOLO/HIHI Pressure shut down alarm set @ 20PSI (1.4 BAR) / 95PSI (6.6 BAR)
PIT-1002	Filter Inlet Pressure Sensor	HIHI Pressure shut down alarm set @ 95PSI (6.6 BAR)
PIT-1003	5-Micron Filter Inlet Pressure Sensor	HIHI Pressure shut down alarm set @ 95 PSI (6.6 BAR)
PIT-1004	High-Pressure Pump Inlet Pressure Sensor	LOLO/HIHI Pressure shut down alarm set @ 10PSI (0.7 BAR) / 75 PSI (5.2 BAR) LO/HI Pressure alarm set @ 15PSI (1 BAR) / 71 PSI (4.9 BAR)
PIT-1005	High-Pressure Pump Outlet Pressure Sensor	HIHI Pressure shut down alarm set @ 990 PSI (68 BAR)
PIT-1006	Membrane Array Outlet Pressure Sensor	HIHI Pressure shut down alarm set @ 990 PSI (68 BAR)
PIT-1007	Product Outlet Pressure Sensor	HIHI Pressure alarm set @ 60 PSI (6.7 BAR)
PSL-1001	Low-Pressure Switch	Low-Pressure Switch shutdown set @ 6 PSI (0.4 BAR).
PRV-1003	Product Pressure Relief Valve	Pressure relief set at 3.1 BAR (45 PSI)
AE/AIT 1001	Product Conductivity Probe and Meter	HI conductivity alarm set @ 1000 micro siemens
FIT/FE 1002	Flow Transmitter	HI flow ALARM set @ 10% above normal product flow rate HIHI flow shutdown ALARM is set 20% above normal product flow rate

Table 4.4 – Safety Set Points

SECTION 5
COMMISSIONING

5 COMMISSIONING

5.1 COMMISSIONING CHECKLIST

1) Inspect - Make sure all external plumbing connections are made per the P&ID diagram. Make sure all electrical connections to all external devices are connected properly per the electrical schematics.
2) Install micron filters – See Section 7.2
3) Install Fresh Water Flushing Filter. – See Section 7.3
4) Install Membranes – See Section 7.4
5) Valve Alignment – See table below.

Call Out	Description	Alignment
BV-1006	Fresh Water Flush Valve	Closed
MV-1001	Feed Valve Inlet	Indicator in FEED water Inlet
NV-1000	Underflow valve	Close and then open one turn.
SV-1000	Air bleed valve on 20-micron pre-filter housing	Closed then open to purge air then close.
SV-1001	Air bleed valve on 5-micron pre-filter housing	Closed then open to purge air then close.
BV-1014	Pre-filter drain Valve	Directed to High Pressure Pump.
PI-1005	High Pressure pump outlet Pressure Gauge	Indicates the discharge pressure from the high-pressure pump.
MV-1009	High Pressure Bypass Valve	Motorized valve should start in the open position to purge air.
BPRV-1002	Back Pressure Regulator Valve	Adjusted at factory to 800 psi (56 BAR).
MV-1010	Product Diversion Valve	Valve should start out in reject position.
BV-1011	Reject/Chem Diversion Valve	Valve directed to reject flow.

Table 5.0 Valve Alignment

5.2 VALVE LINEUP

Verify three-way selector valves are pointing to the correct positions.

1) BV-1014 valve normal operation, the red arrows on the handle point upward and to the left to connect the Feed line to the high-pressure pump inlet.

2) BV-1011 valve handle normal operation, the red arrows on the point downward and to the left to connect the Reject discharge line to the Reject outlet connection (TIE-1005).

3) In the images below, the yellow arrows indicate flow direction.

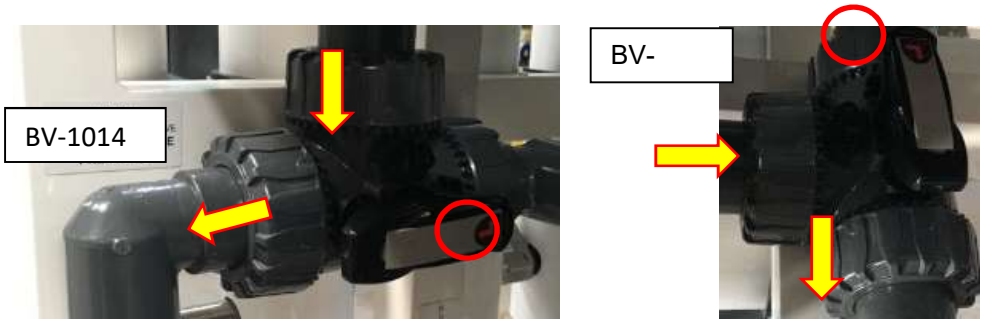


Figure 5.0 – Valve Handles

5.3 STARTING THE SYSTEM

1) Supply Water Flow - Establish water flow to system. Check for leaks and purge air from system.

2) Supply Electrical Power – Verify by HMI panel is illuminated.

3) Verify HMI Screen – View HMI that all the optional devices included with the system are properly enabled and shown on the P&ID screen. Compare your digital readings to analog readings from gauges.

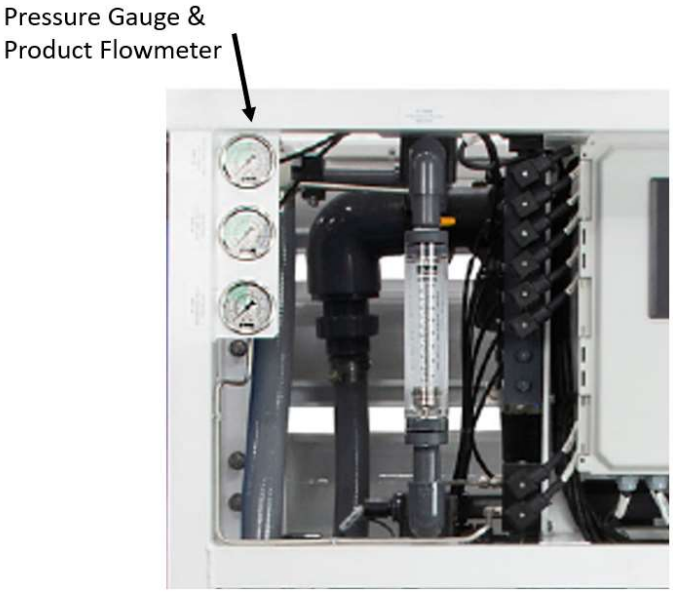


Figure 5. 1 – View of Gauges

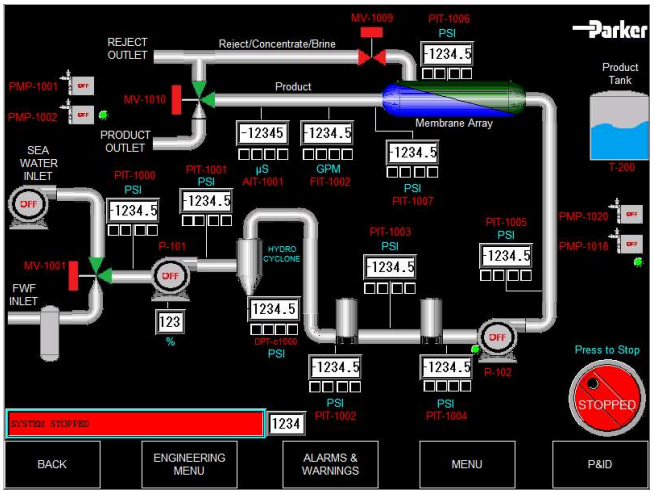


Figure 5.2 – HMI P&ID Screen

5.4 PRIME SYSTEM

The entire RO system needs to be properly primed and filled up with water. The Booster pump and optional Feed pump can be used to push seawater through the system when the RO is empty. Manual control of these pumps can be done from the Booster Pump Manual Control screen. The air purge valves on top of the two pre-filter housings can be used to vent air from the system as it is being primed.

5.5 CHECK HIGH-PRESSURE PUMP MOTOR ROTATION

1) Press MENU.

2) Obtain password for program page and log on. Get password from Parker Water Purification, call or email technical support.

3) The operator can access the Engineering Login screen by pressing this button (See item 2 in Figure 5.3 below).

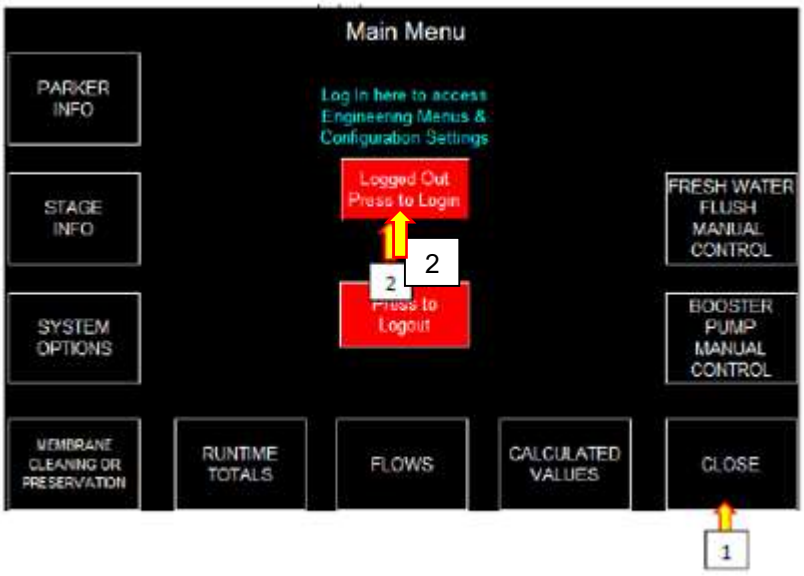


Figure 5.3 – Main Menu

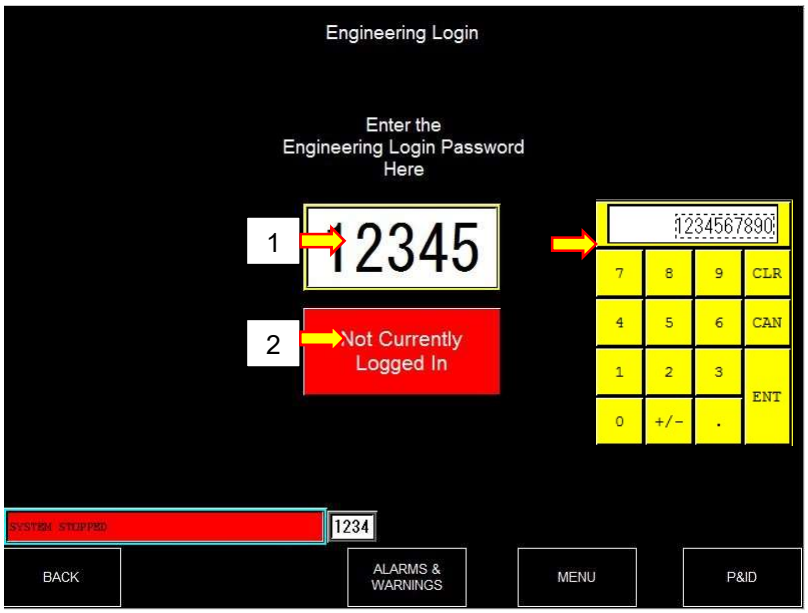


Figure 5.4 – Engineering Login Screen

1) Press on the white value to enter the Engineering password. This indicator shows if the operator is Logged In or not. Once logged in, the operator will be

able to access all the Engineering Menu choices. (Refer to the Engineering Menu section for more information.)

2) When the correct password is entered, the Engineering Menu will pop up.

Note

From the Main Menu, a login password is required to access the Engineering menu. Once the password is entered, the login access will last for 1 hour before it automatically resets.

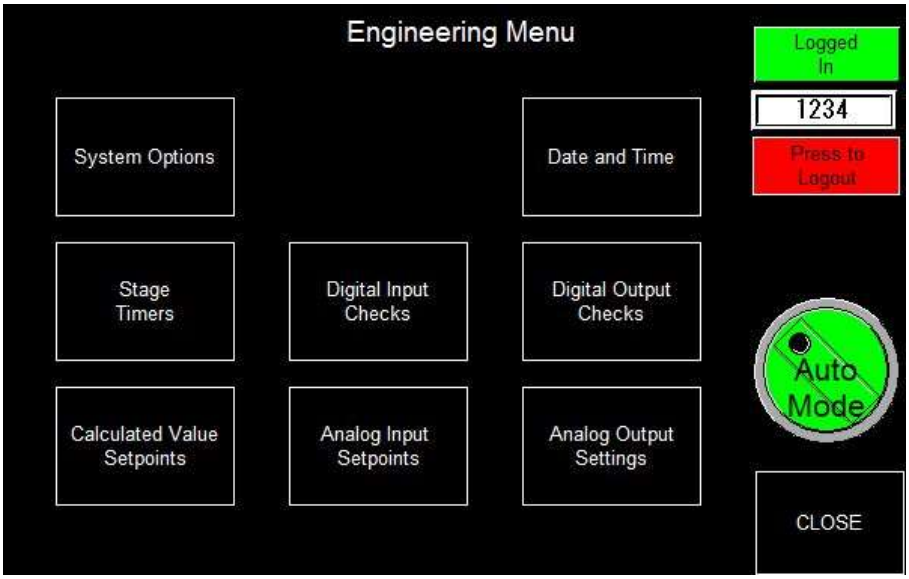


Figure 5.5 – Engineering Menu

Note

All screens that can be accessed from the Engineering Menu are described below. These screens are not accessible without the Engineering login password.

1) Press Digital Output Checks (See Figure 5.5 above).

