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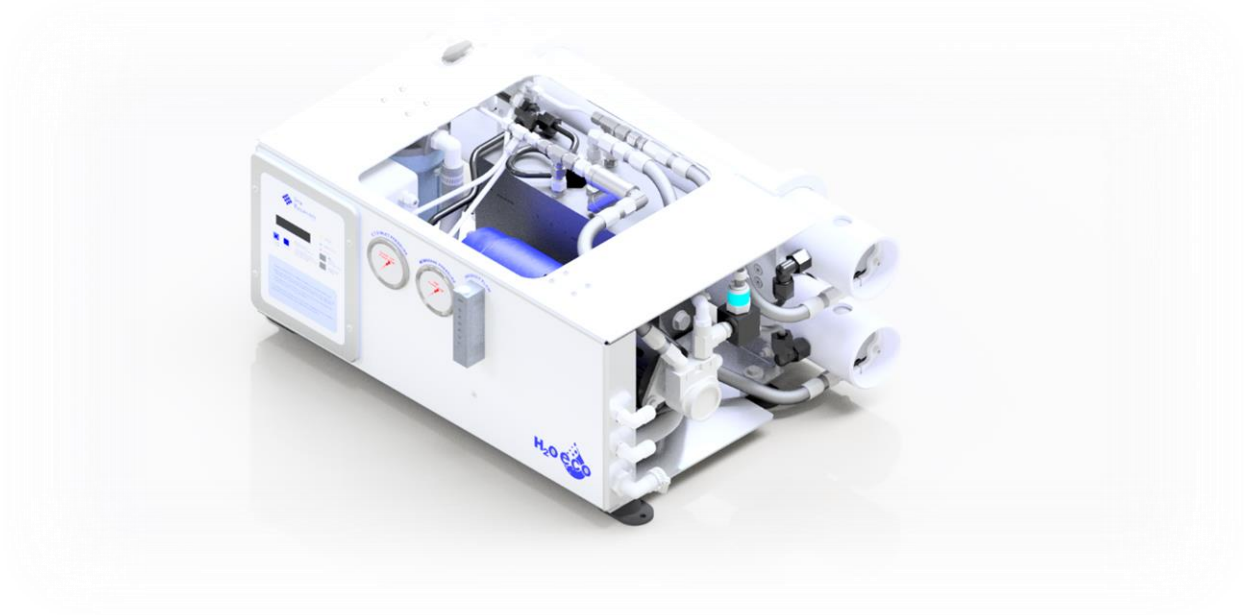
H2O ECO – A012C

Technical Manual



Parker – Water Purification

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REVISION HISTORY

REV	DATE	DESCRIPTION	AUTHOR
-	April, 2021	INITIAL RELEASE	OM
A	July, 2021	ADDED CONTROLLER TROUBLE SHOOTING AND WIRING DIAGRAM	OM

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.

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1.0 SYSTEM DESCRIPTION:

Reverse Osmosis System:

- **DC Systems:**

PART NUMBER	VOLTAGE (DC)	CAPACITY GPD	CAPACITY GPH	CAPACITY LPD	CAPACITY LPH
A012C-111	12V	400	16.7	1512	63
A012C-121	24V	400	16.7	1512	63
A012C-211	12V	600	25	2280	95
A012C-221	24V	600	25	2280	95

- **AC Systems:**

PART NUMBER	VOLTAGE AC (Single Phase)	CAPACITY GPD	CAPACITY GPH	CAPACITY LPD	CAPACITY LPH
A012C-311	110 (50/60Hz)	400	16.7	1512	63
A012C-321	220 (50/60Hz)	400	16.7	1512	63
A012C-411	110 (50/60Hz)	600	25	2280	95
A012C-421	220 (50/60Hz)	600	25	2280	95

1.1. SYSTEM SPECIFICATIONS:

Parameter for 400 GPD System:	Specification
Product Water Outlet Flow :	0.28 GPM (1.51 m^3/day) Potable
Sea Water Feed Inlet Flow:	2.3 GPM (12.53 m3/hr). Nominal
Reject Discharge Flow:	(2.02 GPM) (11.01 m3/hr).
Sea Water Feed Inlet water quality	Open Ocean
Sea Water Feed TDS:	Less than 42,000 ppm TDS
Product Water TDS:	<500 PPM TDS, WHO standard
Seawater Temperature Range:	0 °C to 32 °C (32-90°F)
Design Product Water Pressure:	2.07 BAR (30 PSI)
Max. Operating Pressure:	70 BAR (1000 PSI)

Parameter for 600 GPD System:	Specification
Product Water Outlet Flow :	0.42 GPM (2.27 m^3/day) Potable
Sea Water Feed Inlet Flow:	3.2 GPM (17.44 m3/hr). Nominal
Reject Discharge Flow:	(2.78 GPM) (15.15 m3/hr).
Sea Water Feed Inlet water quality	Open Ocean
Sea Water Feed TDS:	Less than 42,000 ppm TDS
Product Water TDS:	<500 PPM TDS, WHO standard
Seawater Temperature Range:	0 °C to 32 °C (32-90°F)
Design Product Water Pressure:	2.07 BAR (30 PSI)
Max. Operating Pressure:	70 BAR (1000 PSI)

Table 1.0 - Performance Specification

1.2. PHYSICAL CHARACTERISTICS

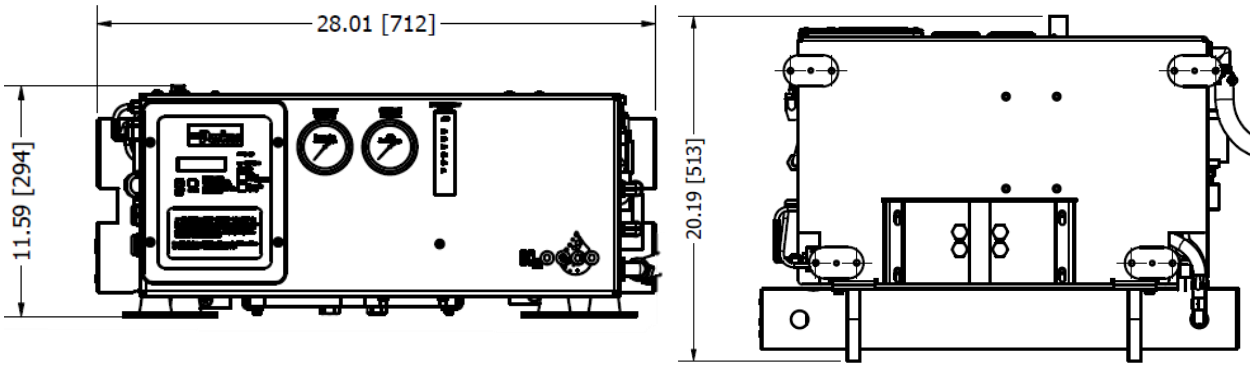


Figure 1.1: RO System Dimensions

PART NUMBER	DRY WEIGHT	WET WEIGHT
A012C-111	115 lbs (52 Kg)	128 lbs (59 Kg)
A012C-121	115 lbs (52 Kg)	128 lbs (59 Kg)
A012C-211	163 lbs (74 Kg)	176 lbs (80 Kg)
A012C-221	130 lbs (59 Kg)	143 lbs (65 Kg)
A012C-311	168 lbs (76 Kg)	200 lbs (91 Kg)
A012C-321	168 lbs (76 Kg)	168 lbs (76 Kg)
A012C-411	180 lbs (82 Kg)	180 lbs (82 Kg)
A012C-421	180 lbs (82 Kg)	180 lbs (82 Kg)

Table 1.1: Unit Weights

1.3. UTILITY REQUIREMENTS

System Motor	HP	W
400 GPD High pressure motor (12V, 24V, AC)	0.33	246
600 GPD High pressure motor (12V, 24V, AC)	0.5	373

Table 1.2: Pump Horsepower

Utility System Pump	Connection
Sea water Feed	3/4" FNPT NYLON PVC HOSE BARB
Reject Discharge Flow	5/8" FNPT NYLON PVC HOSE BARB
Product water Flow	5/8" FNPT NYLON PVC HOSE BARB

Table 1.3: Flow Requirements

1.4. RECOMMENDED SPARE PARTS LIST

Spare Parts and Special Tools	Part No.
Filter, 10 Ft2, 5 Micron	33-0117
Flushing Filter, Carbon	33-0311
MEMBRANE 450GPD AW W-SEAL	2724011233

Table 1.4: Recommended Spare Parts

1.5. SPECIAL TOOLS LIST

SPECIAL TOOLS	Part No.
Solution, Calibration, 30,000 PPM	90-1301
Meter, Ultra, 4p, TDS	3131420156

Table 1.5: Special Tools

2.0 PRE-INSTALLATION NOTES

2.1 PRECAUTIONS

Reverse Osmosis (RO) System 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.

2.2 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.

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.

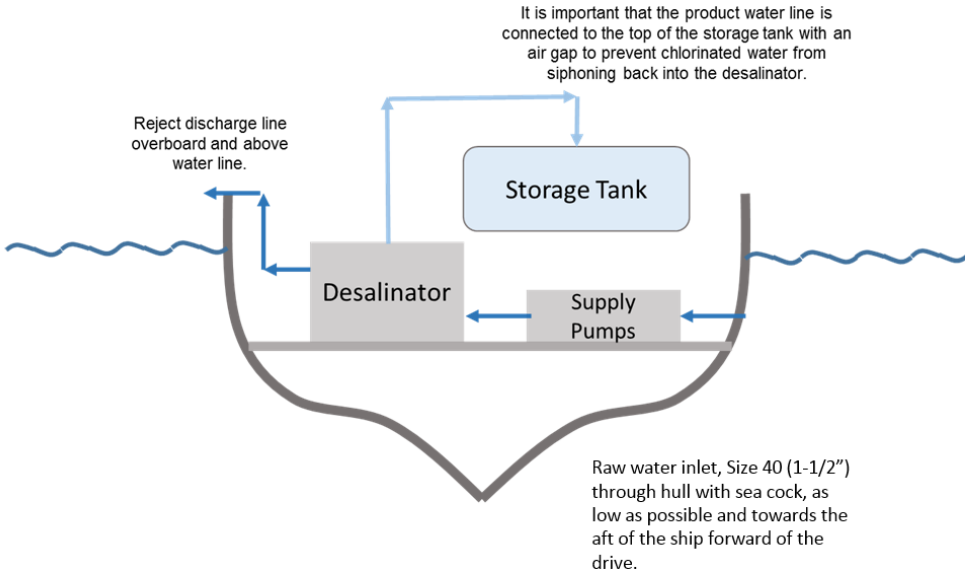


Figure 2.1 – RO Below Water Line

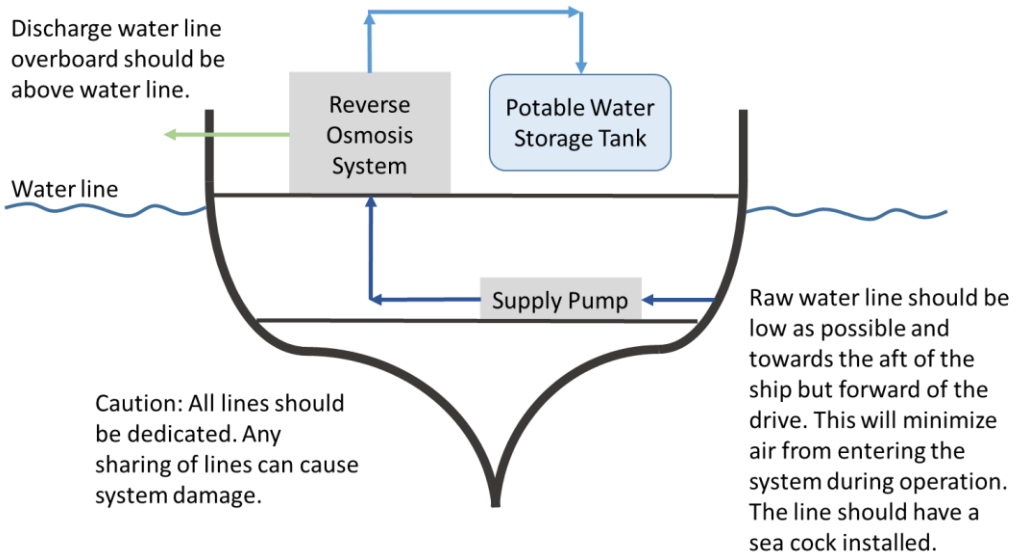


Figure 2.2: RO System Above Water Line

2.3 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 WORKING ON THE RO UNIT. 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.

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.

2.4 PLUMBING & INSTRUMENTATION DIAGRAM (P&ID)

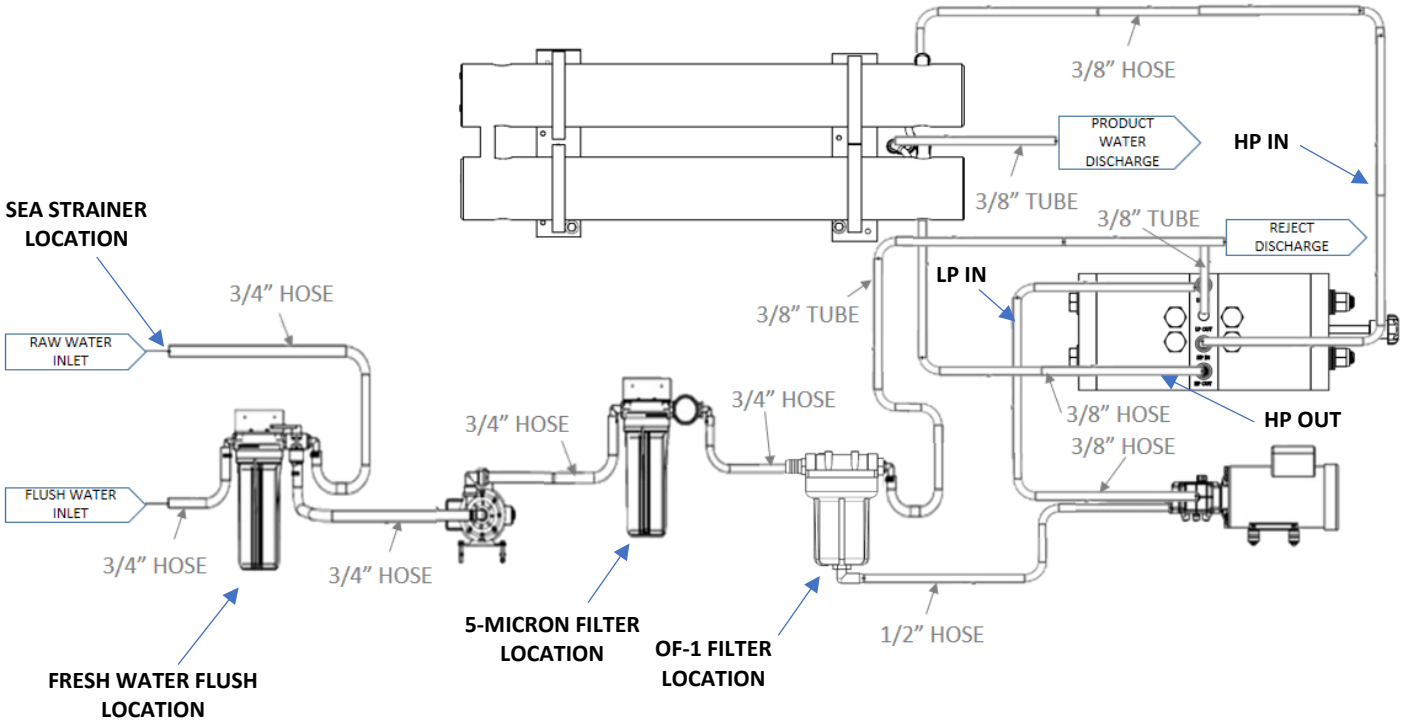


Figure 2.3: P&ID

2.5 COMPONENTS

MOUNT COMPONENTS

Inlet and discharge interconnecting lines should 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 introduces iron that will foul the membranes prematurely.