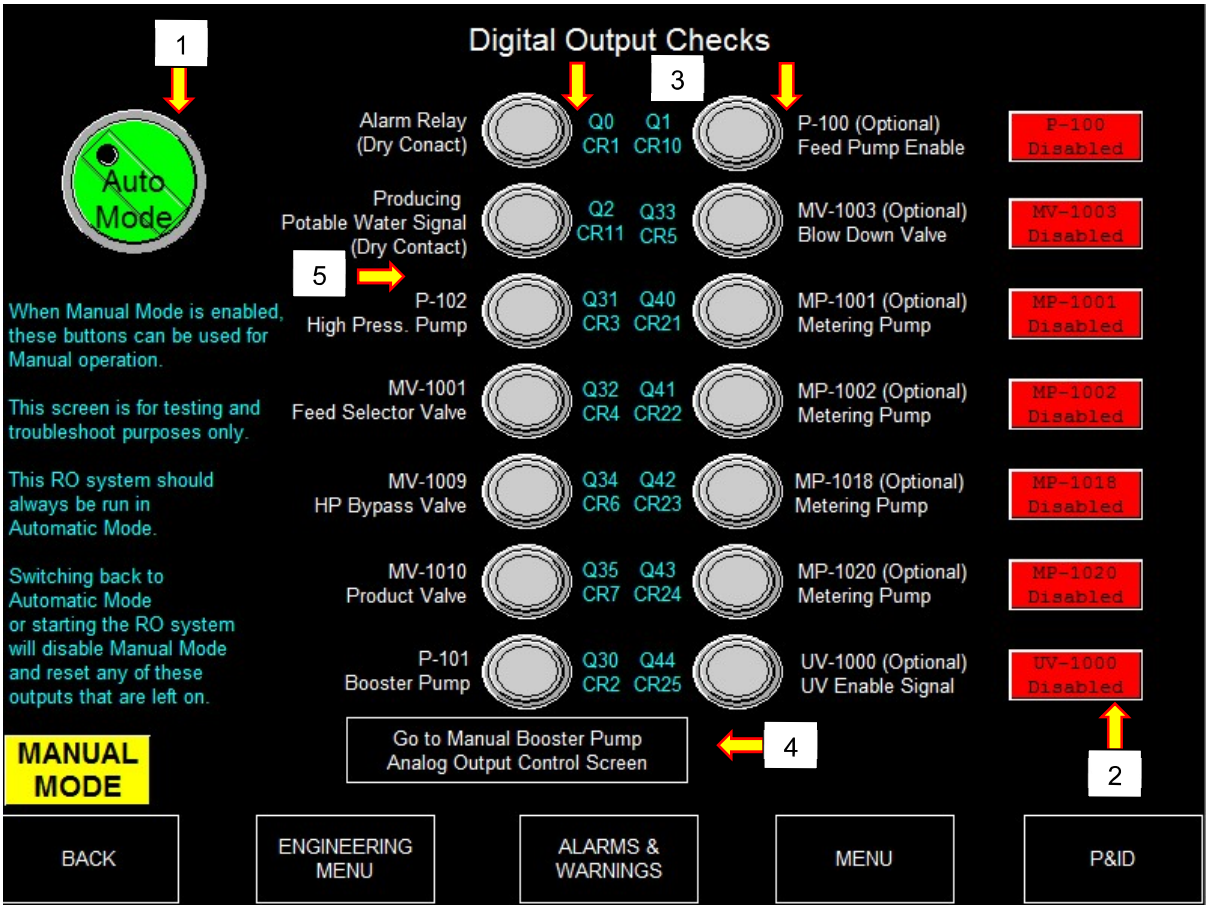


Figure 5.6 - Digital Output Checks

2) Press GO TO MANUAL BOOSTER PUMP ANALOG OUTPUT CONTROL SCREEN (Item 4 in Figure 5.6)

3) Toggle AUTO MODE to go to manual mode for booster pump control (See item 4 in Figure 5.7 below).

Note

When enabling the Booster Pump (P-101), the speed setting must be manipulated in addition to the output on/off signal. The button below the P-101 circular button will go to the Analog Output Settings screen where the VFD speed settings can be adjusted.

Note

By default, the RO system will be set for Automatic VFD control.

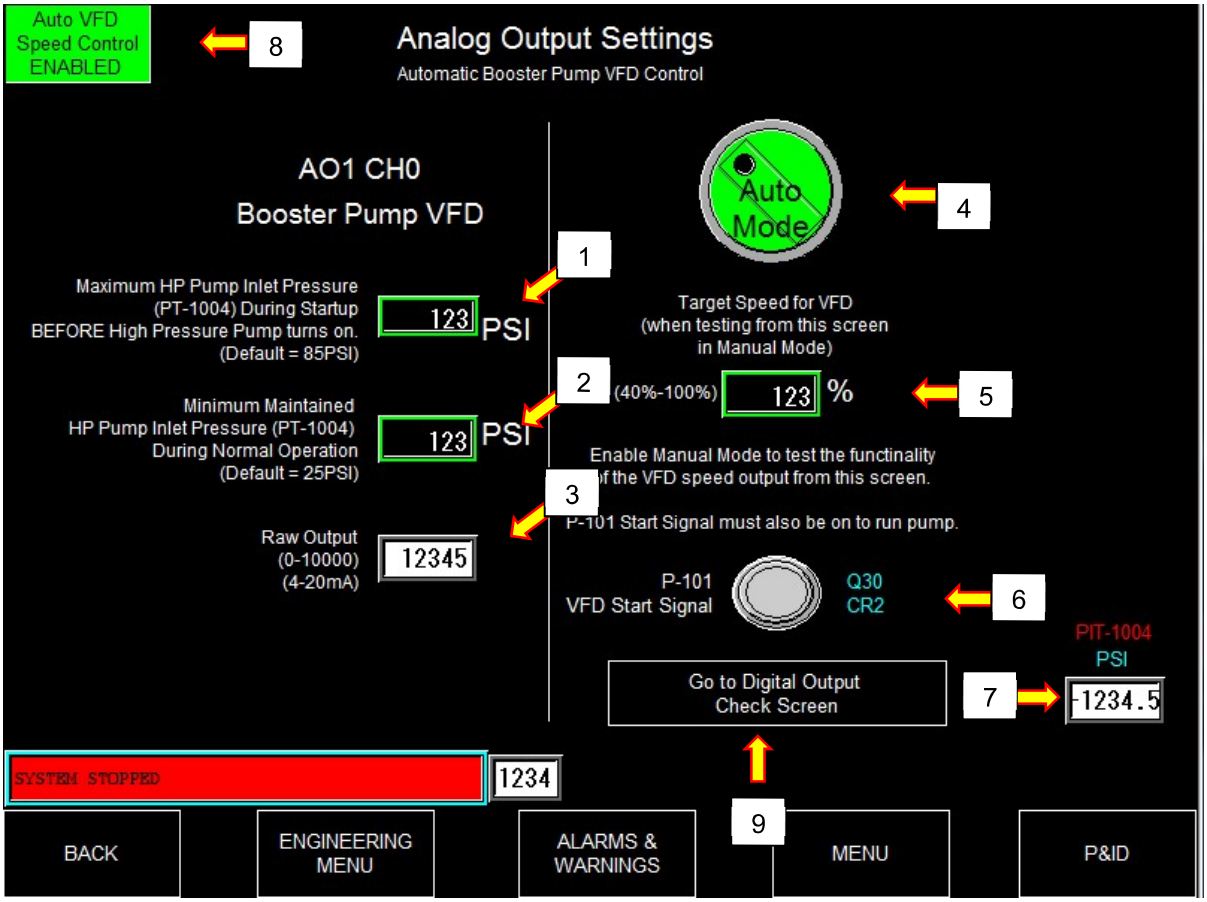


Figure 5.7 - Analog Output Settings (Automatic VFD Speed Control)

Note

The PIT-1004 pressure value should normally be between 25 PSI and 75 PSI to protect the high-pressure pump when it is running. The Booster pump VFD may need to run at a different spend before and after the high-pressure pump starts. Before the high-pressure pump starts, the PIT-1004 inlet pressure should be just between 25 and 75PSI. After the high-pressure pump starts, the PIT-1004 pressure should remain be above 25PSI.

4) Set Booster pump to 65% (See item 5 in Figure 5.7 above).

5) Turn on boost pump – press start signal (See item 6 in Figure 5.7 above). Verify pressure PIT-1004 is between 25 and 75 psi (See item 7 in Figure 5.7 above). If not change % down or up depending on pressure. More % more pressure.

6) Return to digital output screen (See item 9 in Figure 5.7 above).

7) Activate P-102 Start/Stop (See item 5 in Figure 5.6 above) quickly and check rotation. See rotation arrow on pump for correct rotation.

8) If the fan is running in the wrong direction, then isolate the power coming into the power panel and then reverse two of the three incoming wires. Restore the power and recheck the direction of the high-pressure pump fan rotation.

CAUTION

Do not run high-pressure pump without water adequate flow and pressure. High-pressure pump will be damaged.

Note

Three phase power supply will spin the motors and pumps either rotation direction, depending on the phase sequence of the three hot power legs. The high-pressure pump will not be damaged from running momentarily backwards.

9) Press MENU button. Press the Logout button (See Figure 5.5 above). System is now ready for automatic operation go to next section.

SECTION 6

OPERATIONS MANUAL

6 OPERATIONS

6.1 STARTUP - AUTOMATIC MODE

1) Check Valve Alignment – See Table below.

Call Out	Description	Alignment
BV-1006	Fresh Water Flush Valve	Open
NV -1000	Underflow valve	Closed. and then open one turn.
SV-1000	Air bleed valve on 20-micron pre-filter housing	Closed then open to purge air then close.
SV-1001	Air bleed valve on 5-micron pre-filter housing	Closed then open to purge air then close.
BV-1014	Pre-filter drain Valve	Directed to Drain.
BV-1011	Reject/Chem Diversion Valve	Valve directed to reject flow.

Table 6.0 – Valve Alignment at Startup

2) After 5 minutes, direct Pre-Filter Drain Valve to the high-pressure pump.

CAUTION

The Pre-Drain Valve is used to prevent debris from entering the high-pressure pump. Debris can damage the pump.

3) Apply power.

4) Examine HMI screen – while system is stopped and there are no active alarms, the system can be started by pressing the button in the lower right part of the main P&ID screen:

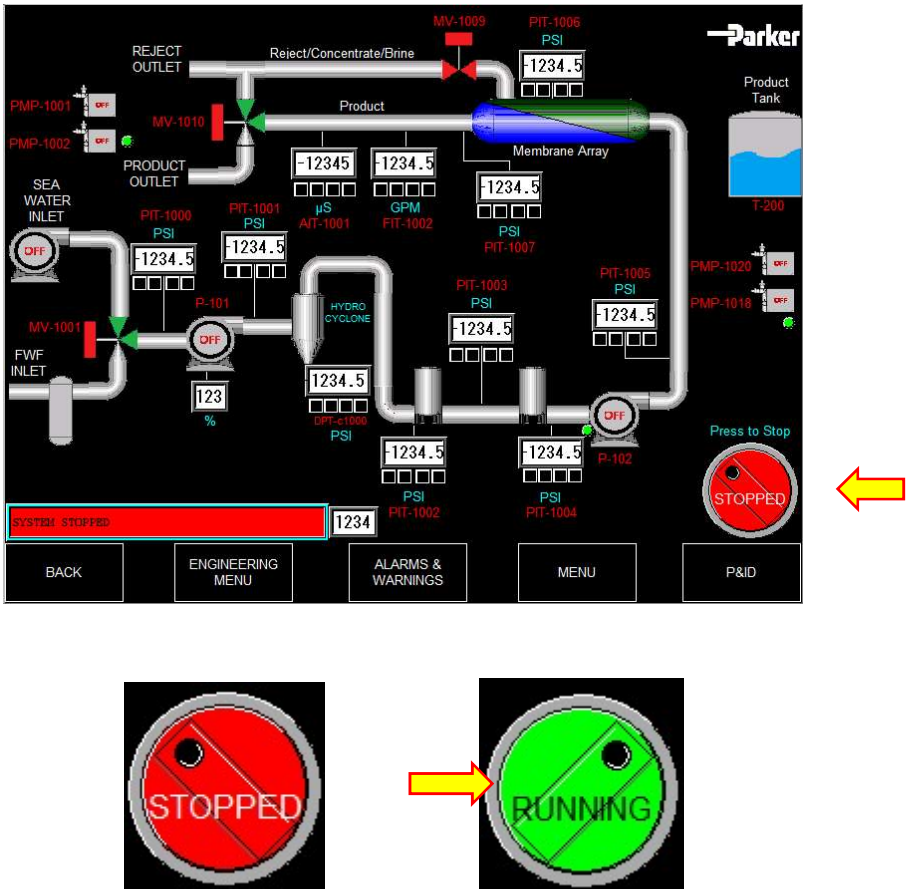


Figure 6.0 – Main HMI Screen

Note

Pressures, flows, valve position and pump status are shown on the P&ID.

Note

The following sequence of events will occur.

6.2 AUTOMATIC STARTUP SEQUENCE DESCRIPTION

1) The timed sequence of events begins.

2) If system is equipped with either an optional feed pump, anti-scalant chemical injection pump or media filter, the pumps are activated at this point. A small delay will occur before the next stage.

3) The main Booster feed pump is activated. The Pressure range should be within 20 psi / 1.4 BAR or below 95 psi / 6.6 BAR. The reading is displayed on the P&ID screen, see PIT-1001 Booster Pump Outlet Pressure. The Booster Pump timer counts down to zero before beginning the next stage.

4) The High-Pressure Pump is activated. The High-Pressure Pump inlet pressure should be between 15 psi / 1 BAR or 71 psi / 4.9 BAR. The reading is displayed on the gauge panel and on the P&ID screen, see PIT-1004 High-Pressure Pump Inlet Pressure. If the pressure is below 15 psi / 1 BAR, check the Hydrocylone Control Valve and adjust to increase the pressure. If the pressure remains low, check differential pressure across micron filters. If situation persists, go to Troubleshooting section. After a delay timer, high-pressure bypass valve closes. The High-Pressure Pump Outlet Pressure will increase to between 300 psi / 20.7 BAR and 990 psi / 68 BAR. If it is not within this range, adjust the back pressure regulating valve.

5) Adjusting the Back Pressure Regulating Valve.

Note

As external conditions change over time, the backpressure regulator valve may need to be adjusted to change the system pressure and to produce the appropriate product output flow rate. Achieving the target product flow rate value is more important than the specific pressure value. In general, the pressure at the High-Pressure Pump Outlet should be around 800 PSI when the backpressure valve is adjusted to achieve the target product flow rate for the RO system.

Figure 6.1 – Back Pressure Regulator Valve

Note

See the system size information in the front section of this manual for the target product flow rate.

6) The optional post chemical metering pumps are activated.

7) Once 25 seconds have passed, the Product Diversion valve will open if the salinity level is below the alarm setpoint. The Producing Potable Water output signal will be on when water is being produced. When the salinity level comes down to an acceptable level, the system will display “SYSTEM ONLINE (RUNNING)” on the status bar.

8) At this point, the system will run automatically.

Note

A summary of the these events can be viewed on the “Stage Info” screens which can be accessed from the Main Menu.

Note

During automatic operation, if any pressure values or other setpoints are not within normal parameters, the system will notify the operator about the specific condition. The system alarm and system shutdown alarms will notify the operator and be indicated on the HMI.

6.3 SHUTDOWN – AUTOMATIC MODE

1) While the RO system is running, the system can be stopped by pressing the button in the lower right part of the main P&ID screen. There are two ways to stop the system with this button:

- Pressing the button once will initiate a normal shutdown where the RO goes through all 5 stages of shut down.
- Pressing and holding the button for 5 seconds will completely stop the system.