1) Parker recommends mounting a sea strainer **BELOW** the vessel's waterline.

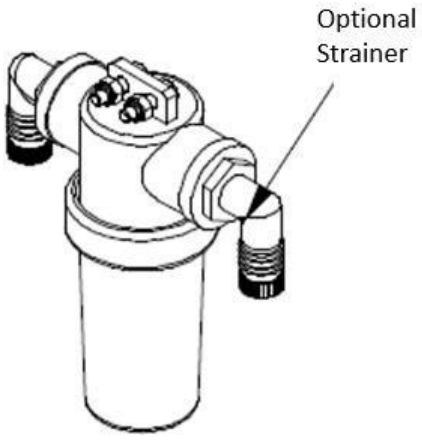


Figure 2.4: Optional Strainer

2) Mount the three-way manual Freshwater Flush Valve (attached to Fresh Flush Filter Housing) BELOW waterline. Refer to Figure 1.3 for a view of the flush filter and freshwater flush valve.

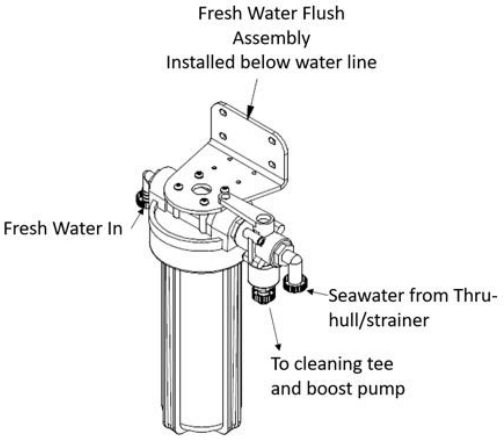


Figure 2.5: Freshwater Flush Assembly

NOTE

Parker Hannifin recommends the Manual Freshwater Flush Assembly be installed BELOW waterline. However, the three-way valve can be removed from the filter housing and relocated below waterline, leaving the freshwater flush filter housing ABOVE waterline. A hose can be plumbed from the freshwater

flush filter housing to the three-way valve. This ensures the seawater feed does not go above waterline to avoid trapping air and creating a priming problem.

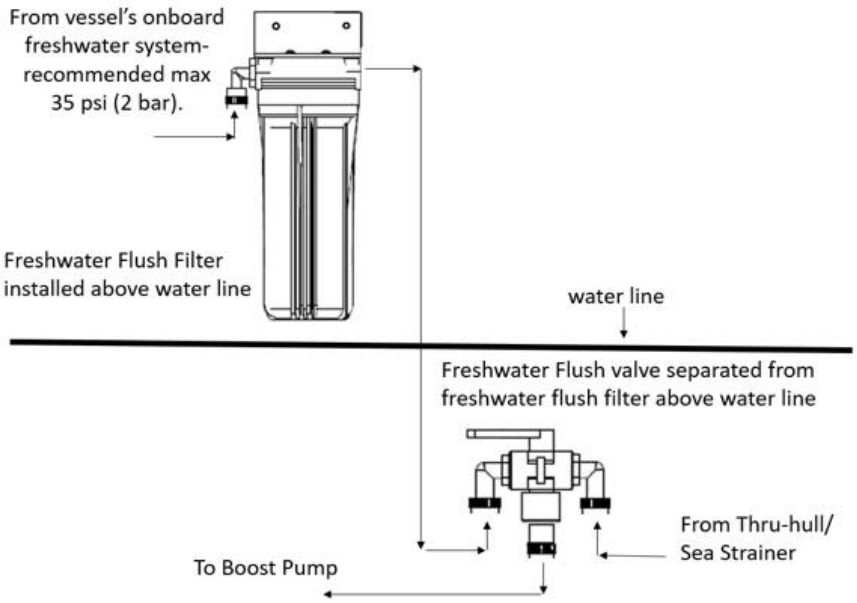


Figure 2.6: Freshwater Flush Assembly with fresh flush valve separated

3) Alternate Configuration see Figure 1.4: Connecting the Freshwater Flush Filter Outlet to the separated Freshwater Flush Valve. Connect 1/2" diameter PVC hoses to connect all the feed water components up to the high- pressure pump. Note the boost pump outlet is a 3/8" diameter barb fitting. Use a short section of 3/8" hose and increase to 1/2" diameter using the step size adaptor supplied.

4) Mount boost pump below the water line.

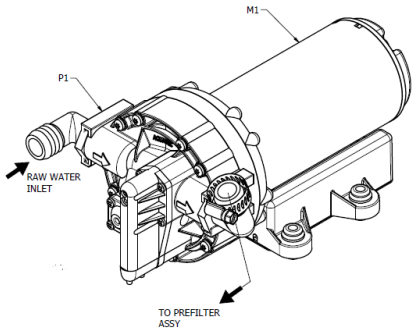


Figure 2.7: Boost Pump Assembly

DC Systems:

PART NUMBER	PERMEATE GPD	VOLTAGE	BOOSTER PUMP
A012C-111	400	12	1212380001
A012C-121	400	24	1212380002A
A012C-211	600	12	1212380001
A012C-221	600	24	1212380002A

AC Systems:

PART NUMBER	PERMEATE GPD	VOLTAGE	BOOSTER PUMP
A012C-311	400	110	70-1500
A012C-321	400	220	70-1500
A012C-411	600	110	70-1500
A012C-421	600	220	70-1500

5) Mount 5-micron prefilter housing assembly in convenient location for the operator to change filters.

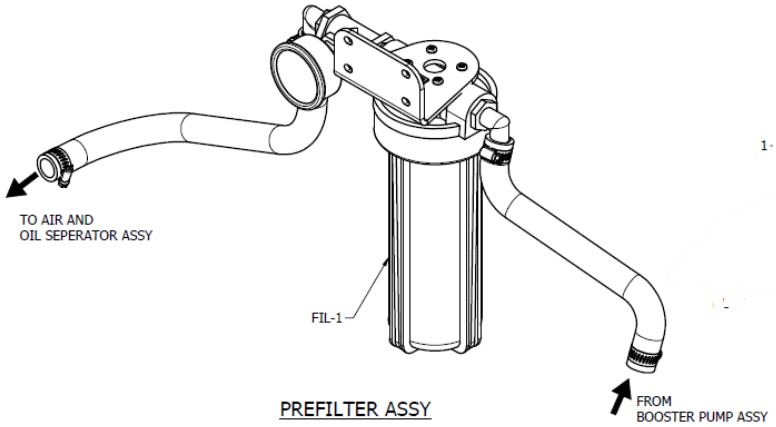


Figure 2.8: 5-Micron Prefilter Assembly

6) Mount RO Boost on the Frame in a convenient location.

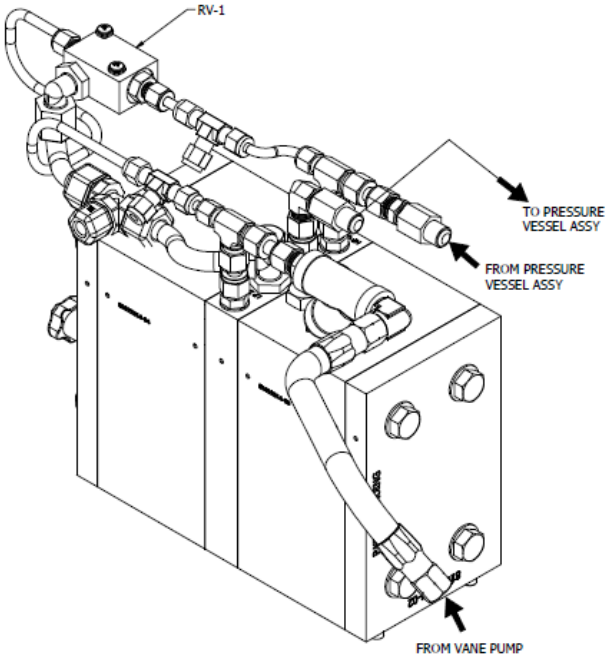


Figure 2.9: RO Boost (ETD)

7) Mount vessel assembly. Locate within distance for high pressure hose to end from the high-pressure (HP) pump and vessel assembly. If longer lengths are required, please contact Parker technical support.

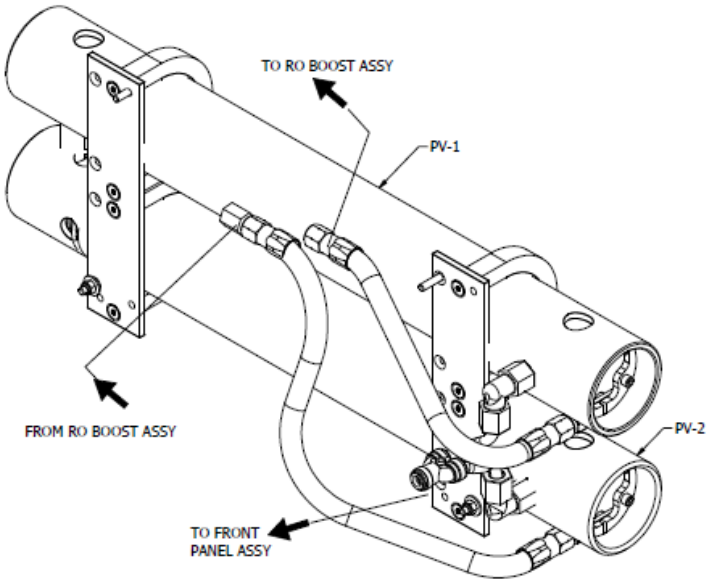


Figure 2.10: Vessel Assembly

8) Mount pump and motor assembly.

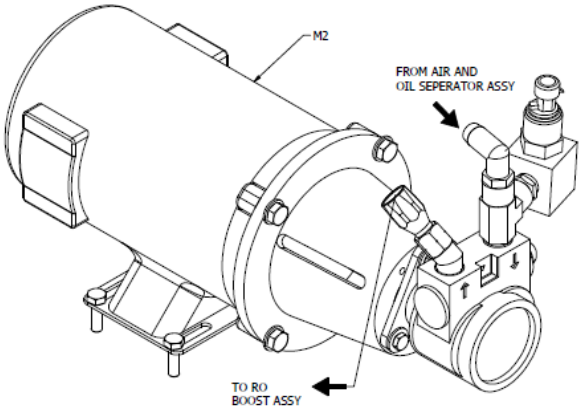


Figure 2.11: High Pressure Pump and Motor Assembly

DC Systems:

PART NUMBER	PERMEATE GPD	VOLTAGE	HP MOTOR	HP PUMP
A012C-111	400	12	15093110CF	12176402DP
A012C-121	400	24	15103210CF	12176402DP
A012C-211	600	12	15103210LE	12176404DP
A012C-221	600	24	15163210LE	12176404DP

AC Systems:

PART NUMBER	PERMEATE GPD	VOLTAGE	HP MOTOR	HP PUMP
A012C-311	400	110	15AG250912	12176402DP
A012C-321	600	220	15AG250912	12176402DP
A012C-411	400	110	1519071010	12176404DP
A012C-421	600	220	1519071010	12176404DP

9) Air and Oil Separator assembly

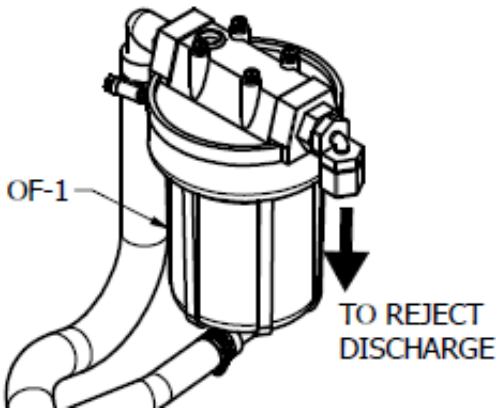


Figure 2.12: Air and Oil Separator assembly

ELECTICAL CONNECTIONS

WARNING

DISCONNECT ELECTRICAL POWER TO THE RO UNIT PRIOR TO CONNECTING OR SERVICING TO THE RO UNIT. FAILURE TO DO SO MAY RESULT IN SERIOUS INJURY OR DEATH TO PERSONS HANDLING THE UNIT.

CAUTION

Strictly observe all applicable electrical codes and regulations governing the installation and wiring of electrical equipment. Typical codes specify the type and size of conduit, wire diameter and class of wire insulation depending upon the amperage and environment. The power supply should always be of a greater service rating than the requirements of the RO unit. Never connect the RO unit to a line that services another electrical device, the RO unit should have its own breaker.

THE RO UNIT SHOULD HAVE ITS OWN INDEPENDENT POWER SUPPLY.

Note

The power supply should always be of greater service rating than the requirements of the RO unit. This will assure proper voltage even if power supply voltage is slightly less than required.

Note

110 VAC 60 hertz units need a three-wire supply, black, white, and green for hot, common and ground respectively.

220 VAC 60 hertz units need a four-wire supply, black, blue, white, and green for hot, hot, neutral and ground respectively - bring a separate neutral from the generator if necessary.

230 VAC 50 hertz units need a three-wire supply, black, white, and green for hot, hot, and earth respectively. Connect power to the main terminal block in the electrical enclosure following the above wire colors.

1. Before connecting electrical power to the watermaker. Select the circuit breaker size of at least 50% more than the operating amps shown on the serial number tag.
2. Verify all power switches and power sources are in the OFF position.
3. DC POWERED 12V RO Unit: 12 VDC units require 6-gauge wire and a 25- amp fuse or circuit breaker. Connect RO unit motor to vessel circuit breaker.
4. AC POWERED 110V/220V Little Wonder MODULAR: Connect RO unit motor to vessel circuit breaker. Parker recommends use of a 15-amp fuse or circuit breaker.
5. Connect the boost pump motor wires to vessel circuit breaker

3.0 THEORY OF OPERATION AND GENERAL DESCRIPTION

3.1 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.

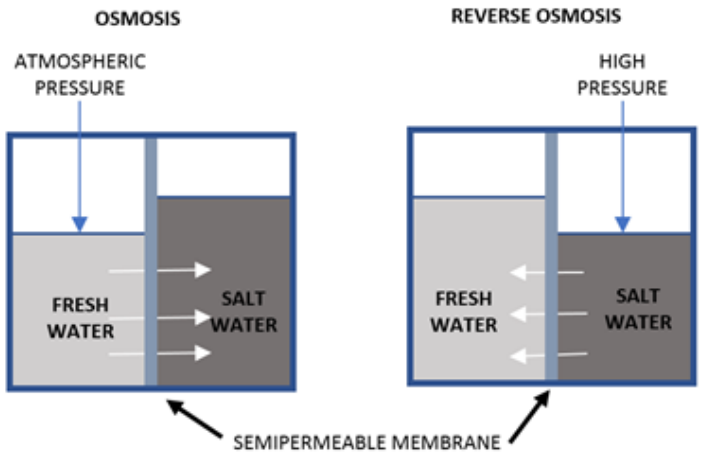


Figure 3.1: Simple (Reverse) Osmotic System

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.

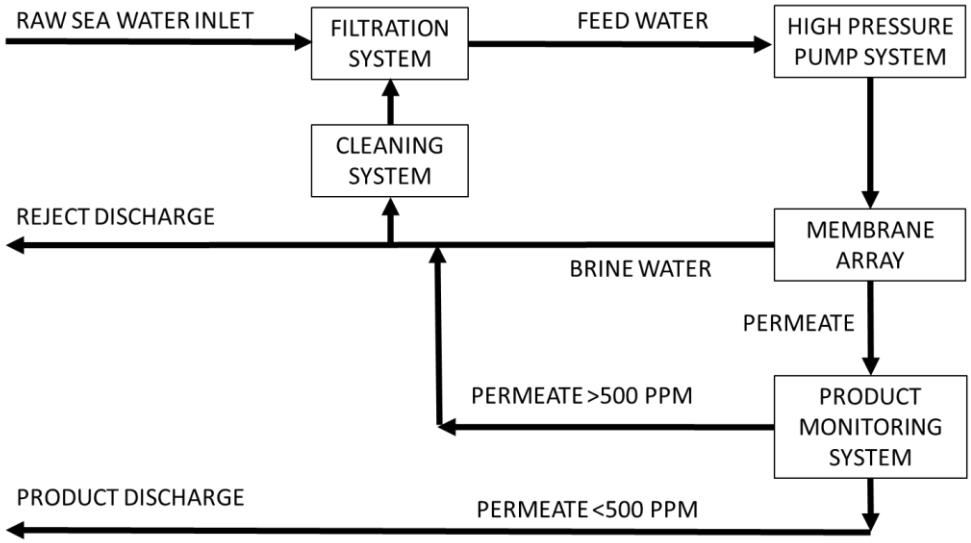


Figure 3.2: Simplified Schematic of an RO System

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%.

3.2 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 3.0 - Drinking Water Standards

3.3 FACTORS AFFECTING PERMEATE PRODUCTION

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 3.1: 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 freshwater 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.

3.4 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 3.2: Temperature Correction Factors (TCF)

3.5 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.

Callout	Description	Function
ST-1	Raw water strainer	Strains away the impurities at the initial stage
CF-1	Fresh Water Flush (F.W.F) Cartridge Housing	Housing contains the carbon filter to remove harmful chlorine from the freshwater flush process.
M1	Motor for Booster Pump	Activates booster pump
P1	Booster Pump	Provides pressure to the high-pressure pump.
FIL-1	5-Micron Pre-Filter	Filters the water below 5 microns.
PG-1	Inlet Gauge of range 0-70 PSI	Indicates inlet pressure to the oil separator.
BV1	E.T.D By-Pass Valve	By Passes Release Valve when Clogged
BV2	F.W.F By-Pass Valve	By Passes Release Valve when Clogged
RV-1	Release Valve	Automated release valve. Releases trapped air when system is shut off.
OF-1	OIL/AIR SEPARATOR	Filters out the oil and air molecules.
PT-1	Pressure Switch	Protects the high-pressure pump from low pressure.
M2	Motor for High pressure Pump	Activates high pressure pump
P2	High pressure Pump	Provides pressure to the RO membranes.
PG-2	Inlet Gauge of range 0-300 PSI	Indicates inlet pressure to the ETD.
PG-3	Inlet Gauge of range 0-1400 PSI	Indicates inlet pressure to the pressure vessels.
PV-1	Membrane Pressure Vessel	Pressure vessel that holds the RO membrane.
PV-2	Membrane Pressure Vessel	Pressure vessel that holds the RO membrane.
AE-1	Product Conductivity	Indicates the product conductivity/TDS to the HMI.
SOV-1	Solenoid Valve	Bleeds air from membrane housing.
FM-1	Flow indicator of range 0 – 2.1 LPM	Allows operator to see the product flow rate.

E1	Energy Transfer Device (E.T.D)/R.O Boost	Increases system Efficiency & Production
T1	Transducer	Electrical sensor used to determine the pressure inlet of the system