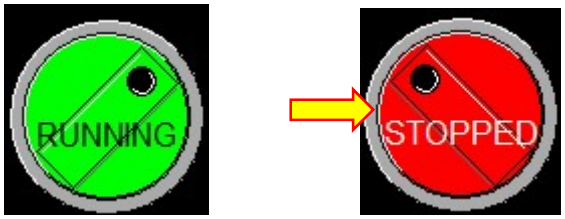


Figure 6.2 – Running/Stop Button

CAUTION

Not fresh water flushing can shorten the life of the membranes.

6.4 AUTOMATIC SHUTDOWN SEQUENCE DESCRIPTION

Here is the normal sequence of events that occur after a normal automatic shutdown is initiated:

1) The Product diversion valve closes, and the High-Pressure Bypass valve opens.
   The High-Pressure Pump turns off.
   All optional metering pumps are turned off.
   The timer counts down to zero before beginning the next stage.

2) The Booster pump turns off.
   The timer counts down to zero before the next stage.

3) If system is equipped with optional equipment, they will turn off. The timer counts down to zero before beginning the next stage.

4) The feed inlet valve turns toward the Fresh Water Flush inlet line, shutting off the sea water feed line and opening the fresh water line. The timer counts down to zero before beginning the next stage.

5) The feed inlet valve turns back toward the sea water feed inlet line. The timer counts down to zero and the system is now fully stopped and ready for short term layup.

Note

Short term layup is two weeks and requires no maintenance. After two weeks, refer to extended shutdown procedure in the Maintenance section in this manual.

Note

A summary of the events can be viewed on the “Stage Info” screen which can be accessed from the Main Menu.

6.5 FRESH WATER FLUSH MANUAL CONTROL

1) Apply power to the system.
2) Ensure the fresh water flush valve is open and supplying fresh water to the system.
3) The Fresh Water Flush Manual Control screen can be accesses from the Main Menu.
4) Press the Start/Stop FWF button. The timer will automatically control the duration of the fresh water flush.

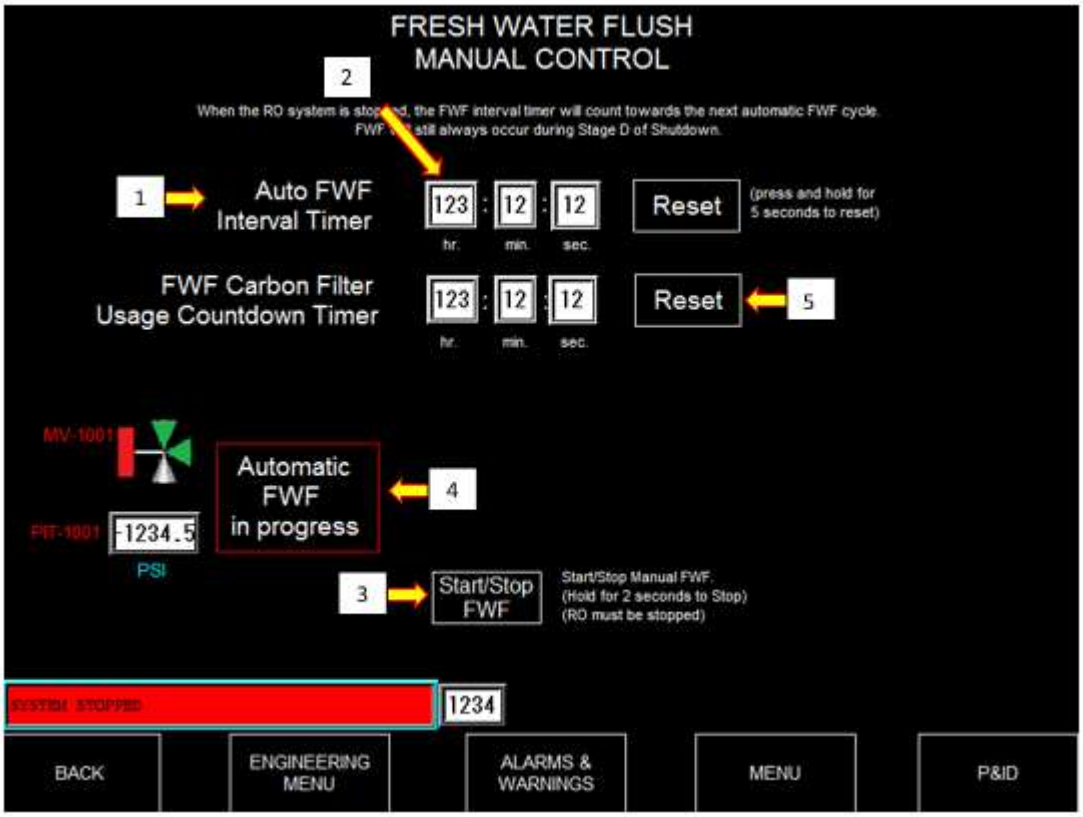


Figure 6.3 – Fresh Water Flush Screen

SECTION 7

MAINTENANCE AND REPAIR

7 MAINTENANCE & REPAIR

7.1 GENERAL

The service life of most of the system equipment is directly related to the raw water inlet conditions. Improper maintenance will also significantly reduce the life expectancy of the major unit components (such as the membranes, filters and pumps) as well as the reliability of the unit. Under normal conditions, and with proper maintenance, a reverse osmosis membrane (which is the major consumable item) should have an effective service life somewhere between 3 to 5 years heavy use.

	Daily	Weekly	Monthly	Quarterly	Semi-Annually	Annually	As Required	HMI Alert	Labor Hours (approximate)
Replace micron filter(s)								•	0.5
Fresh Flush Filter Replacement								•	0.1
Replace membranes							•		2.0
Clean membranes								•	4.0
Lubricate pump motors						•			0.2

Table 7.0 - Maintenance Task Chart

7.2 MICRON FILTER ELEMENT REPLACEMENT

The HMI will indicate when the filter will need to be changed. The filter elements should be replaced when the differential pressure across either filter exceeds 15 psi (1 BAR). A warning alarm will come on at 10 psi (0.7 BAR) and a shutdown alarm will occur at 15 psi (1 BAR).

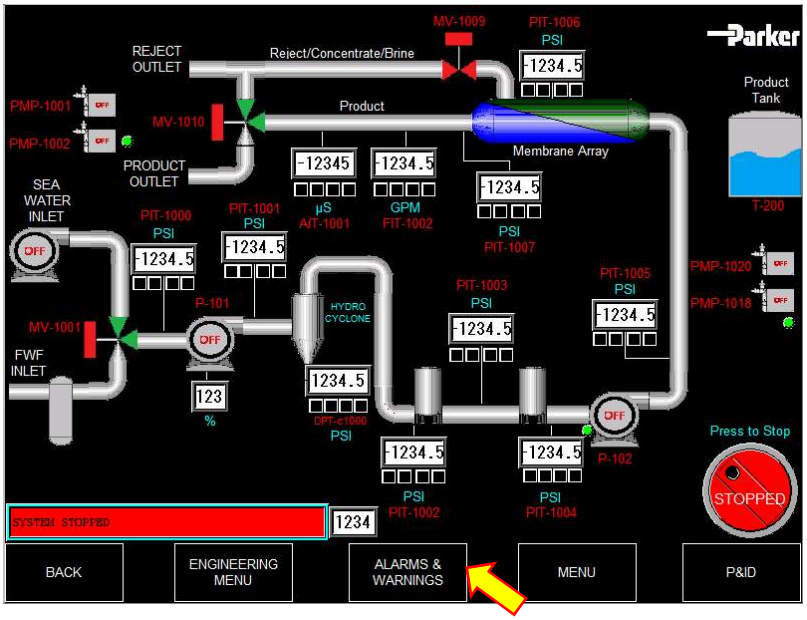


Figure 7.0 P&ID Screen

The Alarms, Caution and Shutdown indicator will turn yellow when there is an active condition. Pressing this button will take the operator to the Alarms screen which displays any active alarm. Active alarms will be shown in red text while inactive alarms will be blue. Caution alarms will alert the operator to a pending shutdown condition. Shutdown alarms will shut down the RO system. Shutdown alarms need to be reset once the condition is no longer present. Caution alarms do not need to be reset manually because they automatically reset themselves when the condition no longer exists.

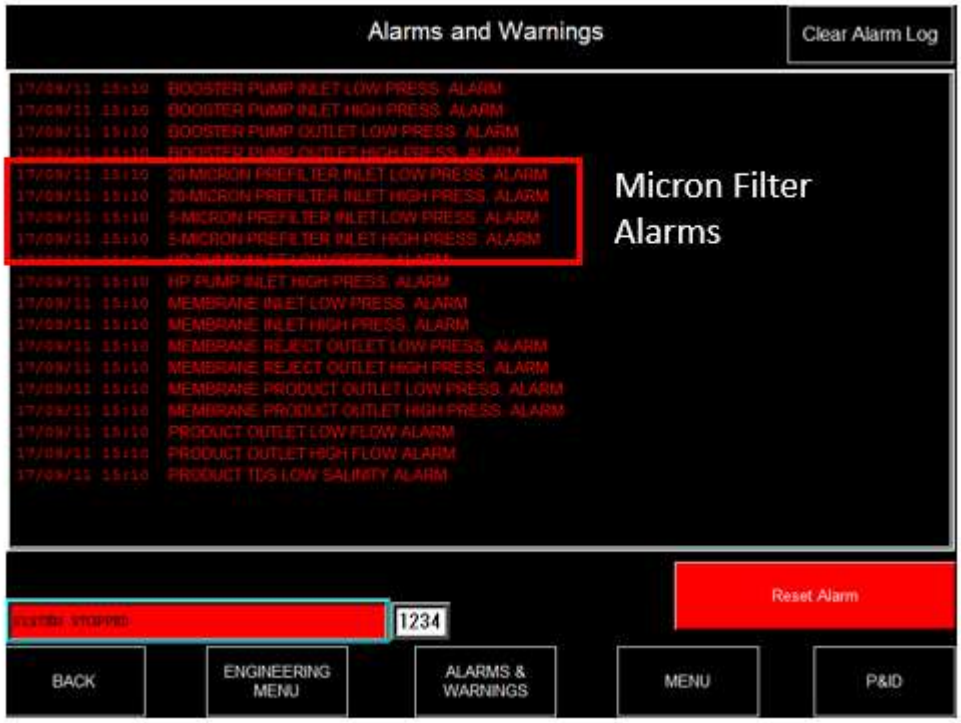


Figure 7.1 – Micron Filter Alarms

Part No.	Description	QTY
33-5105	20-MICRON CARTRIDGE FILTER ELEMENT	1
33-5104	5-MICRON CARTRIDGE FILTER ELEMENT	1

Table 7.1 - Filter Parts List

CAUTION

Parker filter cartridges are specifically designed for RO applications and constructed with an oil attractive polypropylene. Use of non-approved cartridges will void the RO unit warranty.

Replace the filter element(s) using the following procedure:

1) Shut down the RO unit. Close the raw water supply (external) to RO unit.

Note

20 and 5-micron filters install the same way.

Figure 7.2 – Filter Change Out

2) Push down cap to relieve pressure.

3) Lift out retaining ring from housing.

4) Lift cap out of the housing.

5) Lift old filter out of housing, if installed.

6) Insert new filter by using handle, making sure filter is seated properly.

7) Once filter is installed, replace cap and retaining ring.

CAUTION

Generally unfiltered water is present after changing the filters. The unfiltered water needs to be sent to drain. High-Pressure pump can be damaged from unfiltered water.

8) Turn Pre-filter Drain Valve handle to drain operation.

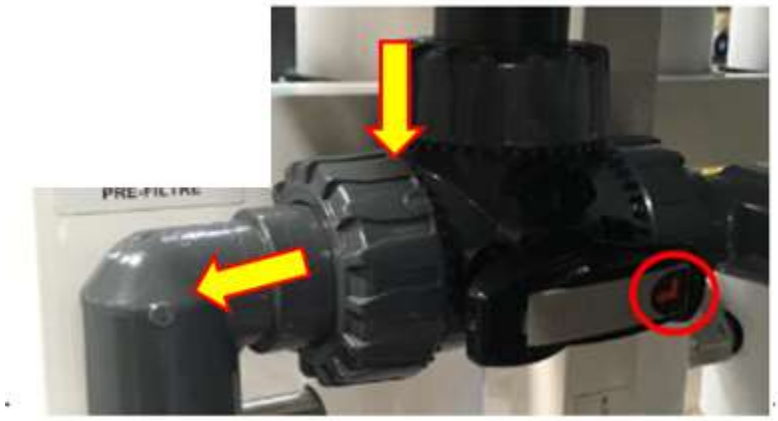


Figure 7.3 – Pre-Filter Drain Valve

9) Initiate fresh water flush cycle.

10) When fresh flush cycle is complete, turn Pre-filter Drain Valve handle to normal operation.

11) The RO unit is now ready for operation.

7.3 FRESH WATER FLUSH FILTER ELEMENT REPLACEMENT

The filter elements will need to be replaced. The HMI will indicate when the filter will need to be changed. The yellow ALARMS indicator will turn on and the alarm message will say to “CHANGE CARBON FILTER”. To clear the alarm, the FWF usage countdown timer reset button needs to be pressed. Estimated change frequency every six months. The default is set to 25 hours of Fresh Water Flush. The system employs one fresh flush filter.

Part Number	Description	QTY
0803004873	FWF ELEMENT	1

Table 7.2 – Fresh Water Flush Filter Parts List

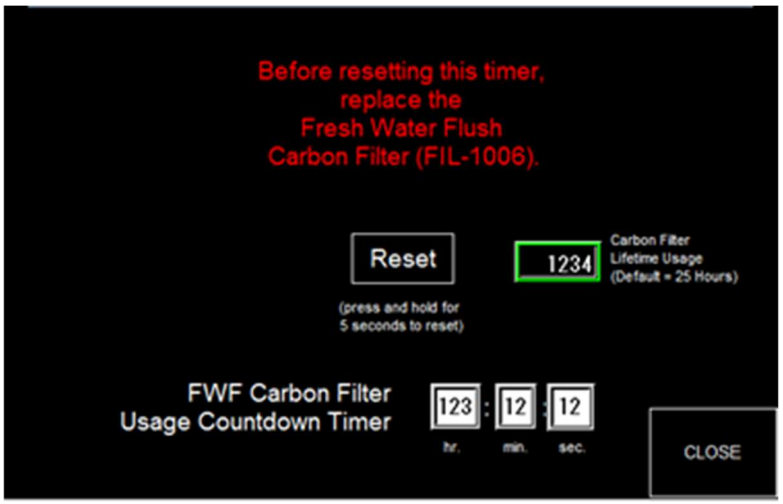


Figure 7.4 – Fresh Water Flush Reset

Replace the filter element using the following procedure:

1) Close the Fresh Water Flush valve.