Table 3.3 – System Component and Function

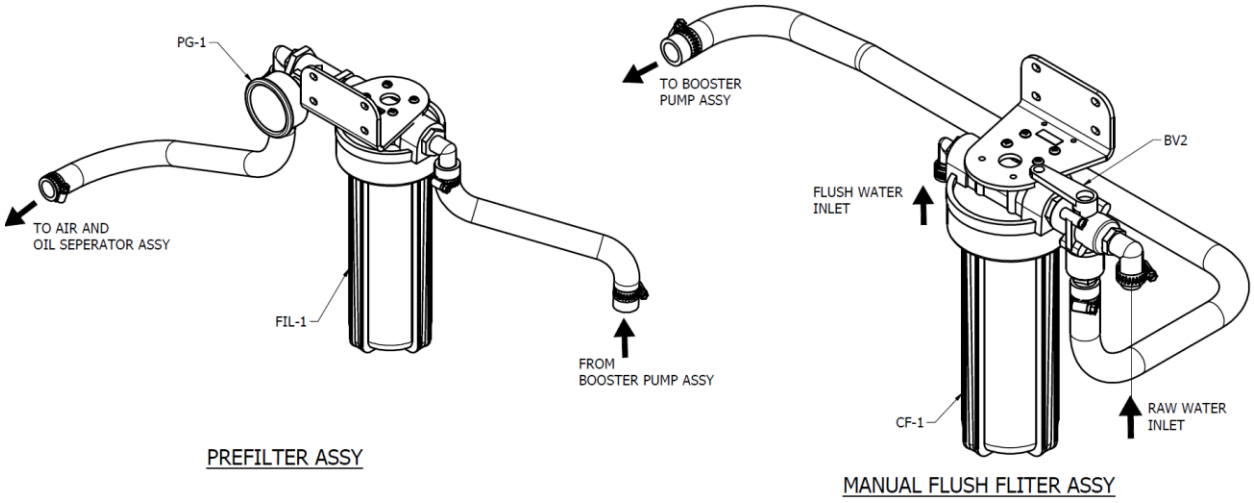


Figure 3.3: Component Callout of Prefiltration

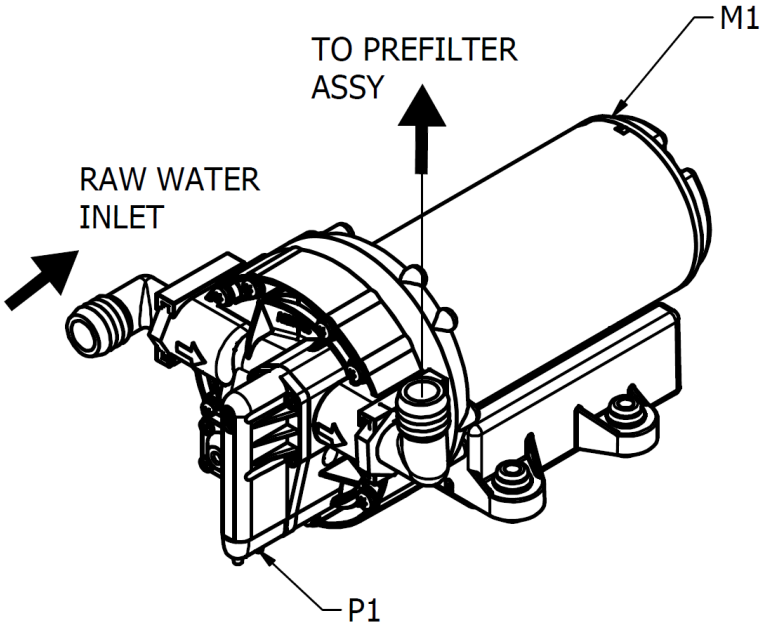


Figure 3.4: Component Callout of the Booster Pump

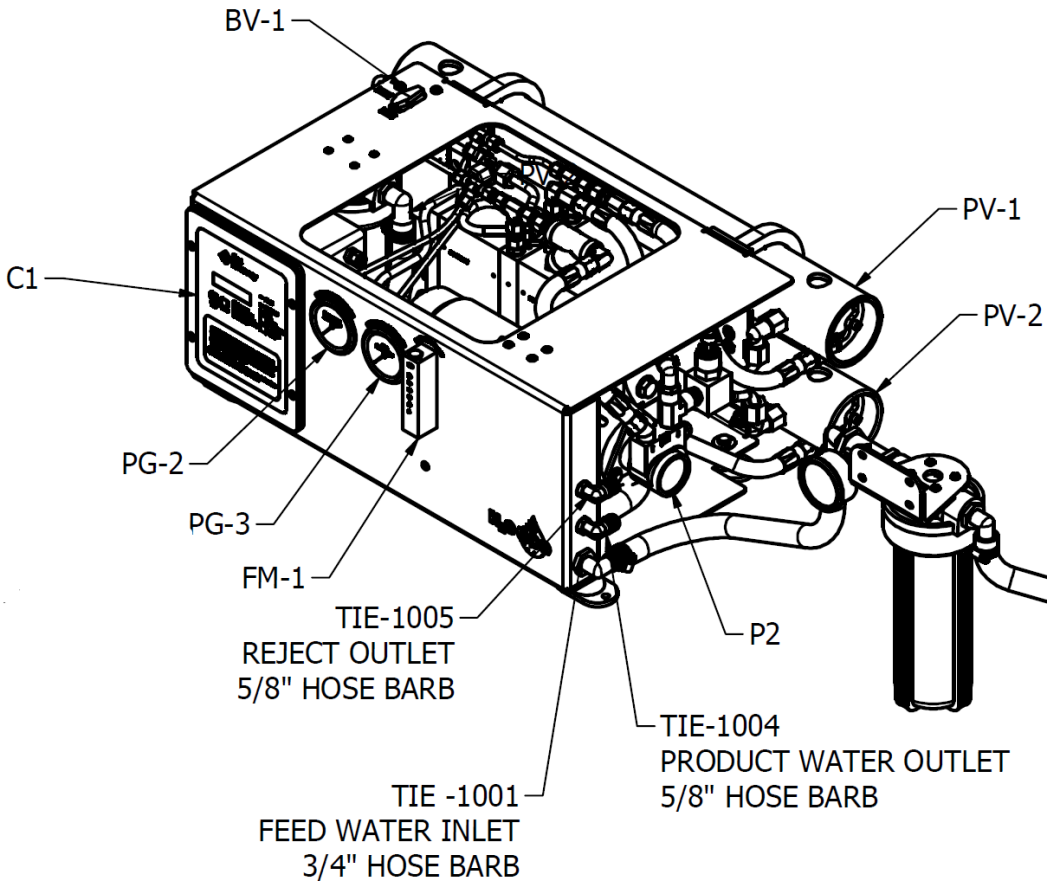


Figure 3.5: Component Callout of the RO System

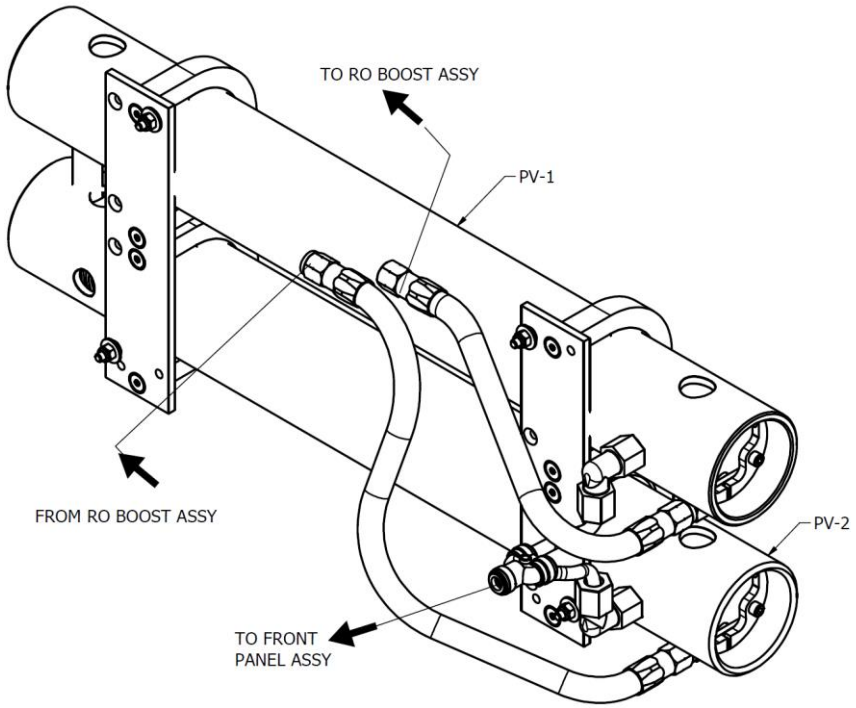


Figure 3.6: Component Callout of Pressure Vessels

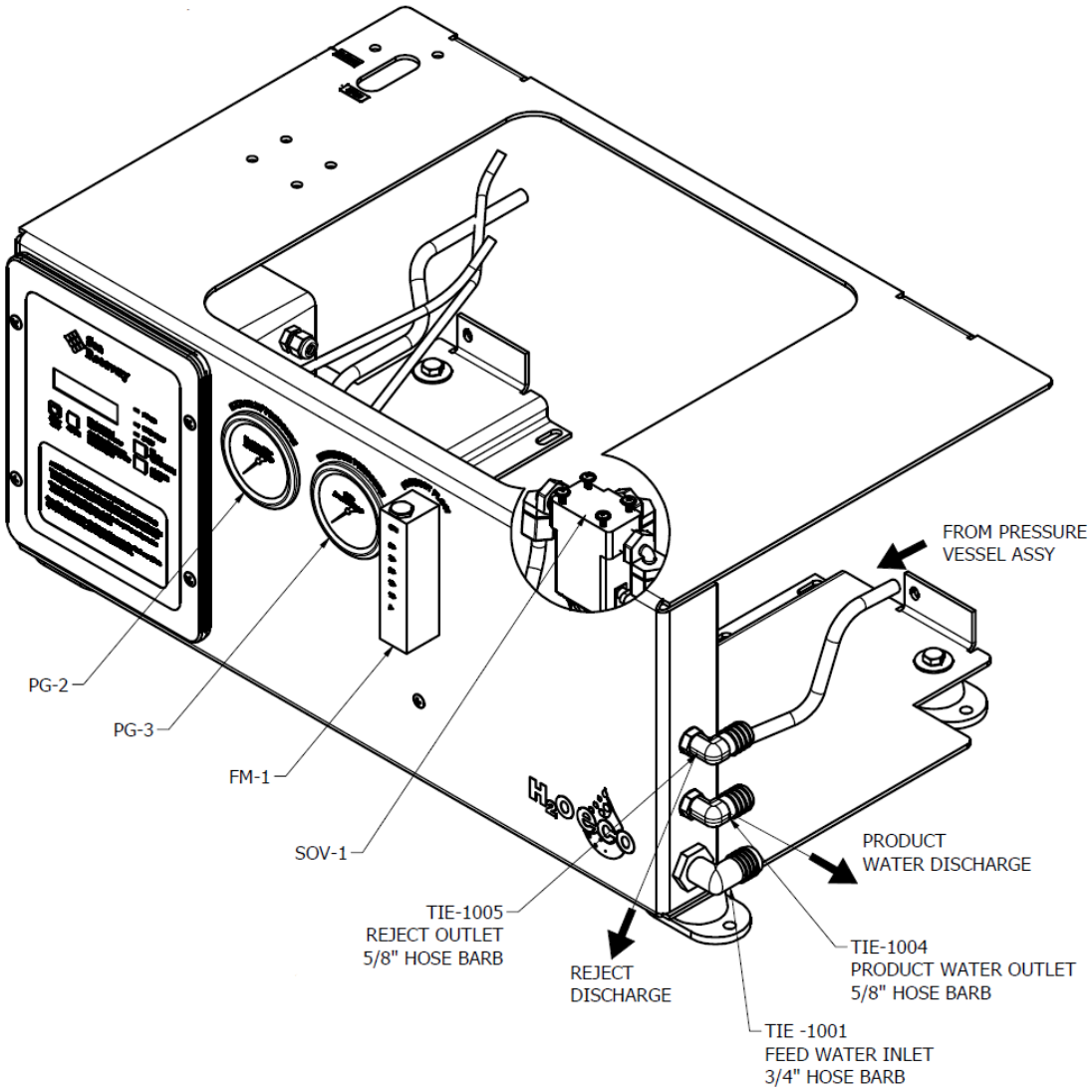


Figure 3.7: Component Callout of the RO System

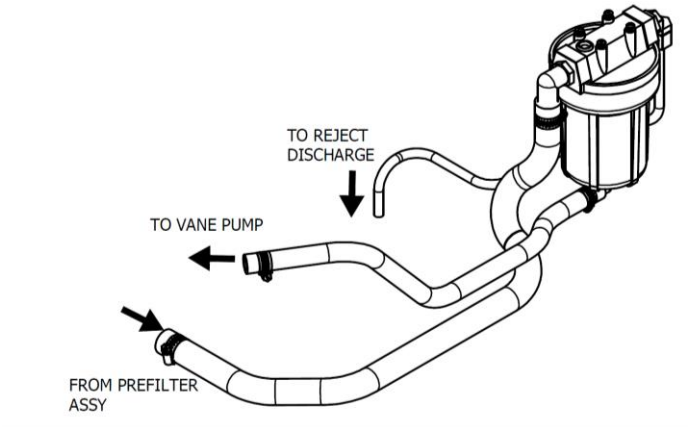


Figure 3.8: Air/Oil Water Separator

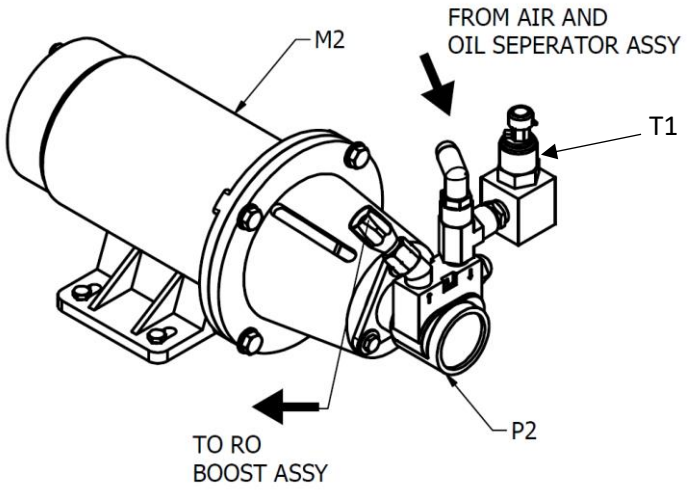


Figure 3.9: Component Callout of Main Pump & Motor

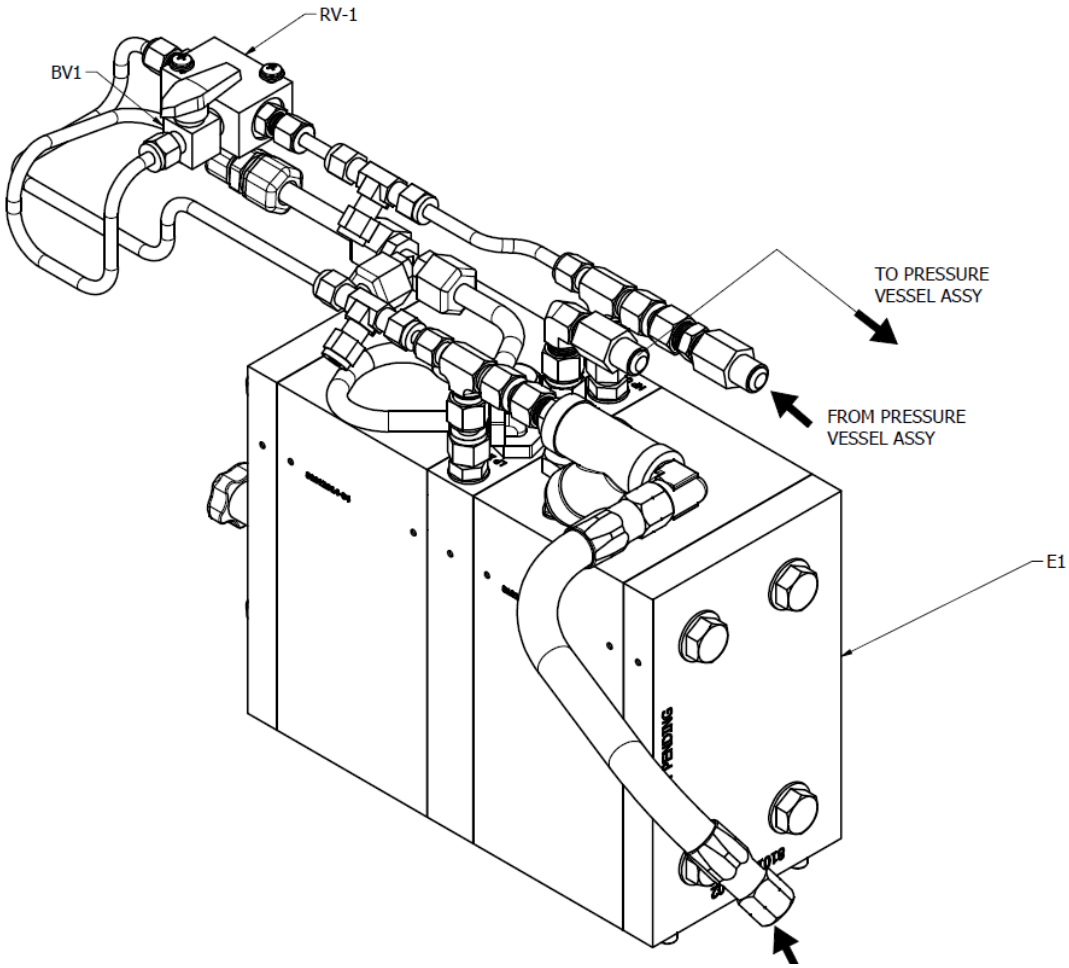


Figure 3.10: Component Callout of E.T.D/R.O Boost Assembly

3.6 RO FILTRATION SYSTEM DESCRIPTION

The raw seawater supplied flows to the booster pump were the pressure is increased to flow through the filtration section of the system.

The fresh water passes through the Freshwater Flush Filter, which is designed to reduce chlorine of the fresh water entering the unit when flushing. The filter housing consists of one carbon filter cartridge (see section 1.4). The filter also has a manual bypass valve on the top of the filter housing to diverge water coming to the unit. The raw seawater is bypassed through the valve to skip the freshwater flush filter and enter the unit.

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 inlet and discharge pressure from the filter housing are monitored by the pressure gage & transmitter, which allows the operator to determine when the filter element requires replacement.

3.7 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).*

3.8 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.

3.9 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.

3.10 FRESH WATER FLUSH SYSTEM

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

3.11 HUMAN INTERFACE (HMI)

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

Figure 3.11 – Human Interface (HMI)/Controller

3.12 Energy Transfer Device (E.T.D) / R.O Boost

The Energy Transfer Device (ETD) in combination with the High-Pressure Pump (P2) drives the raw water through the RO membranes. This energy recovery design utilizes most of the energy from the high-pressure reject stream to provide the pressure required to complete the RO process. The energy that is saved reduces the wattage requirement of the system motor, resulting up to 50% reduction of energy usage. The ETD mechanically self-adjusts so no operator adjustment is needed. The product water TDS is monitored by the monitor/controller of the unit.

CAUTION

Starting and stopping the unit in quick succession can lead to the Energy Transfer Device (ETD) being in the stuck position. When stopping the system wait 1 minute before restarting to allow ETD to vent pressure.

Ensure RV-1 releases Air when system shuts off (audible sound of air releasing should be heard)

Ensure System is flushed regularly after each use. Failure to flush system regularly can damage RV-1 and cause failure to vent pressure.

Failure for RV-1 to vent pressure can cause the Energy Transfer Device Pistons to become aligned and will require the Energy Transfer Device (ETD) to be reset.

In the event RV-1 fails to vent pressure, use manual bypass valve BV-1. See section 5.2 for instructions.

4.0 COMMISSIONING

4.1 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.
3. Install Fresh Water Flushing Filter.
4. Install Membranes.
5. Valve Alignment – See table below.
6. Ensure that the installation has been properly performed.
7. Ensure that the tube-shipping plug has been removed from the potable water outlet port of the Water Control Manifold (Compact System) or from the RO Membrane/Vessel Product Water Port (Modular System) and that all 1/4-inch and 3/8-inch product water tubes are connected.
8. Check the RO Membrane Element as described below.

NOTE

Some systems are shipped WITHOUT the RO Membrane Element. This is to accommodate, for example, boat builders who install the system well in advance of commissioning the boat and the Parker Hannifin System.

If the RO Membrane Element has been installed, there will be an Element Serial Number tag attached to the RO Membrane/Vessel Assembly. Find this serial number tag to ensure that the RO Membrane Element has been installed.

If the RO Membrane Element Serial Number tag is missing or does not contain a serial number and date, then immediately contact the company that sold the system to you or Parker Hannifin. Provide Parker Hannifin with the system serial number and model number of H2O ECO System.

CAUTION

DO NOT attempt to operate the system without a RO Membrane Element installed in the system, as extensive damage will result.

9. Ensure that the manual bypass lever located on the side of the 3-Way Product Water Solenoid Diversion Valve is positioned outward (away from the coil body).
10. Check each hose and tube connection to the system to ensure that the installer has properly connected and routed each hose and tube. Ensure that there are no kinks or blockages in any of the hoses or tubes leading to and from the H2O ECO. Improper routing and any blockage in any line causes damage to the system. *Do not rely on the installer's word; check it yourself.*
11. Make sure that the electrical power source, the boat's circuit breaker, to the system is switched "OFF."
12. Open the front panel of the Main Power Enclosure. Check all electrical and electronic connections for proper wiring and attachment.
13. Ensure that the installer has used the proper-sized power wire and Booster Pump wire.
14. Close the Main Power Enclosure front panel.
15. Open the Sea Cock Valve.
16. Open any auxiliary valve within the incoming feed line, Outgoing Brine Discharge Line and Outgoing Product Water Line.

CAUTION

Caution: Any auxiliary valve in these lines damages the Parker Hannifin System if left closed during starting and/or operation of the system.

17. If the optional Clean Rinse Valves are installed, ensure that they are positioned properly for normal operation.
18. Switch the electrical power source to the "ON" position, the boat's circuit breaker.
19. Caution: Any auxiliary valve in these lines damages the Parker Hannifin System if left closed

during starting and/or operation of the system.

20. If the optional Clean Rinse Valves are installed, ensure that they are positioned properly for normal operation.
21. Switch the electrical power source to the "ON" position, the boat's circuit breaker.
22. Perform a Feed pump motor rotational check. Ask an assistant to view the fan chapter of the Feed Water Pump Motor while "jogging" this electric motor.

NOTE

Press the "START/STOP" button; then immediately after the booster pump starts, press the "START/STOP" button. Ensure that the Feed Water Pump Electric Motor is turning in the proper rotation.

To change rotation in DC systems, reverse polarity to the electric motor by interchanging the positive and negative power leads to the motor. Then check the rotation again to ensure proper rotation.

CAUTION

Caution: The Feed pump is a very close tolerance vane pump. It requires water for lubrication. Operating this pump dry will damage it within 30 seconds. Prime the system with water up to the Feed pump inlet to ensure that it is wet prior to starting.

23. To start the system, press, the "START/STOP" button. If the system automatically shuts off immediately or after 20 seconds of operation, this may be due to a system fault. Look at the Controller to confirm whether a fault has occurred. If Error ID 2 or 3 (High /Low Pressure Error) appears on the screen, ensure that the system feed line is primed and that there is no air in the feed water line. Then, restart the system. Initial new system commissioning may require priming of the feed water up to the Feed Pump inlet and through the pre-filtration to build sufficient feed water pressure to maintain operation. Refer to the Troubleshooting Section of this manual.
24. If there are no unforeseen abnormalities, the H2O ECO pressure will automatically increase to normal operating range immediately after starting. The R.O. BOOST will increase pressure to a point at which the system produces the specified amount of product water. The next section (Production, Operating Pressure and Operating Power Consumption) lists approximate expected pressures that a new system should develop when operating in typical sea water of 35,000 PPM TDS at 77 F / 25 C. If any abnormality develops, stop the system and correct the problem.
25. Although the system is producing "product water," the "product water" may not be "potable" for up to 30 minutes. New RO Membrane Elements require operating time to flush storage chemical from the product water channel. Daily operation requires operating time to flush dissolved solids from the product water channel. The operating time required to flush the product water channel is normal for reverse osmosis systems. The salinity of the product water diminishes gradually and is measured by the salinity probe. When the salinity of the product water has diminished to the factory setting, the salinity controller will energize the 3-Way Product Water Diversion Valve. At that instant, product water will be routed to the charcoal filter, pH neutralizer and UV sterilizer onward to the potable water storage tank.
26. Check for the following:

a) A constant feed water flow.
b) A consistent system pressures.
c) Leaks in the system.
d) Unusual noises or other occurrences.