2) Unscrew and remove the blue housing by turning counter-clockwise. Lower vessel out of RO frame.

Note

Pipe strap wrench can assist in the removal of the filter housing.

Figure 7.5 - Installation of Fresh Water Filter

Figure 7.6 – Installation of Fresh Water Filter (Cont'd)

3) Insert filter as shown and replace vessel by turning clockwise.

4) After the filter element has been changed, reset Fresh Water Filter timer on HMI screen.

5) The Fresh Water Flush Manual Control screen can be accesses from the Main Menu.

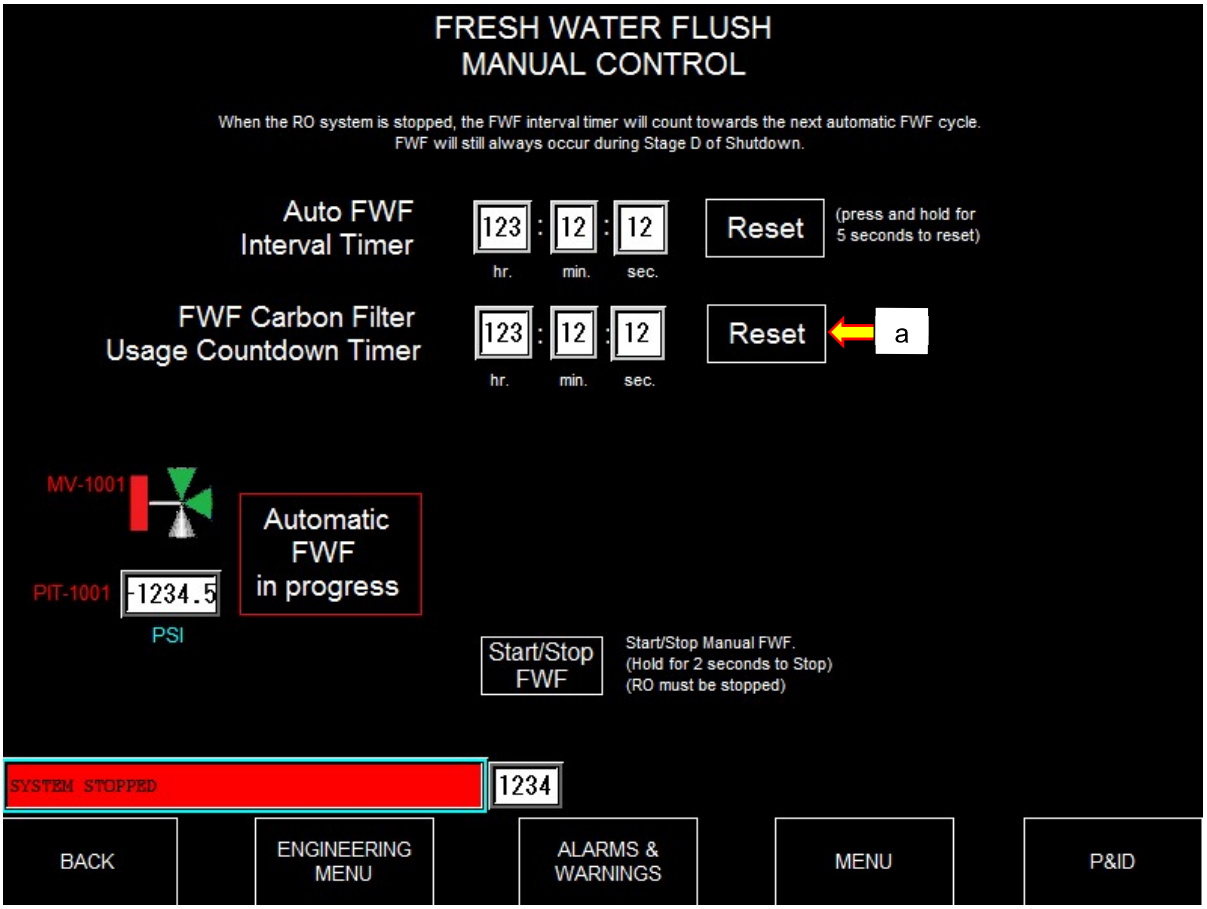


Figure 7.7 – Fresh Water Flush Manual Control Screen

6) Press reset button (a) to open the pop-up screen that allow the operator to reset the FWF Carbon Filter Usage Countdown timer.

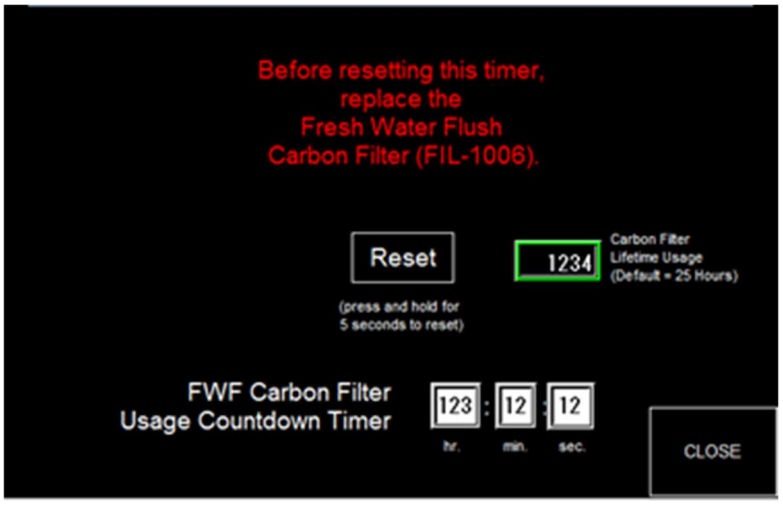


Figure 7.8 – Fresh Water Flush Reset

7.4 INSTALL OR CHANGE RO MEMBRANE ELEMENT

CAUTION

Install the membrane elements when the system is ready for commissioning. This ensures that the membrane elements do not dry out and become damaged.

CAUTION

The membrane is packaged with storage solution. Avoid skin and eye contact with this solution. In case of skin contact, rinse the skin thoroughly with water. In case of eye contact, flush repeatedly with water and notify a physician immediately. (THE STORAGE CHEMICAL IS WATER, SODIUM BISULFITE & PROPYLENE GLYCOL).

7.4.1 MEMBRANE REPLACEMENT PROCEDURE

NOTE

It is not necessary to remove a pressure vessel from the RO unit for disassembly.

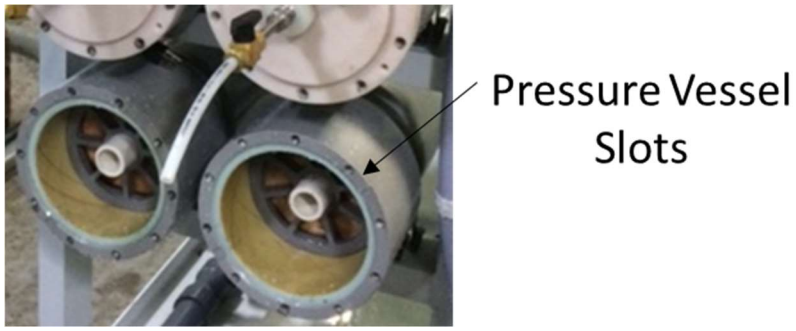
1) Secure the RO unit. Close the raw water supply (external) to RO unit.

2) Disconnect all plumbing connections from the pressure vessel to be disassembled.

Figure 7.9 – Pressure Vessel Plumbing

3) Remove the bolts holding each end plug in place with an Allen wrench. Place a mark on each end plug removed and its corresponding collar. This will ensure proper orientation during assembly.

4) Locate the prying slots on opposite sides of the end cap on either side of the collar to assist in removal.



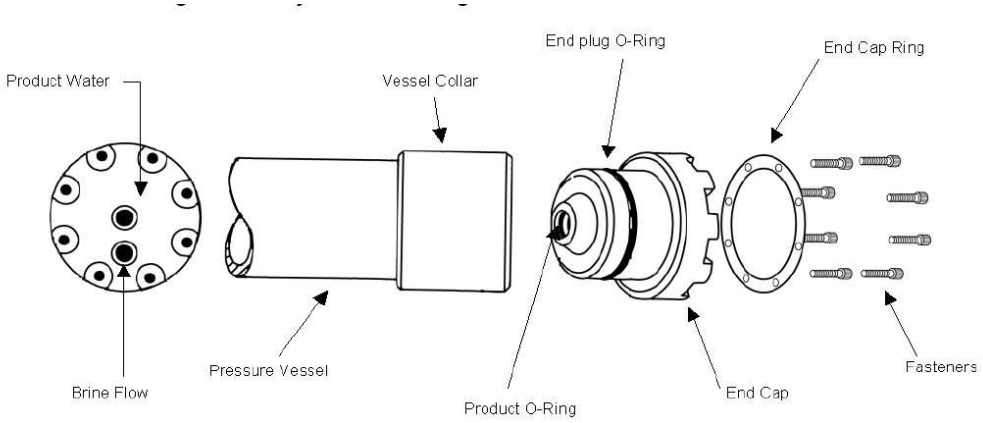


Figure 7.10 – Pressure Vessel Assembly

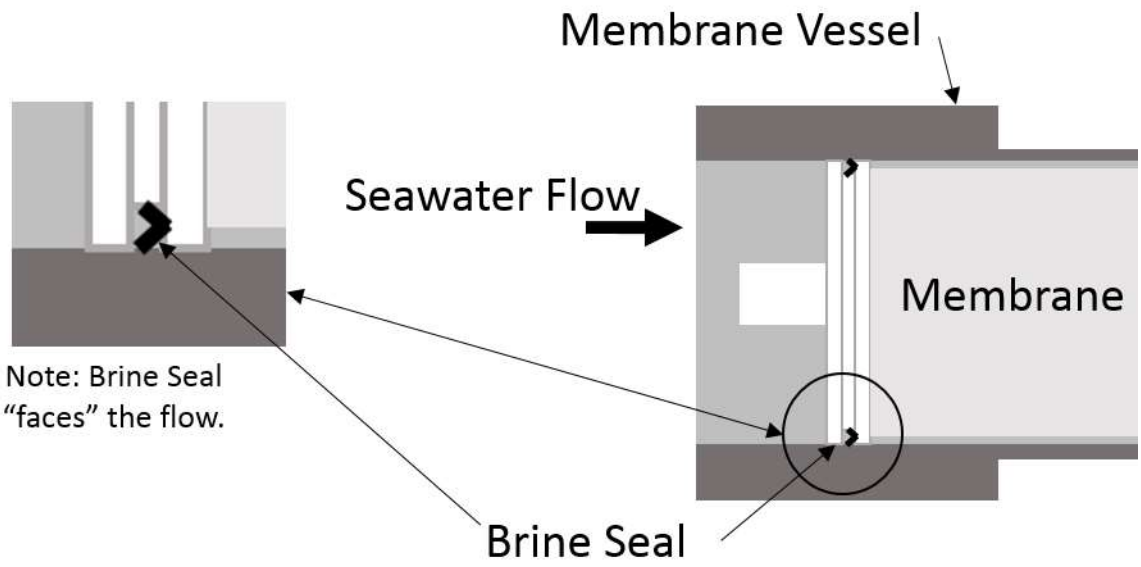


Figure 7.11 - Brine Seal Orientation

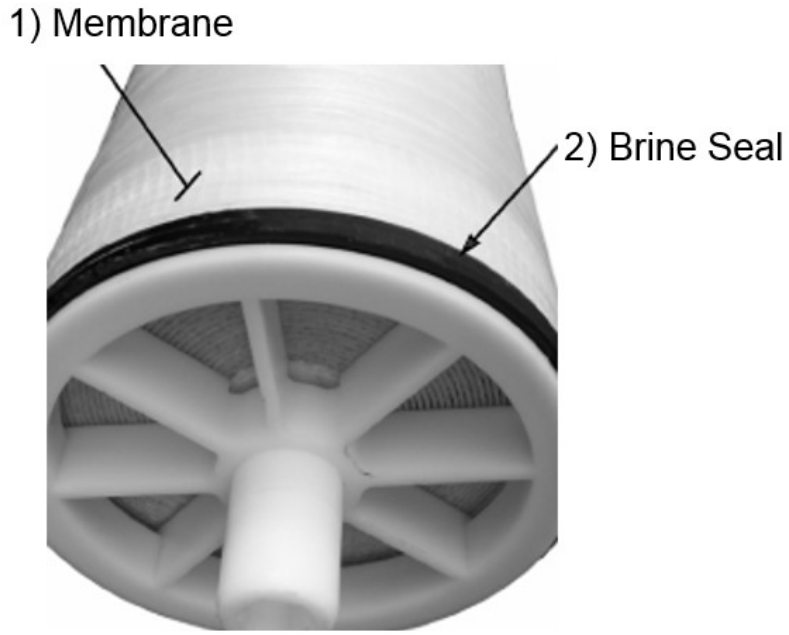


Figure 7.12 - RO Membrane Brine Seal

5) Note which end of the pressure vessel the brine seal is visible from. This is the feed end of the pressure vessel. When reinstalling the RO membrane, the brine seal must be located at the feed end of the pressure vessel. Note the feed flow direction on the outside of the pressure vessel or trace the flow direction from the high-pressure pump to confirm the high-pressure flow direction. See Figure 6.2.

CAUTION

Never force a membrane out of a pressure vessel by applying pressure on the product water tube (center tube) as this will damage the membrane. If the membrane is difficult to remove, use a length of 2" plastic pipe to apply pressure on the protected end of membrane.

6) Whenever possible, remove the membrane from the discharge end of the pressure vessel (opposite the brine seal). This is accomplished by pushing on the membrane from the feed end of the pressure vessel until it is visible at the discharge end. Then grasp the protruding membrane and pull it out of pressure vessel. Place the membrane in a clean area.

7) Remove the product water O-rings and end plug O-ring from each end plug for inspection. The product water O-rings are internal O-rings located inside the center hole in the end cap.

8) Clean all parts thoroughly. Inspect the O-rings on all fittings. Replace any parts that are damaged.

NOTE

Do not apply Teflon tape or other sealant to straight thread fittings such as those used on HP hose assemblies and their adapters.

9) Install the product water and end plug O-rings onto the end plugs. Lubricate the O-rings and entrances to the pressure vessel with glycerin or silicone lubricant. Locate the discharge end of pressure vessel. Install the end plug into the discharge end making sure to align the end plug holes and the mounting holes on the pressure vessel while paying attention to the reference mark (see Section 6.3.1, Step 2). Apply pressure to the end plug until screws can be threaded into the collars. If the end plug will not slide into the pressure vessel sufficiently, see Figure 6.2 for an installation aid. Install and hand tighten the screws.

10) Lubricate the brine seal and product water tubes of RO membrane with glycerin or silicone lubricant. Do not use a petroleum-based lubricant. Orient the membrane such that the end without the brine seal enters the feed end of the pressure vessel first. Slide the membrane into the pressure vessel until resistance is felt. Continue to apply moderate pressure until the product water tube seats in the end plug.

11) Install the remaining end plug making sure to align the end plug holes with the mounting holes on the pressure vessel while paying attention to the reference mark (see Section 6.3.1, Step 2). Apply moderate pressure to the end plug until the screws can be threaded into the collar. If the end plug will not slide into the pressure vessel sufficiently, see Figure 6.2 for installation aid. Install and hand tighten the cap screws.

12) Make sure that anti-seize compound is applied to each screw before the final tightening and torque the screws to 15 ft-lbs.

13) Reconnect all plumbing connections to pressure vessels.

WARNING

DO NOT use compounds or lubricants other than the lubricant provided with the membrane. Most lubricants are petroleum-based and unsafe for use in potable water production. Failure to follow this warning may result in injury or death to personnel.

CAUTION

- RO vessel end caps must be installed in the correct position and orientation for proper connections to align.
- Use care when installing RO vessel end caps to prevent damaging 0-ring seals.
- Failure to follow these cautions may result in damage to equipment.

7.5 MEMBRANE CLEANING PROCEDURE

CAUTION

Read Chemical Data Sheet before handling.

The Clean-In-Place (CIP) procedure can be performed without having to remove membranes from the vessels. The following parts are required for the cleaning procedure.

Part Number	Description	QTY
40012004	CIP CLEANING ELEMENT #1	1
40012005	CIP CLEANING ELEMENT #2	1

Table 7.3 – Membrane Cleaning Chemicals

Membranes should be cleaned when temperature corrected product flow rate decreases by 10%.

The Cleaning can be accessed from the Main Menu. The following four screens provide a 6-step guide to performing the cleaning procedure.

1) Secure the RO unit. Close the raw water supply (external) to RO unit.

2) Press Membrane Cleaning or Preservation button. The Membrane Cleaning or Preservation procedure can be accessed from the Main Menu. When this button is pressed, the operator will be taken to the selection screen.

Figure 7.13 Membrane Cleaning or Preservation Button

3) Press Cleaning Selected.

Figure 7.14 Membrane Cleaning Selected Button

4) Bring up Membrane Cleaning Screen on HMI.

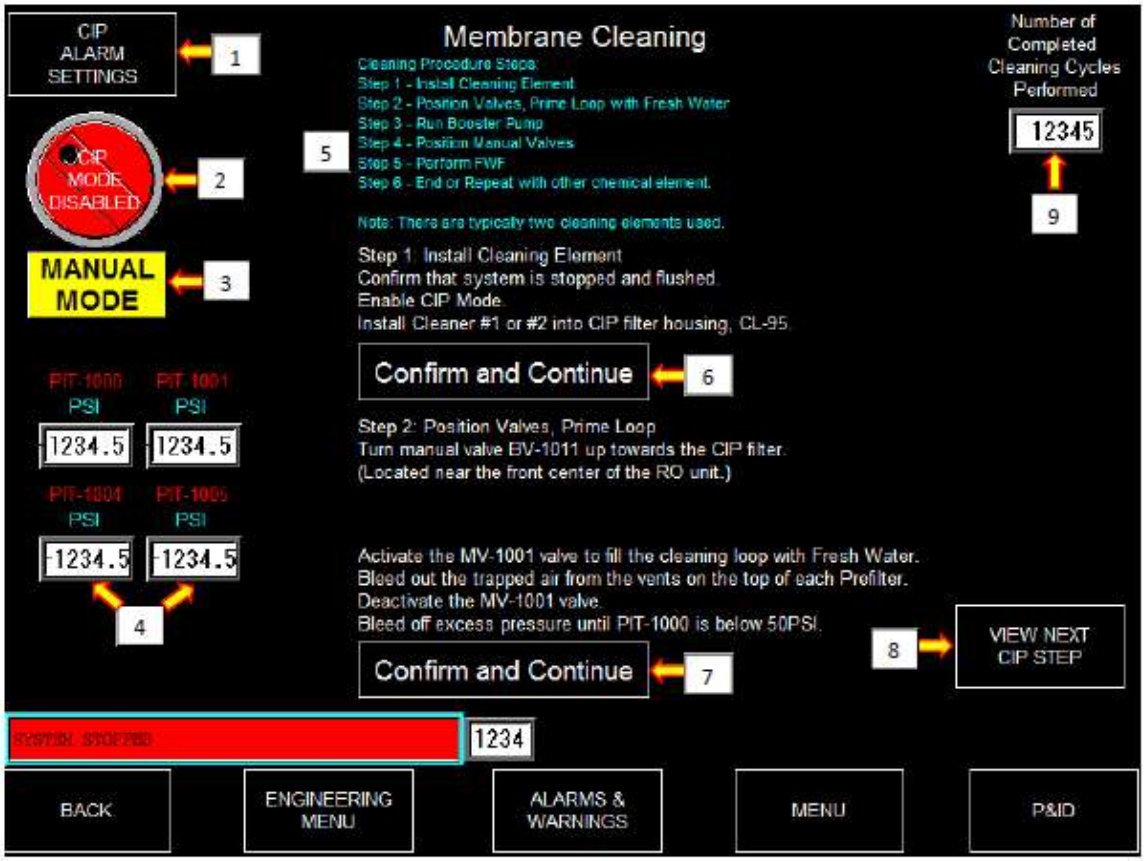


Figure 7.15 – Membrane Cleaning Screen Step 1&2

1. The Cleaning Alarm Settings screen can be access from any of the Membrane Cleaning screens.
2. CIP mode can be toggled between enable and disable with this button. Disabling CIP mode will reset any CIP steps that have already been confirmed.
3. If Manual mode is enabled, this indicator will be visible.
4. Some relevant pressure values are displayed here for reference.
5. A brief overview of all the CIP steps is listed here.
6. The operator can press here to confirm that step 1 has been completed and proceed to step 2.
7. The operator can press here to confirm that step 2 has been completed and proceed to step 3.
8. The operator can navigate to the other CIP screens, but progress will only be made once the “Confirm and Continue” buttons have been pressed for each step.
9. After a complete CIP process has been performed, this counter will increase by 1. For this to occur, the booster pump must run for at least 30 minutes in step 3 and the FWF must run for at least 10 minutes in step 5.

5) Install Cleaning Filter Element. CIP CLEANING ELEMENT #1. See Figure 7.17 - Installation of cleaning cartridge in the cleaning cartridge housing.

Figure 7.16 - Membrane Cleaning (CIP)

Remove vessel by turning counter-clockwise.

Lower vessel out of RO frame

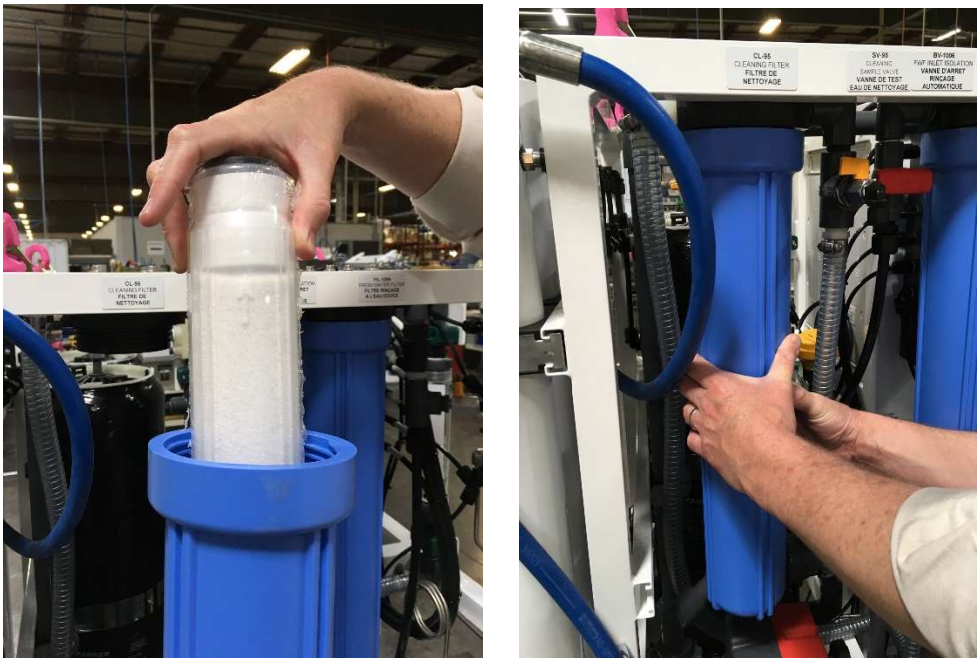


Figure 7.17 - Membrane Cleaning (CIP) (Cont'd)

6) Position Valves - Rotate Reject/Chem Diversion Valve handle to recirculation, the red arrows on the handle indicate direction. In Figure 7.18 below, the yellow arrows indicate flow direction. This position will force the chemical cleaning to recirculate in the system.

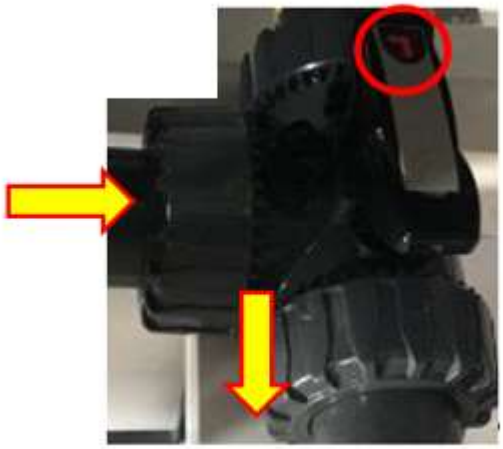


Figure 7.18 – Reject/Chem Diversion Valve

7) When step 2 is reached, a button will appear (MV-1001 Feed Selector Valve). This is used to prime the loop with fresh water.

8) Run booster pump by pressing CIP BP CMD. The pump will automatically run for 30 minutes and stop. Press Confirm and Continue.

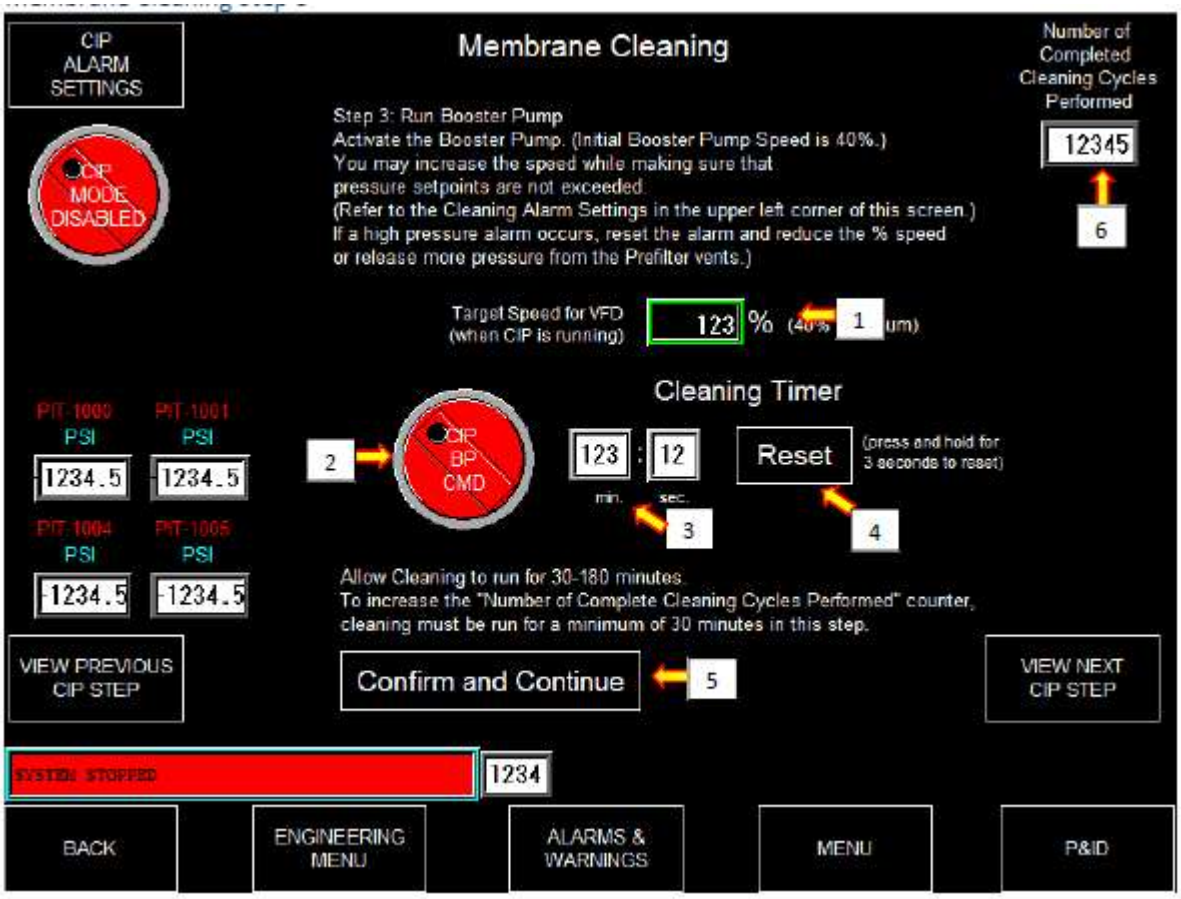


Figure 7.19 – Membrane Cleaning Procedure Step 3

1. This setting controls the flow rate of the Booster pump VFD during CIP Step 3. This value only applies during CIP Step 3.
2. This button is red when the Booster Pump is stopped. This button is green when the Booster Pump is running.
3. The CIP Booster Pump timer will be shown here.
4. The Cleaning Timer can be reset by holding down the Reset button for 3 seconds.
5. Once the Booster pump has run and recirculated the cleaning chemical for at least 30 minutes, this button is used to confirm that step 3 has been properly completed.
6. After a complete CIP process has been performed, this counter will increase by 1. For this to occur, the booster pump must run for at least 30 minutes in step 3 and the FWF must run for at least 10 minutes in step 5.