27. Complete the "**NEW SYSTEM INITIAL READINGS**" form at the end of this chapter.
28. Prior to stopping the system, determine if the system will be stored for a period of time or if it will be turned over to the owner and operated regularly. Failure to properly flush and/or store the system will lead to premature fouling or drying out of the RO Membrane Element, which is not covered by the Parker Hannifin Warranty and is the liability of the person commissioning the system.

a) If the system will be operated within the next two weeks, no action is necessary. However, if the system will be exposed to freezing temperatures, you must perform winterizing procedures. Freezing temperatures will cause extensive damage if the system is not properly protected.
b) If the system will not be operated within the next two weeks, perform a freshwater flush. If the Parker Hannifin Automatic Freshwater Flush is installed, ensure that the potable water storage tank has potable water for the freshwater flush to utilize in rinsing the system. If the system does not include an automatic freshwater flush, then perform a manual freshwater flush.
c) If the system will not be operated within the next two months or longer, perform a long-term storage operation.

CAUTION

Caution: Do not use storage chemicals in the R.O. Boost. Doing so in a short term and/or long-term storage will damage the internal of the R.O. Boost. Please follow the storage closed loop configuration for storing your system.

29. Stop the system by pressing the "START/STOP" button once. If the freshwater flush assembly is installed, the freshwater flush lamp will illuminate, intermittently blinking for 2 minutes. This time delay is to allow the R.O. BOOST to dissipate its pressure. After the 2-minute wait period, the freshwater flush automatic cycle will begin, as indicated by a steady, non-blinking illumination of the freshwater flush.
30. The freshwater flush cycle will last for approximately 10 minutes. The 10-minute cycle is adjustable from 6 to 10 minutes. After the freshwater flush cycle is complete, the freshwater flush lamp will illuminate and intermittently blink in the stand-by mode. Every 7 days, the freshwater flush rinse cycle will repeat automatically.

    If the "START/STOP" button is pressed twice, the automatic freshwater flush cycle will be cancelled, and the freshwater flush lamp will not be illuminated.

31. Close the Inlet Sea Cock Valve. This is a safeguard for vessel installations.
32. If the freshwater flush is installed and activated, do not interrupt power. If the freshwater flush is not installed or is not activated, turn off the electrical power source (circuit breaker) to the system. This eliminates the chance of inadvertently starting the system. If the power source has been turned off, the freshwater flush will not cycle every 7 days.

4.2 Pressure Changes

The system operating pressure (the pressure applied to the RO Membrane Element) varies with the feed water temperature, the feed water salinity and the condition of the RO Membrane Element. The system design specifications are based on feed water temperature of 77° F / 25° C and a feed water salinity of 35,000 PPM-TDS (parts per million-total dissolved solids). Each RO membrane element can vary +/- 15%, which will cause the final operating pressure to decrease or increase accordingly. However, assuming the "perfect RO Membrane," at this temperature and salinity the system will operate at the standard system pressure listed within the specifications at the beginning of this Owner's Manual.

If the feed water salinity increases or if the feed water temperature decreases, the system operating pressure will increase. Inversely, if the feed water salinity decreases or if the feed water temperature increases, the system operating pressure will decrease. Furthermore, if the RO Membrane Element is new or old and fouled, the system operating pressure automatically decreases or increases accordingly to overcome the RO Membrane Element condition.

NOTE

Operating amperage and operating pressure will increase if:

1. The feed water temperature is lower than 77º F / 25º C.;
2. The feed water salinity is greater than 35,000 PPM TDS (3.5% Total Dissolved Solids);
3. The RO Membrane Element becomes fouled.
4. The RO Membrane Element is new and on the minus 15% side of the specifications.

Operating amperage and operating pressure will decrease if:

1. The feed water temperature is higher than 77º F/ 25º C.
2. The feed water salinity is less than 35,000 PPM TDS (3.5% Total Dissolved Solids).
3. The RO Membrane Element is new and on the plus 15% side of the specifications.

By monitoring feed water salinity, temperature and resulting system operating pressure, it is possible to measure and monitor the fouling of the RO Membrane Element over time and use. As the feed water vane pump becomes worn from normal use, it will lose flow and the ability to build up pressure. A reduction in product water production could be caused by insufficient pressure and/or flow from the R.O Boost pump. If the R.O Boost pump becomes worn resulting in reduced pressure and/or flow, it may be returned to Parker Hannifin for rebuild or replacement. Because of the specific matching requirements of the wear parts and tight tolerance, it is not practical to repair in the field. Please refer to maintenance table.

PARKER HANNIFIN H2O ECO NEW SYSTEM INITIAL READINGS

At the time of commissioning the NEW system, record the following information after one hour of continuous proper operation of the system. Retain this form in the Owner's Manual for future reference and troubleshooting. This information is valuable to the servicing technicians in providing technical support to the owner and future operators of the H2O ECO. Provide this information to service technicians when requesting technical assistance.

Serial Number: _____

Check Model Number: _____

Compact System _____ 400; or _____ 600

Name of Operator: _____

Date: _____

Installer Information:_____

Company:_____

Street Address: _____

City, State: _____

Country, Postal Code: _____

Telephone Number: _____

Name of Installer: _____

System Power: _____Volts AC, ____Hz or ____Volts DC

Feed Water Temperature: Fahrenheit or Celsius

Hour Meter Reading: ____Hours

PRESSURE GAUGE READINGS:
E.T.D Inlet Pressure Gauge Reading: ____ PSI, ____ Bar, ____KPa, or ____Kg/Cm2 RO
Membrane/Vessel Assy Outlet Pressure Gauge Reading:
____ PSI, ____ Bar, _____KPa, or ____ Kg/Cm

TIME OF PRESSURE RELEASE
Time of pressure release after shutdown out of the entire system ____m____s (Over 2 minutes check system connections)

WATER FLOW METER READINGS:
Product Water Flow Meter: _____ US Gallons Per Hour, or _____ Liters Per Hour Brine Water Flow Meter: _____ US Gallons Per Hour, or _____ Liters Per Hour

WATER QUALITY:
Feed Water Salinity: ppm or Location of Use:

Product Water Salinity: _____ ppm
Unusual Occurrences or Noises:

_____
_____

5.0 OPERATIONS

5.1 Startup – Automatic Mode

1) Check Valve Alignment – See Table below.

Call Out	Description	Alignment
BV-1	Bypass release valve	**Always Open** during normal operation
RV-1	Differential Release Valve (RV-1)	**No Alignment needed. Automated**

Table 5.0 – Valve Alignment at Startup

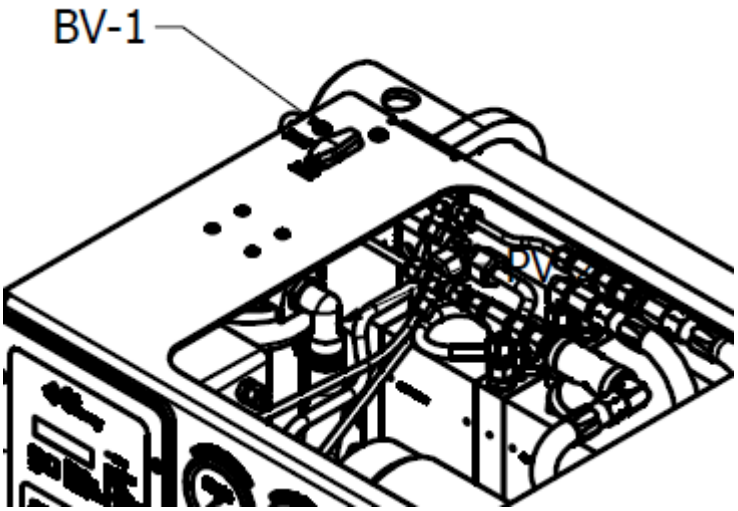


Figure 5.0: BV-1 Location

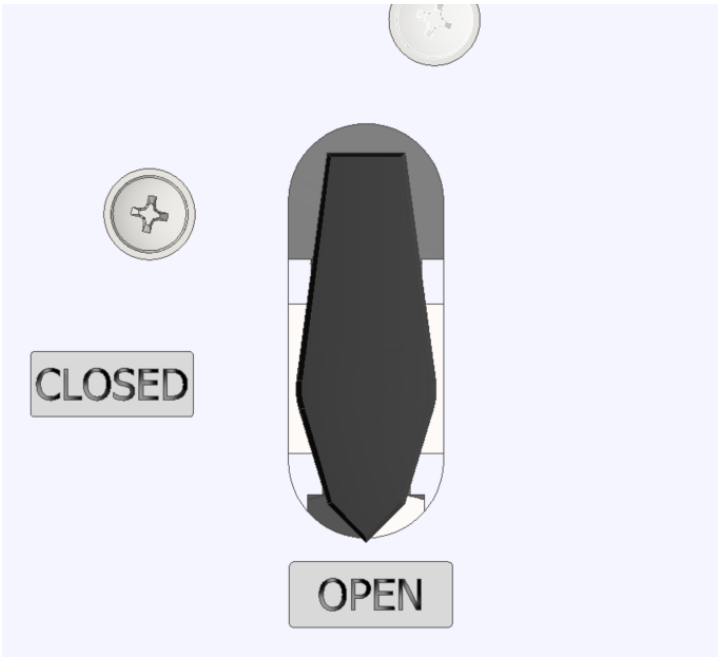


Figure 5.1: BV-1 in Open Position

2) Controller Operation:

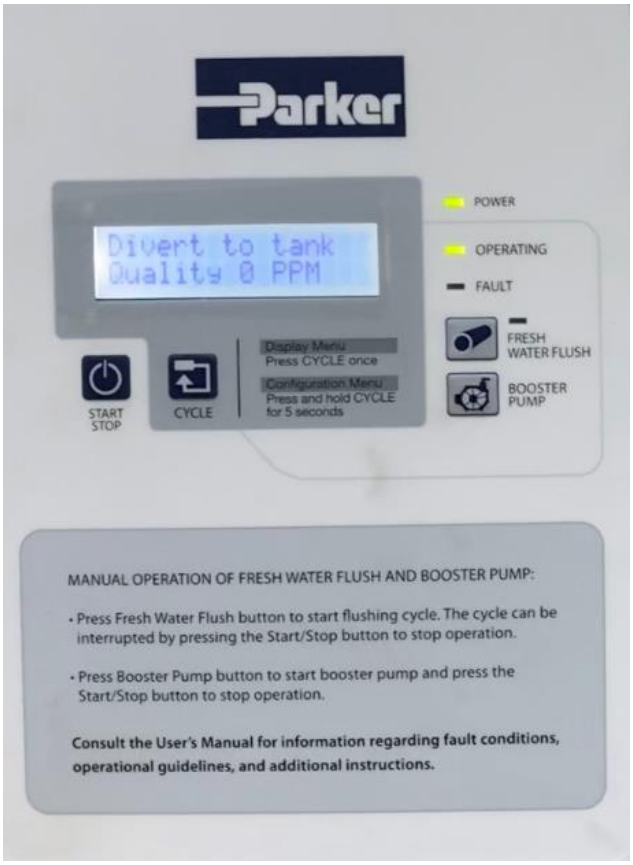


Figure 5.2 – Human Interface (HMI)/Controller

Start/Stop button

1. Powers on and sets the system in its initial state.
2. When the system is producing water and the START/STOP button is pushed, the system stops all pumps and diverts water into the sea.
3. Resets all faults.

NOTE

Note: this button performs its designated action, regardless if you are browsing a menu.

Cycle button

This button allows the operator to cycle through the process and configuration parameters.

- Press the CYCLE button once to view to view the Display Menu.
- Press and hold CYCLE for 5 seconds to view the Configuration Menu.

Display Menu

This menu monitors measured values (e.g. pressure, flow and salinity); system states (e.g. FWF, running, FWP); and timers. Press the CYCLE button once to view this menu and CYCLE again to scroll

through the menu items. Every time CYCLE is pressed, the next item is shown. If you release, and do not push the CYCLE button for more than 5 seconds, you will return to the main screen.

1. Pre-Filter Press – Inlet pressure in Bar or PSI (pre-filter inlet)
2. HP Inlet Press – Inlet pressure in Bar or PSI (High-Pressure pump inlet)
3. Membrane Press – Membrane pressure in Bar or PSI
4. Product Flow – Product water flow in l/min or GPM
5. Brine Flow – Brine flow in l/min or GPM
6. Water Quality – Salinity (water status) in ppm
7. Total Hours – High-Pressure pump/ETD hour meter (counted in seconds but shown in whole hours)
8. Tank Full–Yes or no
9. Tank Empty–Yes or no
10. Booster Relay - Booster pump on or off
11. FWF Relay – Fresh Water Flush on or off
12. HP Relay – High-Pressure pump on or off
13. DV Relay – Diversion valve on or off
14. UV Relay – Ultraviolet on or off
15. Supply Voltage – volts (used only for diagnostics)
16. Version – software version

Configuration (Change) Menu

This menu shows a list of configuration parameters that can be changed by the operator. Press the CYCLE button and hold for 5 seconds to view this menu and CYCLE again to scroll through the menu items. Every time CYCLE is pressed, the next item is shown. Holding the CYCLE button for more than 5 seconds selects the displayed menu item. Note that this menu does not allow the operator to monitor the state of these configuration parameters. Please use the Configuration (Read) Menu to do so.

1. Unit – units (metric or US)
2. Low-Pressure 1 Inst – S1 Lo pressure sensor installed (yes or no)
3. Low Press 2 Inst – S2 Lo pressure sensor installed (yes or no)
4. Prod Flow Inst – Product flow meter installed (yes or no)
5. Brine Flow Inst – Brine flow meter installed (yes or no)
6. Tank Full Inst – Tank level full sensor installed (yes or no)
7. Tank Empty Inst – Tank level empty sensor installed (yes or no)
8. FWF Delay – High-Pressure pump stop to FWF delay (HH:mm:ss)
9. Time to AutoShut – Auto shutdown after X hours in state FWP (HH:mm:ss)
10. AutoShut Time – Auto shutdown after time (yes or no)
11. AutoShut Tank – Auto shutdown on tank full (yes or no)
12. FWF Duration – FWF duration time (HH:mm:ss)
13. FWF Interval – FWF interval time (HH:mm:ss)
14. PassiveUVoff – Time from leaving fresh water production to turning UV off (HH:mm:ss)
15. UV off delay – Time from UV on to diversion valve to tank (HH:mm:ss)
16. AutoStart Tank – Autostart on tank empty (yes or no)
17. BP Delay – Time from feed pump to High-Pressure pump/ETD (HH:mm:ss)

18. Salinity Level – Salinity error level (ppm)
19. Min Pressure – minimum pressure (Bar or PSI)
20. Min Pressure Time – Min pressure measure time (HH:mm:ss)
21. Max Pressure – Maximum pressure (Bar or PSI)
22. Sol. Valve Time – Solenoid valve time (seconds)

Configuration (Read) Menu

1. This menu monitors a selected list of configuration parameters, which may be of interest to the operator (e.g. units are metric or US, FWF time interval, etc.). This menu is appended to the Display Menu.
2. Unit – units (metric or US)
3. Low-Pressure 1 Inst – S1 Lo pressure sensor installed (yes or no)
4. Low Press 2 Inst – S2 Lo pressure sensor installed (yes or no)
5. Prod Flow Inst – Product flow meter installed (yes or no)
6. Brine Flow Inst – Brine flow meter installed (yes or no)
7. Tank Full Inst – Tank level full sensor installed (yes or no)
8. Tank Empty Inst – Tank level empty sensor installed (yes or no)
9. Time to AutoShut – Auto shutdown after X hours in state FWP (HH:mm:ss)
10. AutoShut Time – Auto shutdown after time (yes or no)
11. AutoShut Tank – Auto shutdown on tank full (yes or no)
12. FWF Duration – FWF duration time (HH:mm:ss)
13. FWF Interval – FWF interval time (HH:mm:ss)
14. AutoStart Tank – Autostart on tank empty (yes or no)
15. Salinity Level – Salinity error level (ppm)
16. Min Pressure – minimum pressure (Bar or PSI)
17. Max Pressure – Maximum pressure (Bar or PSI)
18. Sol. Valve Time – Solenoid valve time (seconds)

Fresh Water Flush button

This button initiates the Fresh Water Flush (FWF) cycle. The cycle can be interrupted by pressing this button again to stop operation. Note that this button starts the FWF cycle, regardless of whether or not you are browsing a menu.

NOTE Automatic Flushing is optionally installed and connected to the controller of the unit.

Booster Pump button

Start the booster pump. Press the Start/Stop button to stop operation. Note that this button starts the booster pump, regardless of whether you are browsing a menu.

5.2 Manual Bypass

Using the Bypass Valve

The Bypass valve (BV-1) is used as a backup valve for the release valve of the unit, RV-1. The main function of RV-1 is releasing built-up air/pressure inside the Energy Transfer Device (E.T.D) after shutdown of the system. Releasing built-up air is critical for the longevity of the unit and its operation.

Call Out	Description	Alignment
BV-1	Bypass release Valve	**Always Open.** Only Closed when RV-1 is clogged, or when system is not building pressure. Manually Open when system is shutoff to bleed air.

Table 5.0 Valve Alignment

Note

System must be flushed on a regular basis after every operation to avoid clogging or damaging the release valve (RV-1). If RV-1 is damaged, it must be replaced to insure automation of the unit.

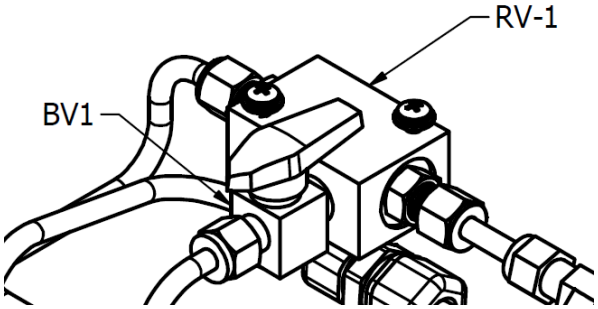


Figure 5.5: RV-1 Under the frame

CAUTION

Failing to release air of the unit could cause damage to the E.T.D. Please follow the instructions below for the scenario where using BV-1 is critical:

A) If RV-1 is clogged or if membrane pressure is not building up, please begin operation using BV-1:

1. Turn BV-1 to Closed position.
2. Turn on System, Pressure should begin to build up on the membrane pressure gage (PG-3).

B) To Turn off system using BV-1:

3. Shut off system
4. **Turn knob back to Open** to release air/pressure built up in the unit.
5. Repeat process A) & B) for next operation

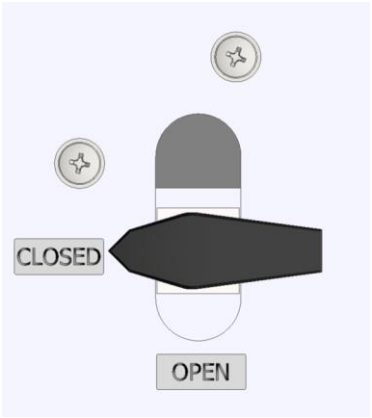


Figure 5.3: BV-1 closed if RV-1 is clogged

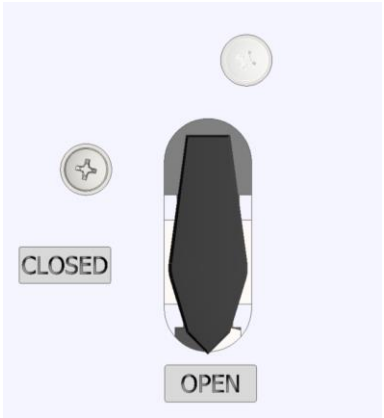


Figure 5.4: BV-1 in Open Position to release Pressure

6.0 MAINTENANCE & REPAIR

6.1 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 (300 HRS)	As Required	HMI Alert	Labor Hours (approximate)
Fresh Water Flush	•								0.1
Replace micron filter(s)							•		0.2
Fresh Flush Charcoal Filter Replacement							•		0.1
E.T.D						•			3.0
Air/Oil Separator Orifice						•			0.2
Sea Strainer					•				0.2
Inspect and clean Y Strainer						•			0.2
Inspect High-Pressure Pump (P2) for leakage						•			0.1
Replace membranes							•		1.0
Clean membranes							•		2.0
Transducer							•		0.1

Table 6.0 - Maintenance Task Chart

6.2 MICRON FILTER ELEMENT REPLACEMENT

The 5-micron Prefilter elements (FIL-1) should be replaced when the differential pressure across the filter and inlet of the system exceeds 15 psi (1 BAR). A shutdown alarm will occur on the inlet of the unit when pressure is under 5 psi (0.35 BAR).

7.0 TROUBLESHOOTING

Note

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

7.1 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.

7.2 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.

7.3 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.

7.4 HIGH PRESSURE PUMP

1) Noisy or runs roughly

2) Leaks water.

3) Not developing enough pressure

Refer to Troubleshooting Guide in 7.8.

7.5 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.

7.6 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 gauge if damaged.

7.7 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 unlocking the tubes from the tee connecting the product water. 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.

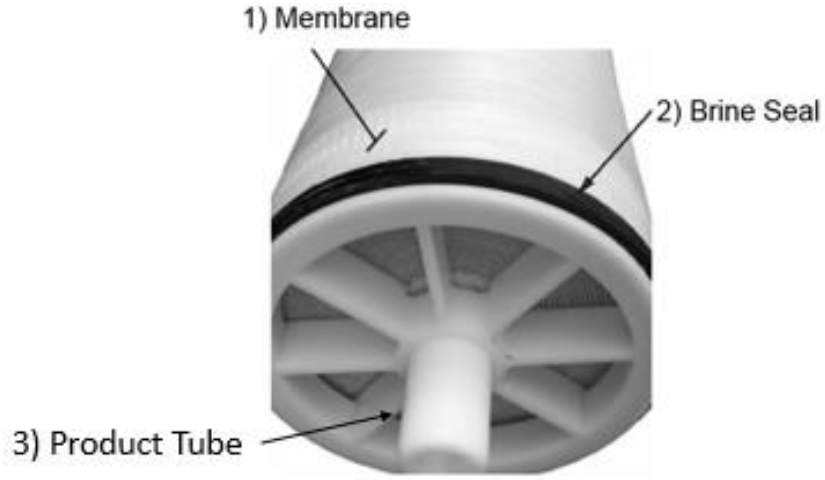


Figure 7.0 – Membrane

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.

7.8 Energy Transfer Device (E.T.D) Troubleshooting

Understanding how the E.T.D (E1) functions allows the operator to determine the problem and how to solve it.

The E.T.D is made up of two components: The Energy Transfer Device Block (E1) and the Release Valve (RV-1). The E.T.D boosts the pressure from the High-Pressure Pump (P2) into the Membrane Vessels (PV-1 & PV-2). The Release Valve releases pressure trapped in PV-1 & PV-2 upon shutdown. **Remember, the release of this pressure is very important upon shutdown**. The pressure release can be observed on pressure gages PG-2 & PG-3 (see sec. 3.4). The pressure should go down to zero on the gages at shutdown.

Note

If the system is unable to build membrane pressure during startup, RV-1 is likely stuck open. This damage is usually caused by lack of freshwater flushing. BV-1 will have to be used manually as a backup valve and RV-1 will have to be replaced. Please refer to section 5.2 for instructions on using BV-1.

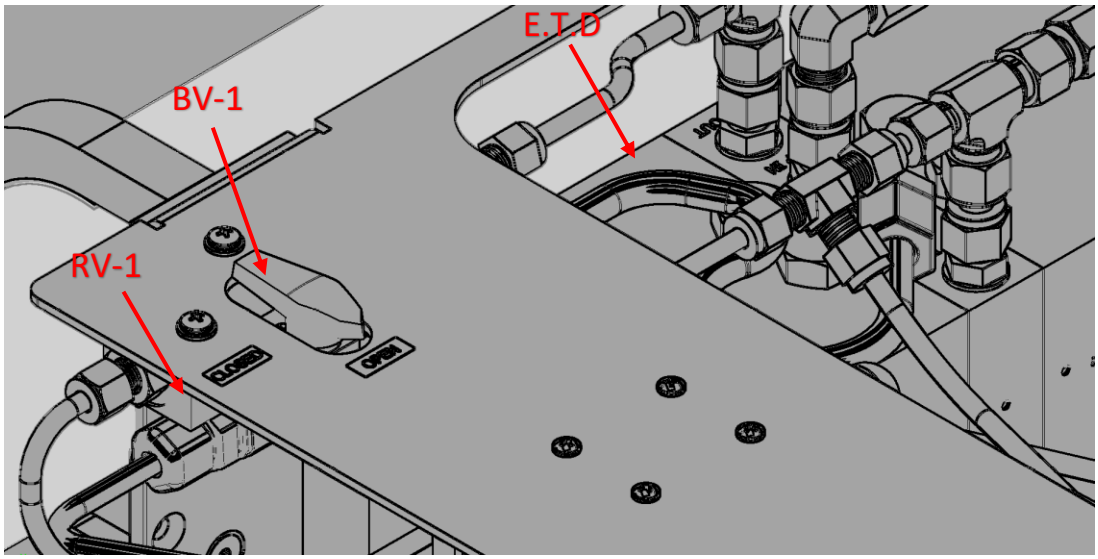


Figure 7.1 Energy Transfer Device (ETD), BV-1, RV-1 (under BV-1)

CAUTION

If BV-1 is not opened upon shutdown, the pressure from the Membrane Vessels (PV-1 & PV-2) could cause the pistons inside the Energy Transfer Device (ETD) to become aligned. If pistons become aligned on start-up, the E.T.D Inlet Membrane gauge (PG-2) will exceed 200 psi and will have no recognizable pulses. The E.T.D will require resetting.

Resetting the E.T.D:

1. Shutdown system.

2. Using appropriate tools to remove the plugs on top of the ETD.
3. Push in reset handle completely.
4. If no torque wrench is available, use the supplied tools. Reinstall plugs finger tight.
5. Using the wrench, apply a ¼ turn. Start system. If plug leaks, apply another 1/8 of a turn. If plug continues to leak, repeat 1/8 turn. Do not exceed three times. If torque wrench is available, torque to 15 ft-pounds.
6. This will allow the pistons to be offset and will start correctly.

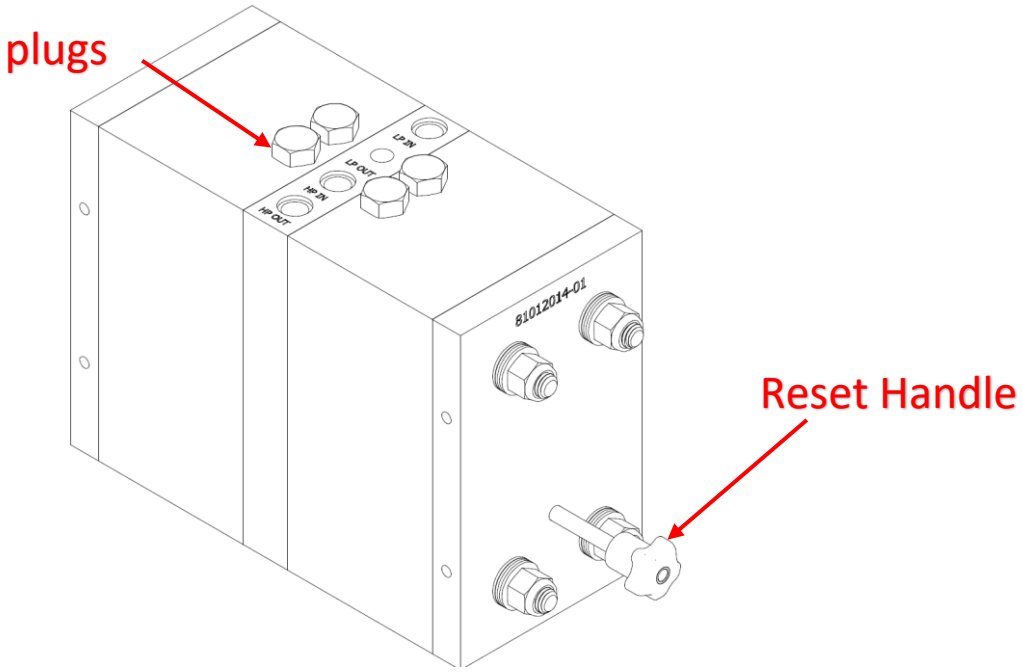


Figure 7.2 Energy Transfer Device (ETD)

E.T.D Plumbing:

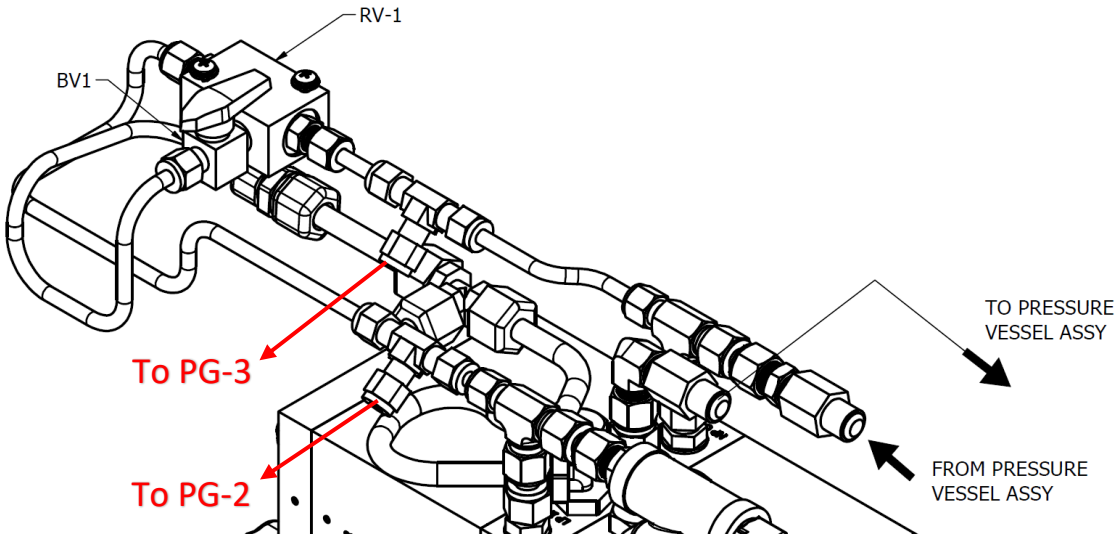


Figure 7.3 Energy Transfer Device (ETD) Plumbing

7.9 GENERAL TROUBLESHOOTING GUIDE

Table 7-1. Troubleshooting Guide

Symptom	Possible Cause	Corrective Action
Leaks at fittings.	1. Loose connections. 2. Worn or damaged O-rings. 3. Damaged fittings. 4. Damaged hose or tubing	1. Tighten fittings. 2. Replace damaged O-rings. 3. Replace damaged fittings. 4. Reapply Teflon tape, as necessary. 5. Replace damaged hose or tubing.
Booster Pump (P1) does not turn on.	1. No power to system. 2. Loose electric connection. 3. Booster Pump (P1) cable/connector damaged. 4. No power to Booster Pump (P1). 5. Malfunctioning Booster Pump (P1).	1. Check for proper power supply. 2. Tighten electrical connections. 3. Inspect Booster Pump (P1) cable/connector for damage. If damaged, replace Booster Pump (P1). 4. Check for proper voltage. If no voltage, see next steps. 5. Check Fuse. If blown replace. If fuse is replaced & problem is apparent. Replace Booster Pump (P1).
Low-Pressure at System Error System Filter Inlet Pressure < 15 psi. System does not stay on when Booster Pump (P1) is turned on.	1. Booster Pump (P1) hose not connected. 2. Clogged Booster Pump (P1) Screen. 3. Raw water hose is kinked or blocked. 4. Difference in height between Booster Pump (P1) and Main System is greater than 15ft (4.5 m). 5. 5-micron filter need to be cleaned. 6. Transducer (T1) is not functioning.	1. Ensure Booster Pump water hose is connected. 2. Clean Booster Pump (P1) Screen. 3. Unkink or unblock raw water hose. 4. Check location and try to relocate Booster Pump (P1) closer to main system. 5. Replace 5-mircon filter element. 6. Check Transducer Electrical Connection. Check fitting. Replace Transducer (T1) if broken.
Low-Pressure at 5 Micron Prefilter (FIL-1). 5-Micron Outlet (FIL-1) < 15 psi	1. 5-Micron Cartridge Filters are plugged.	1. Change 5-Micron Cartridge Filter. Pressure expected range is between 35–60 psi at PG-1.

Table 7-1. Troubleshooting Guide (Cont.)

Symptom	Possible Cause	Corrective Action
Low-Pressure at E.T.D Inlet Gage (PG-2). HP Pump Outlet (PG-2) pressure is <100 psi. System & Filter Inlet and Prefilter Gage (PG-1) are in expected range of 30-60 psi.	1. Release Valve stuck open (RV-1). 2. In-Line Strainer (ST-1) leaking. 3. High-Pressure Pump (P2) making noise 4. Energy Transfer Device (ETD) malfunctioning. 5. High-Pressure Pump (P2) is not making sufficient pressure due to damaged or worn seals. High-pressure pump (P2) failure.	1. Use Bypass Valve (BV-1) to operate manually (see section 5.2). Clean RV-1 if clogged, replace if damaged. 2. Check for leaks in In-Line Strainer (ST-1). 3. Trapped air in High-Pressure Pump (P2). Release air by preferred method. 4. Check Energy Transfer Device ETD troubleshooting (Sec 7.8). 5. Replace High-Pressure Pump (P2).
Low-Pressure at Element Inlet (PG-3). Element Inlet (PG-2) pressure <600 psi using seawater. Element Inlet (PG-2) pressure <100 psi using freshwater. System & Filter Inlet and Prefilter Gage (PG-1) are in expected range of 30-60 psi. HP Pump Outlet (PG-2) at 100-200 psi.	1. Release Valve stuck open (RV-1). 2. In-Line Strainer (ST-1) leaking. 3. High-Pressure Pump (P2) making noise. 4. Energy Transfer Device (ETD) malfunctioning. 5. Check if High-Pressure Pump (P2) is not making sufficient pressure. High-pressure pump (P2) failure.	1. Use Bypass Valve (BV-1) to operate manually (see section 5.2). Clean RV-1 if clogged, replace if damaged. 2. Check for leaks in In-Line Strainer (ST-1). 3. Trapped air in High-Pressure Pump (P2). Release air by preferred method. 4. Check Energy Transfer Device (ETD) troubleshooting. 5. Replace High-Pressure Pump (P2).
Product Flow FM-1 is <15 GPH using seawater or <17 GPH using freshwater. System & Filter Inlet and Prefilter Gage (PG-1) are in expected range of 30-60 psi. HP Pump Outlet (PG-2) at 100-200 psi. Element Pressure expected > 600 PSI (PG-3)	1. Voltage or Amperage low 2. Raw water TDS in excess of 45,000 PPM or < 60 ºF (15 ºC). 3. Product Flow (FM-1) stuck. 4. Membrane Vessels (PV-1 & PV-2) have degraded. 5. Energy Transfer Device (ETD) seals have degraded.	1. Check Power to System. 2. Outside of system parameters – degraded water production expected. 3. Clean Product Flow (FM-1). 4. Replace Membrane for (PV-1 & PV-2). 5. Replace Energy Transfer Device (ETD).
High-Pressure Pump (P2) will not start. Or will shutoff while Booster Pump (P1) is operational. Prefilter Gage (PG-1) is in expected range of 30-60 psi.	1. No signal from transducer (T1), or no pressure input. 2. Control Knob (CK) is damaged. 3. High-Pressure Pump Motor (M2) is damaged.	1. Check T1 connections or electrical damage. Replace if damaged. 2. Replace High-Pressure Pump Motor (M2).

Table 7-1. Troubleshooting Guide (Cont.)

Symptom	Possible Cause	Corrective Action
High-Pressure Pump (P2) is noisy or runs roughly.	1. Air in or entering the system. 2. Loose bolts hold High-Pressure Pump (P2) Adapter. 3. Damaged High-Pressure Pump (P2).	1. Vent air by untightening one of the fittings and retightening it. 2. Tighten bolts holding high-pressure pump (P2) to Motor adapter. 3. Replace High-Pressure Pump (P2).
High-Pressure Pump (P2) leaks water.	1. Damage, corrosion, or worn seals.	1. Pump failure, replace High-Pressure Pump (P2).
Energy Transfer Device (ETD) runs (pulses are present) but does not build pressure.	1. Excessive air entering the system. 2. Air trapped in Energy Transfer Device (ETD) (Note: HP Pump Outlet (PI3) will bounce a little bit during normal operation). 3. In-Line Strainer (ST-1) plugged. 4. High-Pressure Pump (P2) not making sufficient pressure. High-Pressure Pump (P2) failure.	1. Check Booster Pump (P1) and ensure it is submerged, screen is clean and hoses connected. 2. Vent air opening and closing Air Vent Valve. 3. Clean In-Line Strainer (ST-1). 4. Replace High-Pressure Pump (P2).
Energy Transfer Device (ETD) leaks from block.	1. Low temperature water.	1. Tighten bolts. Torque value is 65 ft-lbs. (13 N-m). If no torque wrench available, tighten 1/8 turn.
Energy Transfer Device (ETD) does not build pressure, HP Pump Outlet (PG-2) is < 20 psi.	1. Release Valve (RV-1) stuck open, or damaged. 2. Internal check valve spring broken or damaged preventing check valve from closing.	1. Use Manual Bypass Valve (BV-1). See section 5.2. Clean/unclog RV-1 or replace if damaged. 2. Replace Energy Transfer Device (ETD).
Energy Transfer Device (ETD) does not build pressure, E.T.D Inlet Gage (PG-2) reads < 100 psi in seawater conditions.	1. Release Valve (RV-1) is stuck open. 2. Energy Transfer Device (ETD) is malfunctioning.	1. Use Manual Bypass Valve (BV-1). See section 5.2. Clean/unclog RV-1 or replace if damaged. 2. If Release Valve (RV-1) is functioning replace Energy Transfer Device (ETD).
Energy Transfer Device (ETD) does not build pressure, Membrane Pressure gage (PG-3) reads < 150 psi in seawater conditions.	1. Energy Transfer Device (ETD) seal worn.	1. Replace Energy Transfer Device (ETD).
HP Pump Outlet (PG-2) >200 psi. Energy Transfer Device (ETD) has no recognizable pulses.	1. Energy Transfer Device (ETD) pistons are stuck in center position.	1. Use reset handle to push piston to one side. See Section 7.8.

Table 7-1. Troubleshooting Guide (Cont.)		
Symptom	Possible Cause	Corrective Action
Lightweight Membrane Vessels (LMVs) producing water quality outside of water quality criteria for TDS salt rejection, arsenic, or cyanide.	1. Raw water temperature above 100ºF (38 ºC). 2. Membranes will degrade over time. If the membranes have been installed for more than one year and are fouled, this can cause high TDS. It generally is accompanied by low product flow.	1. Membrane maximum design temperature of 100ºF (38 ºC) has been exceeded, degraded performance should be expected. 2. Refer to Section 3-5 criteria for Lightweight Membrane Vessel (LMV) replacement. Replace Lightweight Membrane Vessel (LMV).

Controller Troubleshooting

Error ID 1: High Pressure Fault

System produces expected product water flow with normal operating pressure after compensating for feed Water seconds.

- We recommend using a portable TDS meter to determine if the problem is with the RO Membrane Element or with the Salinity Probe and Electronic monitoring system.
- A damaged or worn Product Water O-ring at one of the End Plugs within the High-Pressure Vessel is allowing Feed Water to mix with Product Water, which would typically result in higher than normal Product Water Flow. However, a small nick in the O-ring may allow enough Feed Water to mix with the Product Water to cause the condition without resulting in a noticeable increase in Product Water Flow.
- A crack in one of the End Plugs within the High-Pressure Vessel is allowing Feed Water to mix with Product Water, which would typically result in higher than normal Product Water Flow. However, a small crack may allow enough Feed Water to mix with the Product Water to cause the condition without resulting in a noticeable increase in Product Water Flow.
- RO Membrane Element is fouled due to normal use and requires cleaning.
- Salinity Probe has debris on the probe causing the system to read poor water quality. Clean the Salinity Probe with a toothbrush

Error ID 2: High Pressure Fault

If the High-Pressure Sensor increases beyond 950 PSI and the System shuts down, press the "Start/Stop" button. A high-pressure fault can be caused by:

- Low Temperature Feed Water
- High Salinity Feed Water
- Fouled RO Membrane Element
- Blockage in the Brine Discharge Line

- Blockage in the Product Water Line

Error ID 3: High Pressure Fault

A low-pressure fault can occur when the following conditions occur:

- The value at the Low-Pressure Sensor is below 4 PSI for more than 20 seconds
- The Low-Pressure Sensor is disconnected or malfunctioning
- The value at the High-Pressure sensor is below 4 PSI for more than 20 seconds
- The High-Pressure Sensor is disconnected or malfunctioning

To troubleshoot, check for the following:

- Cock Valve must be fully open
- Air suction leaks at all components and fittings prior to the Feed Pump
- Whether or not the Sea Strainer Mesh Screen is clean (no manufacturing or installation debris) and if air suction leaks are present
- Whether or not the Pre-filter Element is clean (no manufacturing or installation debris)
- Whether or not the Plankton Filter Element is clean (no manufacturing or installation debris)
- No kinks, blockages, or air suction leaks in the inlet line
- The Feed Pump is operational and delivering flow and pressure
- Whether or not the Inlet Thru-Hull Fitting is clean (no manufacturing or installation debris) and if air suction leaks are present
- Caulking compound within the opening
- Shipping cover or tape below the hull in the water
- Casting slag on the “fingers” below the hull in the water or within the orifice
- Plastic bag or other debris in the water below the hull in the water.

Error ID 4: High Pressure Fault

Check system voltage inside the Control Panel. The system must receive adequate voltage at start up and during operation for normal operation. DC systems will shut down by design when the voltage falls below:

- 12 VDC Systems: 10.5 VDC
- 24 VDC Systems: 21.5 VDC

Loud or Whining Pump

Loud or whining pump is common after long use. The cause of the loud noise is a drop motor rpms or cavitation. If the pump is cavitating, check for clogs, kinks, or dirty sea-strainer. If the noise still persists, check motor supply voltage at the system source and at the motor. If there is not enough supply voltage, it will cause the motor to run at a lower rpm.

Remaining Pressure in the System After Shut Down

Caution: Do not open pressurized high-pressure water lines to relieve pressure in the system. Doing so may cause bodily injury.

- The orifice mounted in the air/oil separator maybe clogged and need to be cleaned or replaced. Debris or biological matter may be clogging up the orifice hole. Use rubbing alcohol and compressed air to clean the orifice. After cleaning, if there is degradation (pitting) to the orifice, then replace the orifice (refer to exploded parts views in chapter 12).
- Check all brine line for kinks or blockages. If there is an auxiliary valve on the brine line, make sure it is fully open. Do not close auxiliary valves until system is done with the freshwater flush.
- Make sure the brine discharge thru hull is not shared with any other system on the boat. When the brine thru hull fitting shared with another system it will restrict the brine discharge causing a slow bleed off of pressure, this causes pressure to remain in the system longer than it should.
  Brine line being used is too small for where the system is mounted on the boat and how long of a brine discharge line is. The brine line might be too restrictive causing pressure to release at a slow rate.