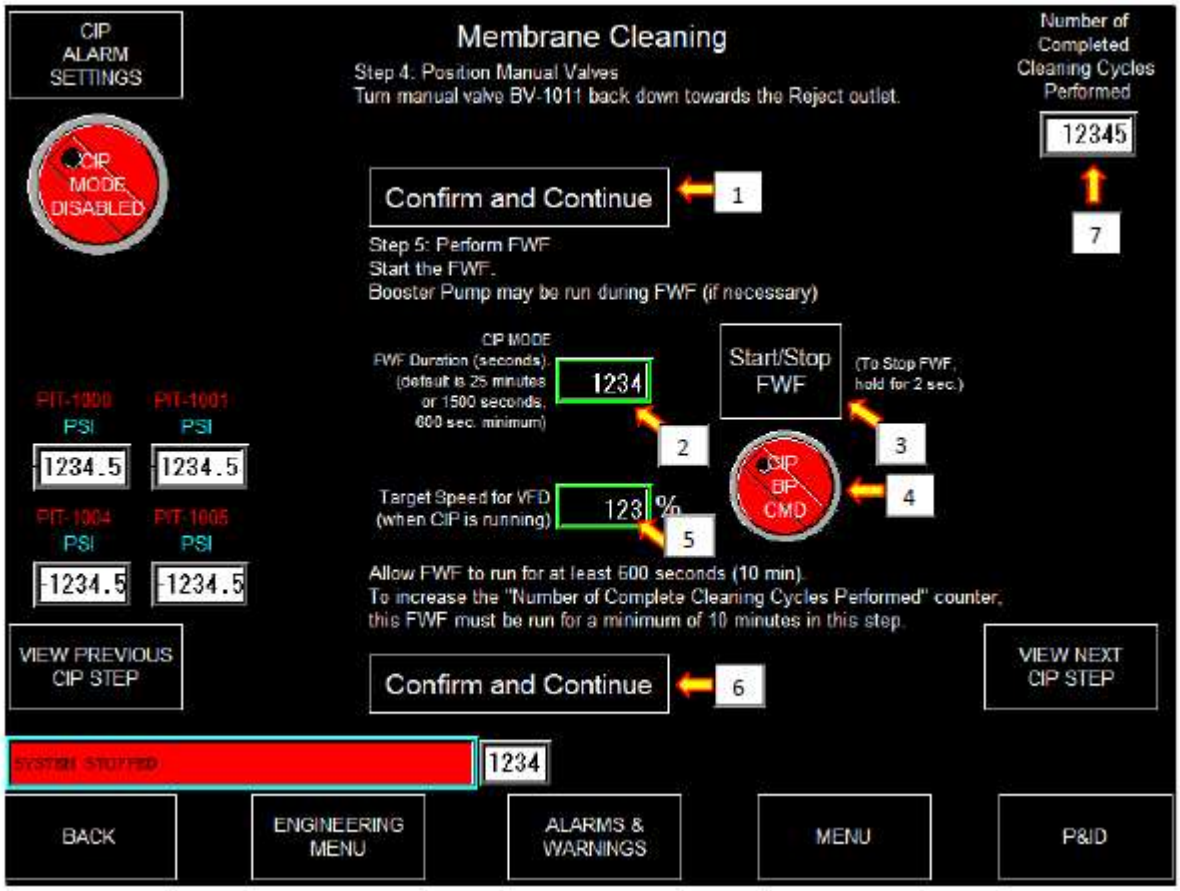


Figure 7.20 – Membrane Cleaning Procedure Step 4 and 5

1. Verify that TIE 1005 is routed to the brine discharge line or optional chemical cleaning tank. Continue with Step 4 on the screen. When Step 4 is complete, press to confirm that step 4 has been completed and proceed to step 5. The buttons and settings of step 5 are hidden until step 4 is completed.
2. The duration time of the FWF in step 5 of the cleaning procedure.
3. This button will initiate the FWF. This will open the Feed Inlet Valve. The FWF will automatically stop after the duration time has expired.
4. This button will turn the Booster pump on or off during the FWF. This is optional and can be used to assist with FWF flow during cleaning step 5.
5. This display indicates the flow rate setpoint of the Booster pump, if the Booster pump is used during step 5.
6. This button is used to confirm that step 5 has been completed and will proceed to step 6. The FWF needs to run for a minimum of 5 minutes (600 seconds) for the PLC to record that a complete cleaning cycle has been performed.
7. After a complete CIP process has been performed, this counter will increase by 1. For this to occur, the Booster pump must run for at least 30 minutes in step 3 and the FWF must run for at least 10 minutes in step 5.

9) POSITION VALVES - Rotate Reject/Chem Diversion Valve handle to discharge, the red arrows on the handle indicate direction. See Figure 7.18, the yellow arrows indicate flow direction. This position will force the chemical cleaning to recirculate in the system. Press Confirm and Continue.

10) Press START/STOP FWF – This will Fresh water flush the system. After the Fresh Water Flush is complete, press Confirm and Continue.

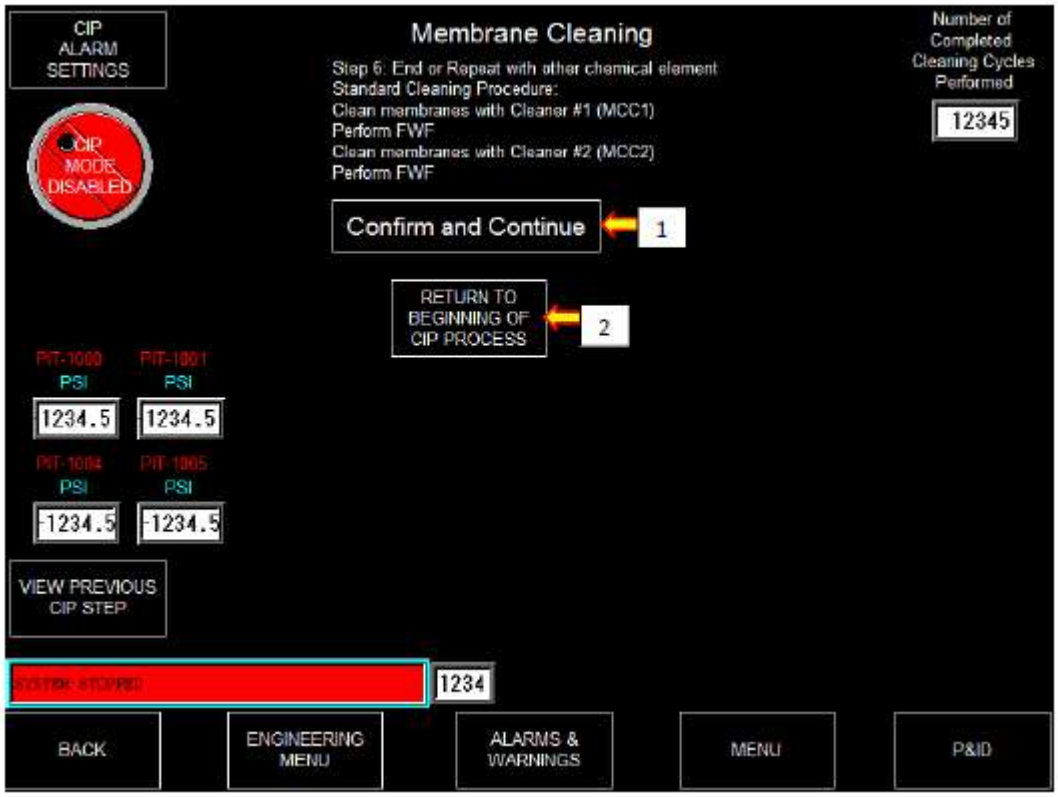


Figure 7.21 – Membrane Cleaning Procedure Step 6

1. Press here to confirm that Step 6 had been acknowledged and that the operator has read the text about the activities of a complete cleaning process.
2. If the cleaning process needs to be repeated with another chemical cleaner, then this button can be pressed to go back to cleaning step 1.

11) STEP 6 - Press RETURN TO BEGINNING OF CIP PROCESS. Go to STEP 1 to repeat the process using CIP CLEANING ELEMENT #2.

12) Once the cleaning process has been completed using CIP CLEANING ELEMENT #1 and #2 press the Confirm and Continue button to complete the cleaning cycle.

7.6 EXTENDED SHUT DOWN PROCEDURE

CAUTION

Read Chemical Data Sheet before handling.

When the system is going to be idle for more than 30 days the fresh water flush shutdown is not adequate to protect the membranes from biological growth. Preservation Chemical Element #3 will need to be introduced to the system and replaced every two months of idle time.

Part Number	Description	QTY
40012019	PRESERVATION CHEMICAL ELEMENT #3	1

Table 7.13 – Preservation Chemicals

1) Secure the RO unit. Close the raw water supply (external) to RO unit.

2) Bring up Membrane Cleaning Screen on HMI.

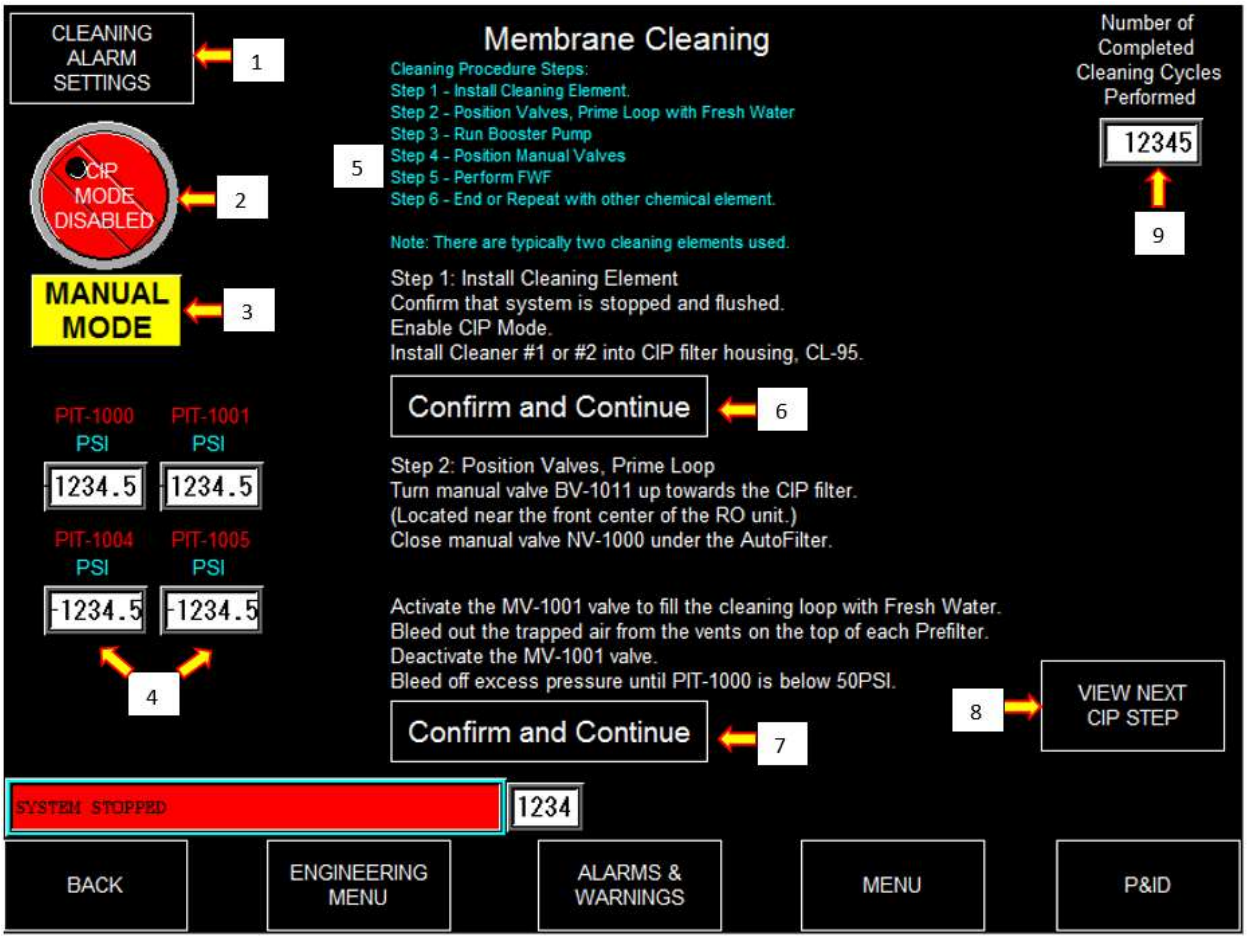


Figure 7.22 – Membrane Cleaning Screen

1. The Cleaning Alarm Settings screen can be access from any of the Membrane Cleaning screens.
2. CIP mode can be toggled between enable and disable with this button. Disabling CIP mode will reset any CIP steps that have already been confirmed.
3. If Manual mode is enabled, this indicator will be visible.
4. Some relevant pressure values are displayed here for reference.
5. A brief overview of all the CIP steps is listed here.
6. The operator can press here to confirm that step 1 has been completed and proceed to step 2.
7. The operator can press here to confirm that step 2 has been completed and proceed to step 3.
8. The operator can navigate to the other CIP screens, but progress will only be made once the “Confirm and Continue” buttons have been pressed for each step.
9. After a complete CIP process has been performed, this counter will increase by 1. For this to occur, the booster pump must run for at least 30 minutes in step 3 and the FWF must run for at least 10 minutes in step 5.

3) Install PRESERVATION CLEANING ELEMENT #3. See Figure 7.23 - Installation of Cleaning Cartridge in the cleaning cartridge housing.

Remove vessel by turning counter-clockwise.

Lower vessel out of RO frame

Figure 7.23 - Membrane Preservation

4) Position Valves - Rotate Reject/Chem Diversion Valve handle to recirculation, the red arrows on the handle indicate direction. In Figure 7.24 below, the yellow arrows indicate flow direction. This position will force the chemical cleaning to recirculate in the system.

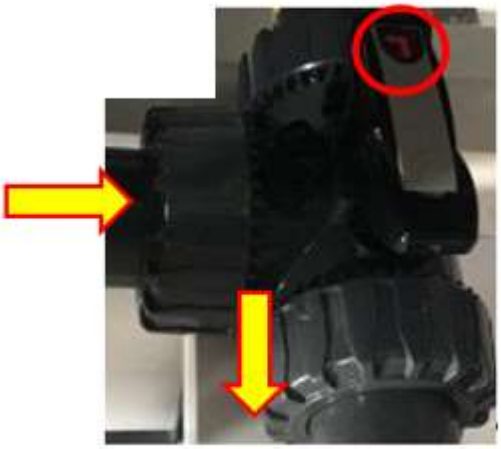


Figure 7.24 – Reject/Chem Diversion Valve

5) When step 2 is reached, a button will appear (MV-1001 Feed Selector Valve). This is used to prime the loop with fresh water.

6) Run booster pump by pressing CIP BP CMD. The pump will automatically run for 30 minutes and stop. Press Confirm and Continue.

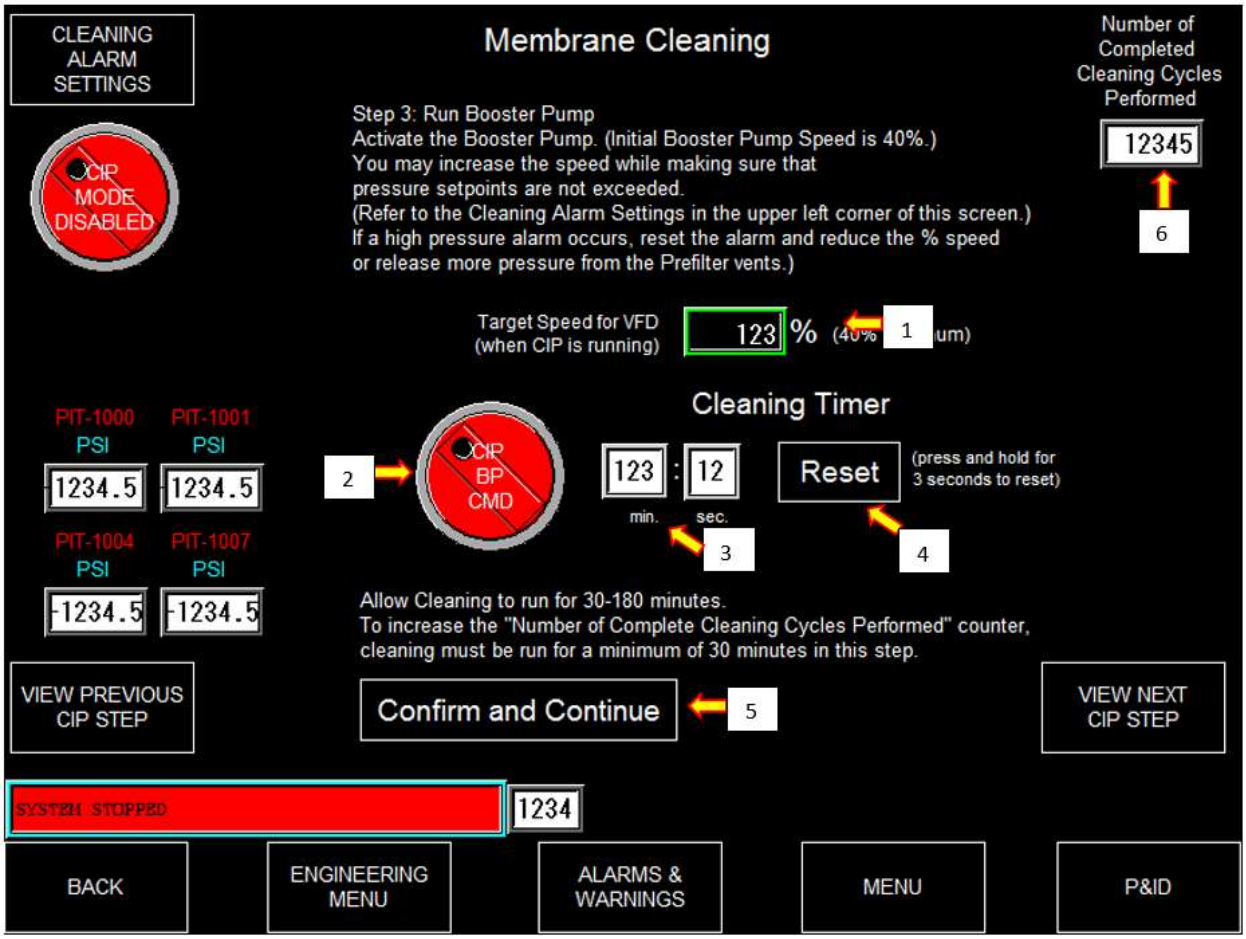


Figure 7.26 – Membrane Cleaning Procedure Step 3

1. This setting controls the flow rate of the Booster pump VFD during CIP Step 3. This value only applies during CIP Step 3.
2. This button is red when the Booster Pump is stopped. This button is green when the Booster Pump is running.
3. The CIP Booster Pump timer will be shown here.
4. The Cleaning Timer can be reset by holding down the Reset button for 3 seconds.
5. Once the Booster pump has run and recirculated the cleaning chemical for at least 30 minutes, this button is used to confirm that step 3 has been properly completed.
6. After a complete CIP process has been performed, this counter will increase by 1. For this to occur, the booster pump must run for at least 15 minutes in step 3 and the FWF must run for at least 10 minutes in step 5.

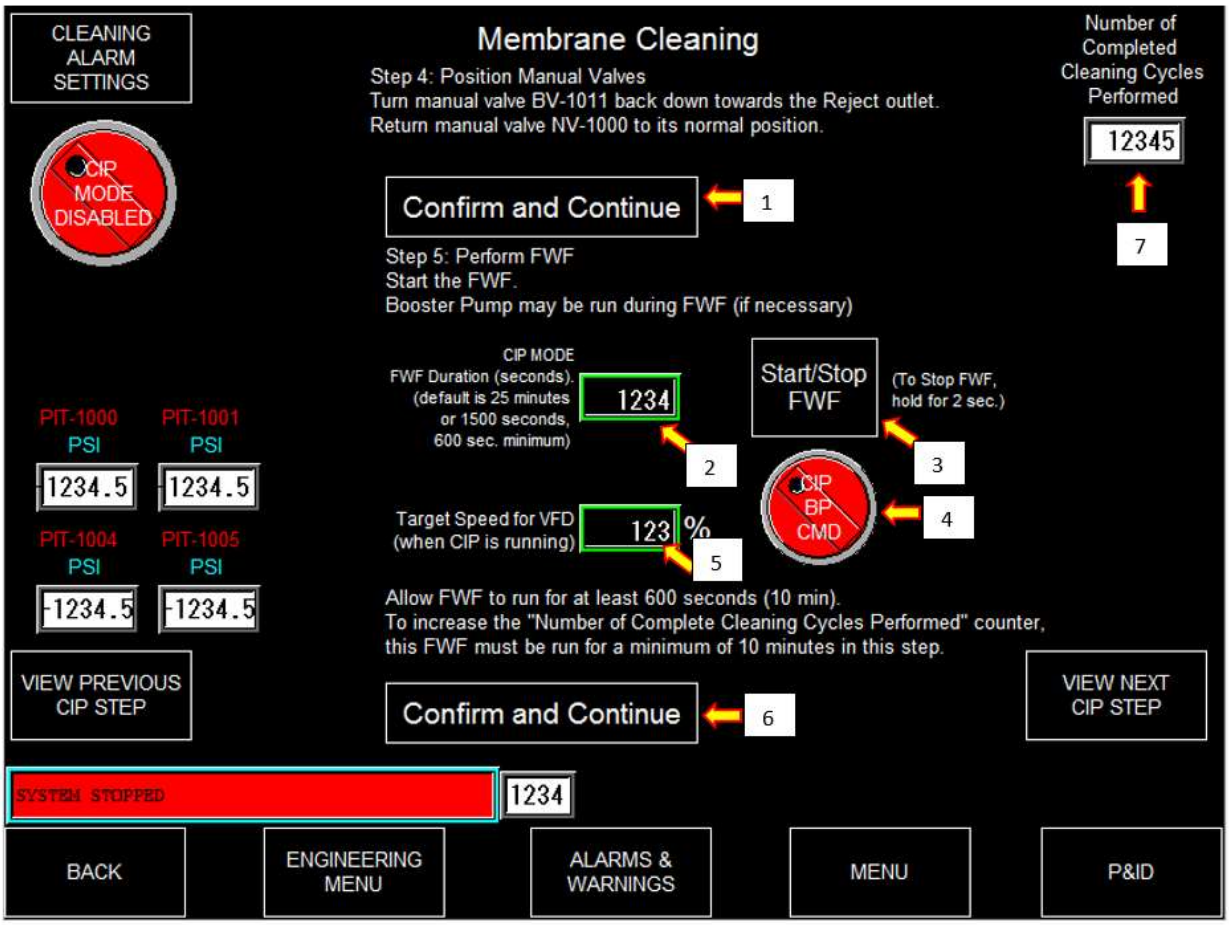


Figure 7.27 – Membrane Cleaning Procedure Step 4 and 5

CAUTION

DO NOT FOLLOW STEP 4 INSTRUCTIONS ON THE SCREEN,

Do not turn BV1011 back to reject outlet.

7) INSTEAD, close BV1006 on the FWF inlet line. Then, CONTINUE to step 5 and start FWF. By starting FWF, this will turn valve MV1001 so that the seawater inlet is isolated (TIE1001) from the RO unit. Verify that MV1001 is fully activated (pointing towards the FWF filter).

8) Turn power off. Valve MV1001 will remain closed, isolating the seawater inlet line. The RO System can now remain idle for a maximum of 6 months.

7.7 RESTART AFTER PRESERVATION

1) Turn power on.

2) Go to the membrane cleaning screens. Enable CIP Mode and skip ahead to Step 4 by pressing the “CONFIRM AND CONTINUE” buttons of Step 1 to 3.

3) Verify that TIE 1005 is routed to the brine discharge line or optional chemical cleaning tank, as required.

4) Open valve BV1011 on the FWF inlet line.

5) Continue with Steps 4, 5, and 6.

SECTION 8

TROUBLESHOOTING

8 TROUBLESHOOTING

Note

For assistance, call or email Parker Hannifin at (310) 608-5600 or watertech@parker.com

8.1 INTRODUCTION

This chapter provides information to help personnel troubleshoot, isolate, and correct malfunctions. Corrective action may be in the form of an immediate ″fix″ of the problem or a directive to personnel to consult a corrective maintenance procedure for adjustment or repair instructions. Before performing troubleshooting, read and follow all safety instructions found in this manual.

8.2 SUGGESTIONS

This chapter is only a guide to solving potential problems. It does not contain all possible malfunctions, nor does it contain all possible ways to determine the cause of a malfunction. The best troubleshooting tool is the knowledge gained over time through the experience of operating the system.

8.3 PRELIMINARY PROCEDURES

Sometimes the problem is a simple valve misalignment or loose wire. The following steps should be performed first, to reduce the chance of wasting time and effort looking for a problem that doesn’t exist or replacing an item that doesn’t need to be.

1) Check for the proper valve lineup for the applicable operating mode.

2) Inspect for loose connections or broken wires when checking electrical parts. Checking for continuity and solid contact can prevent hours of wasted effort.

3) Inspect and test equipment for the probable cause of malfunction before replacing it.

8.4 HIGH PRESSURE PUMP

1) Noisy or runs roughly

2) Leaks water.

3) Not developing enough pressure

Refer to Pump manual in Chapter 9.

8.5 LEAKS IN FITTINGS

1) Check for loose connections.
   Tighten fittings. If problem persists, go to 2.

2) Check for worn or damaged gaskets / O-rings.
   Replace worn or damaged gaskets / O-rings. If problem persists, go to 3.

3) Check for damaged fittings.
   Replace damaged fittings.

8.6 PRESSURE GAUGE INOPERATIVE

1) Check gauge for proper mounting.
   Re-install pressure gauge. If problem persists, go to 2.

2) Check pressure gauge for damage.
   Replace pressure gauge.

8.7 REVERSE OSMOSIS ELEMENTS

Note

It is normal for product water conductivity to increase as the seawater temperature increases. Do not immediately consider replacement of the RO elements.

Poor permeate quality can result from several problems: a defective membrane element created by mechanical failure, fouling of the membrane, defective permeate O-rings in the pressure vessel of the RO element, incorrect installation of the brine seal or high seawater temperature. The plant operator must identify the correct cause of the poor salinity so that proper action can be taken. The following paragraphs discuss the causes of high permeate salinity and identify methods for proper identification of those causes.

The above reasons for high salinity assume the salinity equipment is calibrated and functioning properly.

a) MEMBRANE SAMPLING

To identify a defective element, test the product water salinity from each element by opening the sample valves one at a time and throttling the flow of the sample valve while the plant is operating normally. Test each water sample using the portable salinity meter. If a potentially bad element is found (as indicated by a salinity reading of 700 ppm or higher), then follow the troubleshooting steps below.

b) MEMBRANE FOULING

Membrane fouling occurs over time. If this is the first time starting up the system, proceed to next step.

There are two types of fouling: permanent and temporary. In normal operation, the RO membranes undergo a slow, permanent fouling that becomes evident by steadily increasing product water salinity and decreasing product water output. Under normal conditions the membrane life is 3 to 5 years, but sometimes membrane elements may foul more rapidly and will need to be cleaned. Go to Cleaning Procedure to perform cleaning.

After cleaning, some membranes may have been permanently fouled, identify the poorest performing RO elements by testing each element individually, as described above. Replace the poorest elements with new ones

c) LEAKING PERMEATE O-RINGS

Leaking O-rings of the product water connections in the RO pressure vessel will increase the product water conductivity. Usually leaking O-rings occur upon installation of the membrane because the O-ring or product tube has been damaged during installation. Identify the element producing the poor quality permeate by testing the product water salinity from each element. Inspect all O-rings thoroughly for nicks, cuts, or out of roundness. Also, inspect the O-ring groove for corrosion and erosion. Replace imperfect O-rings and any defective parts. Inspect the product tube on the element for nicks or cuts where the O-ring would seat.

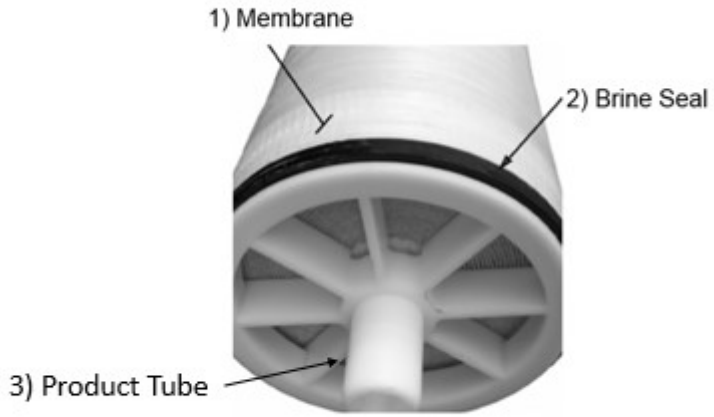


Figure 8.0 – Membrane

d) LOW MEMBRANE PRODUCTION UPON NEW INSTALLATION.

Typically, when new membranes are installed, and a low product water condition is noticed, which can be accompanied by high salinity. The brine seal should be inspected for correct orientation. See Figure 7.11 – Brine Seal Orientation for details.

e) HIGH SALINITY UPON NEW INSTALLATION

If the O-ring and product tube are good and the brine seal is in the correct orientation, the membrane element could be defective. A membrane failure of this type is extremely rare because elements are tested at the factory before shipment. A defective membrane element is usually identified by an abrupt increase in product water salinity and often some increase in permeate production rate as well.

8.8 CALIBRATION

The following steps outline the method for calibrating the system's salinity monitor.

1) Shut down system.

2) Remove salinity probe.

3) Place salinity probe in 300 PPM calibration solution. See Table 2-1.

4) Go to System Settings and Options Screen.

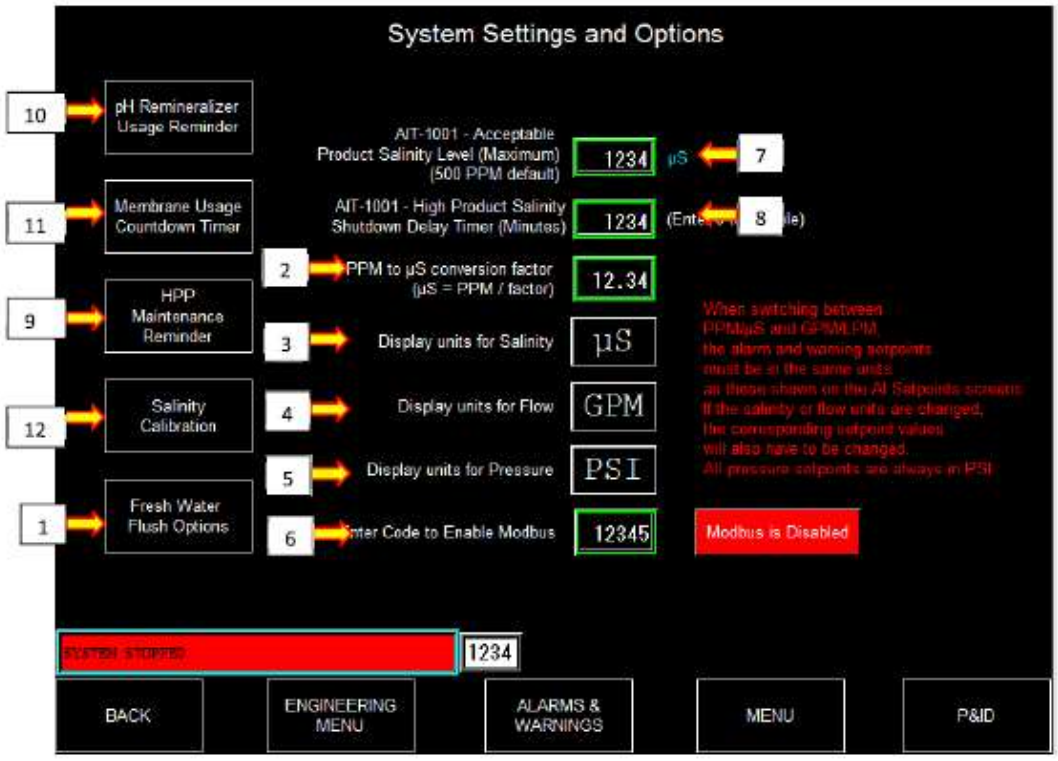


Figure 8.1 System Settings and Options Screen

5) Press Salinity Calibration (#12).

Figure 8.2 - Salinity Calibration Screen

6) Press here to open the salinity calibration screen that will allow the operator to manually adjust the salinity reading.

7) Reinstall salinity probe.

8.9 HMI ALARM AND WARNINGS DETAIL SCREEN

The HMI screen will alert the operator to any alarms or warnings. See Figure 8.3 for an example of list alarms and warnings.

The Alarms, Caution and Shutdown indicator will turn yellow when there is an active condition. Pressing this button will take the operator to the Alarms screen which displays any active alarm. Active alarms will be shown in red text while inactive alarms will be blue. Caution alarms will alert the operator to a pending shutdown condition. Shutdown alarms will shut down the RO system. Shutdown alarms need to be reset once the condition is no longer present. Caution alarms do not need to be reset manually because they automatically reset themselves when the condition no longer exists.

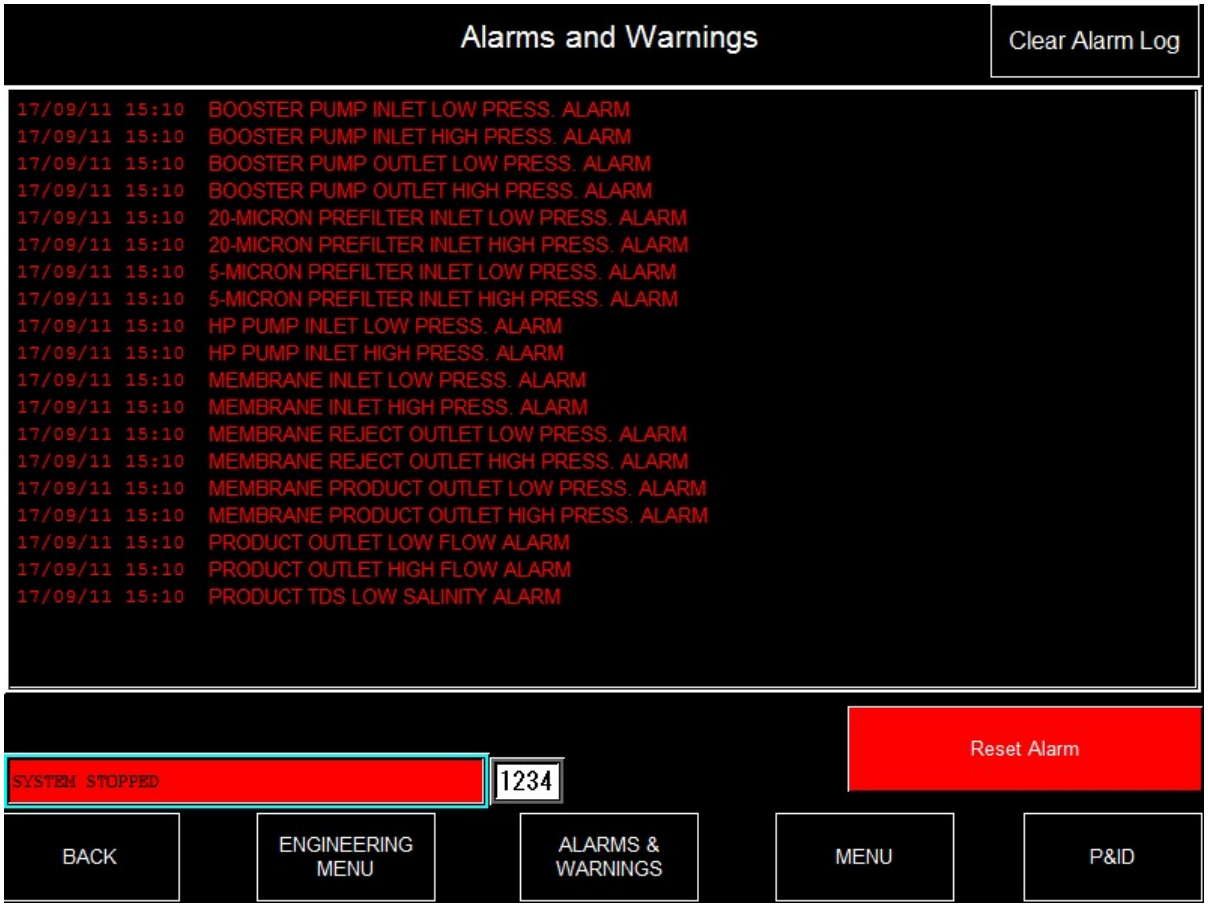


Figure 8.3 – Alarms Details Screen

Touchscreen Message	Default Setpoint	Possible Causes	Remedy
BOOSTER PUMP INLET LOW PRESS. SHUTDOWN	-15 PSI	The sea water strainer external to the unit is plugged. The sea water feed line is blocked or closed. The valves on the optional Multi Media skid are not properly configured to allow water into the RO skid.	Verify strainer is cleaned. Verify flooded inlet source at tie point TIE-1001 Verify the positions of the three external Multi Media valves (if applicable)
BOOSTER PUMP INLET LOW PRESS. CAUTION	-10 PSI		
BOOSTER PUMP INLET HIGH PRESS. SHUTDOWN	65 PSI	The inlet pressure into the sea water supply connection is too high.	Verify pressure of feed line. Install pressure regulator valve if necessary.
BOOSTER PUMP OUTLET HIGH PRESS. SHUTDOWN	80 PSI	The inlet pressure into the sea water supply connection is too high.	Verify pressure of feed line. Install pressure regulator valve if necessary.
20-MICRON PREFILTER INLET LOW PRESS. SHUTDOWN	10 PSI	The Hydrocyclone Control Valve is open. The speed of the VFD on	Throttle Hydrocyclone Control Valve. Verify speed of VFD on

20-MICRON PREFILTER INLET LOW PRESS. CAUTION	25 PSI	the booster pump is too low or in manual mode. The Hydrocyclone is blocked.	Booster Pump. Disassemble and clean Hydrocyclone.
5-MICRON PREFILTER INLET LOW PRESS. SHUTDOWN	10 PSI	The 20-micron filter is dirty and blocking pressure. The Hydrocyclone Control Valve is open. The speed of the VFD on the booster pump is too low or in manual mode. The Hydrocyclone is blocked.	Replace 20-micron filters. Throttle Hydrocyclone Control Valve. Verify speed of VFD on Booster Pump. Disassemble and clean Hydrocyclone.
5-MICRON PREFILTER INLET LOW PRESS. CAUTION	25 PSI		
HP PUMP INLET LOW PRESS. SHUTDOWN	10 PSI	The 5 and 20-micron filter are dirty and blocking pressure. The Hydrocyclone Control Valve is open. The speed of the VFD on the booster pump is too low or in manual mode. The Hydrocyclone is blocked.	Replace 5 and 20-micron filters. Throttle Hydrocyclone Control Valve. Verify speed of VFD on Booster Pump. Disassemble and clean Hydrocyclone.
HP PUMP INLET LOW PRESS. CAUTION	15 PSI		
HP PUMP INLET HIGH PRESS. SHUTDOWN	75 PSI	The inlet pressure into the sea water supply connection is too high.	Verify pressure of feed line. Install pressure regulator valve if necessary.
HP PUMP INLET HIGH PRESS. CAUTION	71 PSI		
MEMBRANE INLET HIGH PRESS. SHUTDOWN	990 PSI	Back Pressure Regulator Valve is set too high.	Back Pressure Regulator Valve needs to be adjusted (opened) to decrease the system pressure.
MEMBRANE REJECT OUTLET HIGH PRESS. SHUTDOWN	990 PSI	Back Pressure Regulator Valve is set too high.	Back Pressure Regulator Valve needs to be adjusted (opened) to decrease the system pressure.
MEMBRANE PRODUCT OUTLET HIGH PRESS. SHUTDOWN	60 PSI	The product line is blocked or pressure relief valve set point is set too high.	Make sure no external valves are closed. Decrease the pressure relief valve setpoint.
PRODUCT OUTLET HIGH FLOW CAUTION	(varies by size)	Back pressure regulator valve is set to produce too much system pressure.	Decrease back pressure regulator valve until the product flow is at the appropriate value.
PRODUCT TDS HIGH SALINITY CAUTION	500 PPM	Go to Section 8.7 in Operation Manual.	Go to Section 8.7 in Operation Manual.
20-MICRON PREFILTER HIGH DIFFERENTIAL PRESSURE CAUTION	10 PSI	The 20-micron filter is dirty.	Replace 20-micron filter
5-MICRON PREFILTER HIGH DIFFERENTIAL PRESSURE CAUTION	10 PSI	The 5-micron filter is dirty.	Replace 5-micron filter

HIGH PRESSURE AT MEMBRANE INLET DURING CLEANING	60 PSI	The Booster Pump VFD percentage is too high.	Increase Booster Pump VFD percentage.
WARNING - BOOSTER PUMP OUTLET LOW PRESSURE DURING FWF	5 PSI	The Booster Pump VFD percentage is too low.	Increase Booster Pump VFD percentage.
HIGH PRESSURE AT BOOSTER PUMP OUTLET DURING FRESH WATER FLUSH	80 PSI	The FWF inlet pressure at Fresh Water Feed is too high.	Reduce the pressure of the FWF inlet line. Install pressure regulator valve if necessary.
E-STOP IS ACTIVE	n/a	E-stop condition is present.	Reset the E-stop Button or turn off the optional E-stop command from MODBUS
HP PUMP INLET LOW PRESSURE SWITCH SHUTDOWN	n/a	The 5 and 20-micron filter are dirty and blocking pressure. The Hydrocyclone Control Valve is open. The speed of the VFD on the booster pump is too low or in manual mode. The Hydrocyclone is blocked.	Replace 5 and 20-micron filters. Throttle Hydrocyclone Control Valve. Verify speed of VFD on Booster Pump. Disassemble and clean Hydrocyclone.
MODBUS E-STOP SIGNAL IS ACTIVE	n/a	E-stop condition is present.	Reset the E-stop Button or turn off the optional E-stop command from MODBUS
CHANGE CARBON FILTER	n/a	The Fresh Water Flush Carbon Filter has been used for the maximum number of hours.	Change Carbon Filter and Reset the "Carbon Filter Usage Countdown Timer" from the Fresh Water Flush Options screen or the Fresh Water Flush Manual Control screen.
CLEAN MEMBRANES	n/a	The Membranes may need to be cleaned. Refer to Section 7.5 in Operation Manual.	Clean if necessary and Reset the "Membrane Cleaning Countdown Timer" from the Cleaning Alarm Settings screen.
PERFORM MAINTENANCE INSPECTION ON HPP PER THE MANUFACTURERS' LITERATURE	n/a	The High-Pressure Pump requires service at 8000 hours. Refer to Manufacturer's Literature.	Reset the "High Pressure Pump Maintenance Countdown Timer" from the System Settings and Options screen.

Table 8.0 - Troubleshooting Table

Touchscreen Message	Default Setpoint	Possible Causes	Remedy
BACKWASH IN PROGRESS . . .	n/a	If running, the RO will stop temporarily while the Media Filter "Backwash in Progress" signal is on.	Wait for the Media Filter Backwash sequence to finish.
CHANGE REMINERALIZER	n/a	The product Remineralizer has been used for the maximum number of hours.	Refill the Remineralizer and Reset the "Remineralizer Usage Countdown Timer" from the Remineralizer Usage Reminder screen. Set timer to 0 to disable reminder.

Table 8.1 - Optional Accessories Troubleshooting Table

SECTION 9

DRAWINGS & DATASHEETS