8.0 DRAWINGS & DATASHEETS

1- Energy Transfer Device (ETD) Spare Parts:

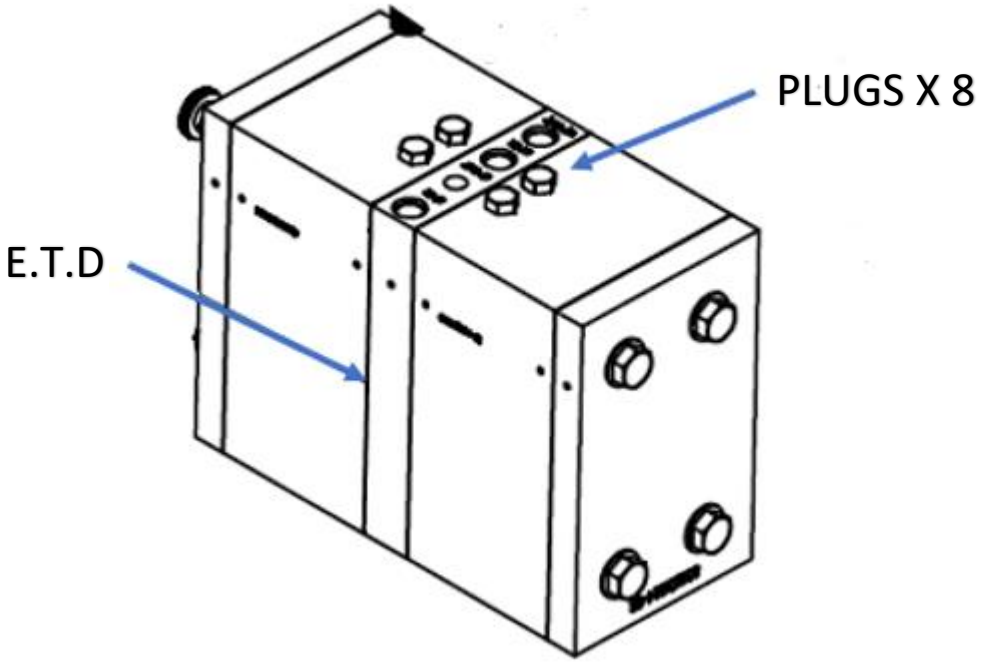


Figure 8.1: Energy Transfer Device (ETD) Reset Handle

Callout	Description	Quantity	Part No.
3	E.T.D, WT,MANUAL RESET	1	81012014
-	PLUG	8	16012269
-	O-RING PLUG	8	30-2077

Table 8.1: Energy Recover Device (ETD) Parts List

2- E.T.D ASSY:

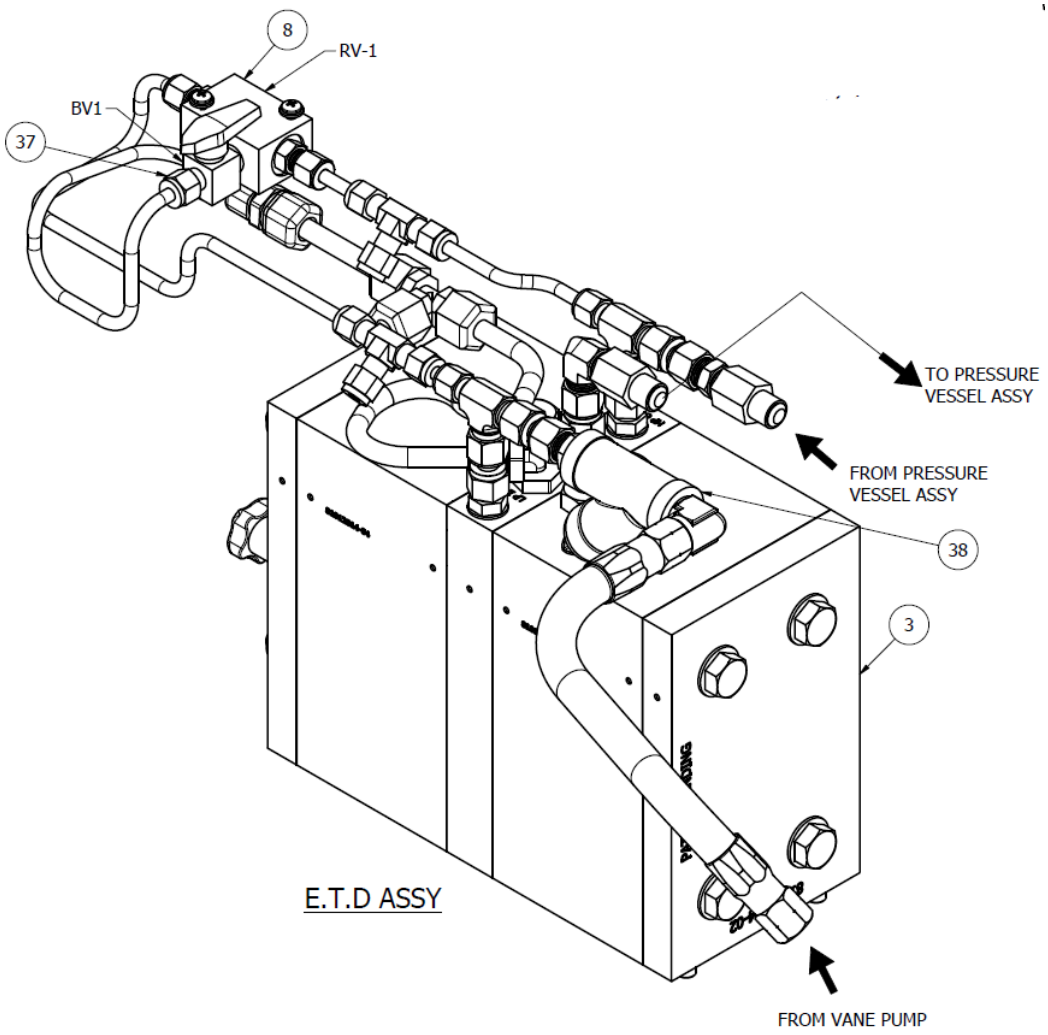


Figure 8.2: E.T.D ASSY

Callout	Description	Quantity	Part No.
7	E.T.D, WT,MANUAL RESET	1	81012014
38	Y-Strainer	1	0101005

Table 8.2 RV-1 Parts List

3- Release Valve Assembly:

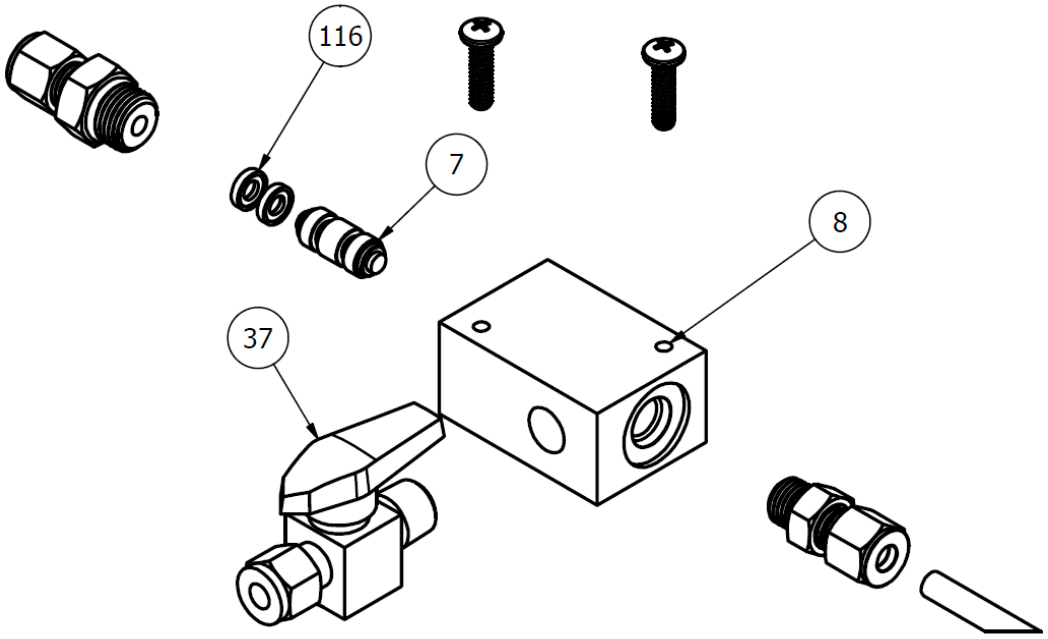


Figure 8.3: Release Valve (RV-1) & Bypass Valve (BV-1) Assembly

Callout	Description	Quantity	Part No.
7	Release Valve Regulator	1	81012014-12
8	Release Valve Block	1	81012014-13
37	Bypass Valve	1	60-0069
116	Release Valve Seal	2	17012088

Table 8.4: RV-1 Parts List

4- P&ID:

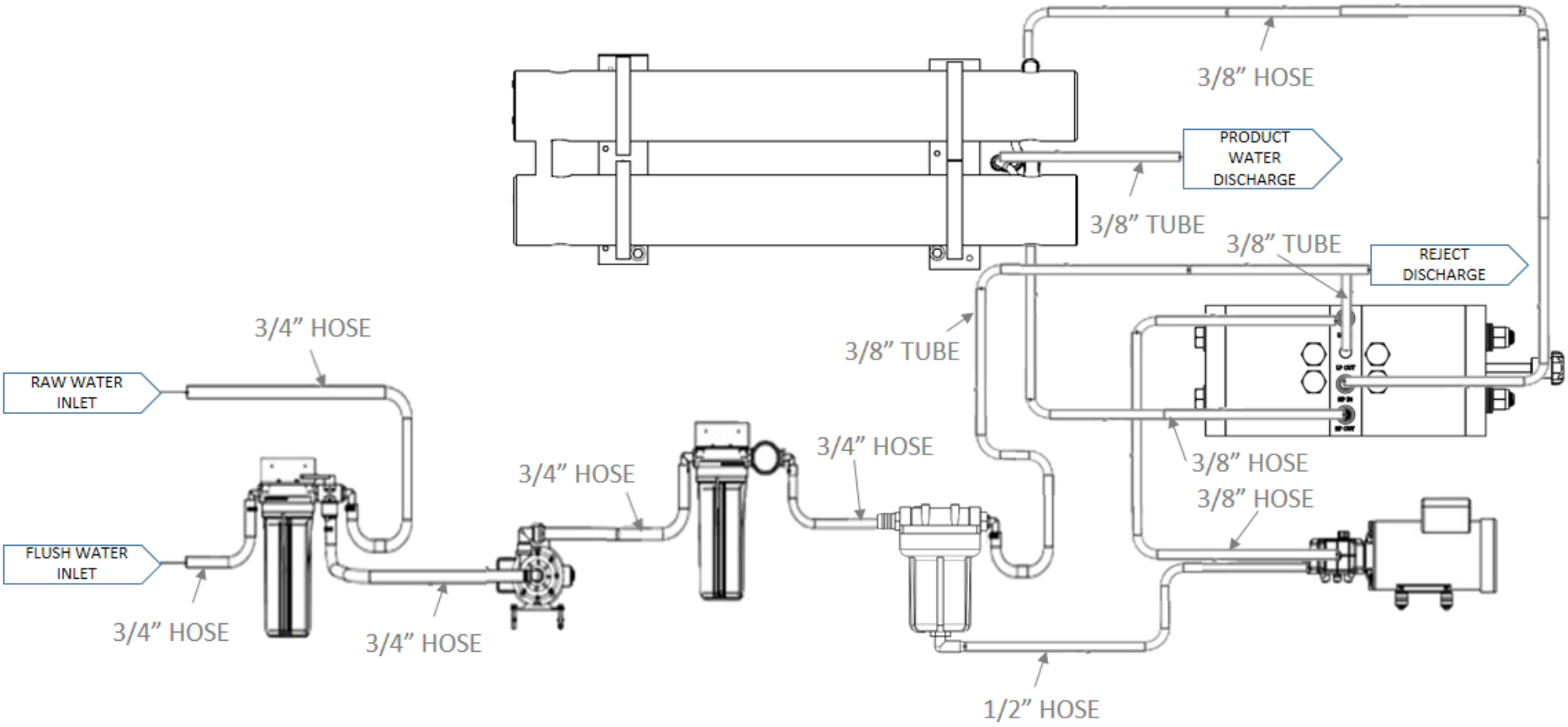


Figure 8.4: PIPING AND INSTRUMENTATION DIAGRAM

5- General Arrangement

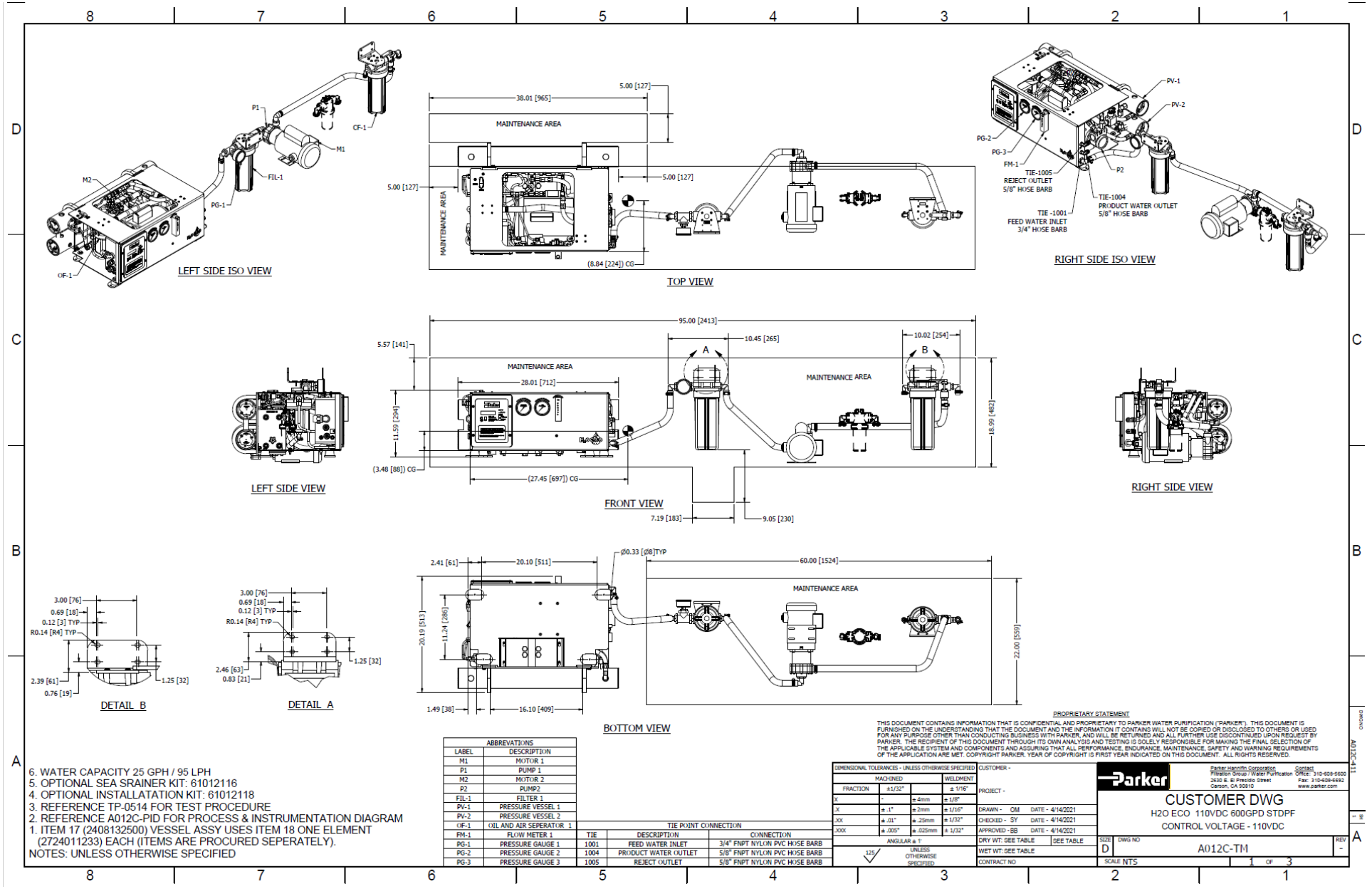


Figure 8.5: GENERAL ARRANGEMENT DRAWING

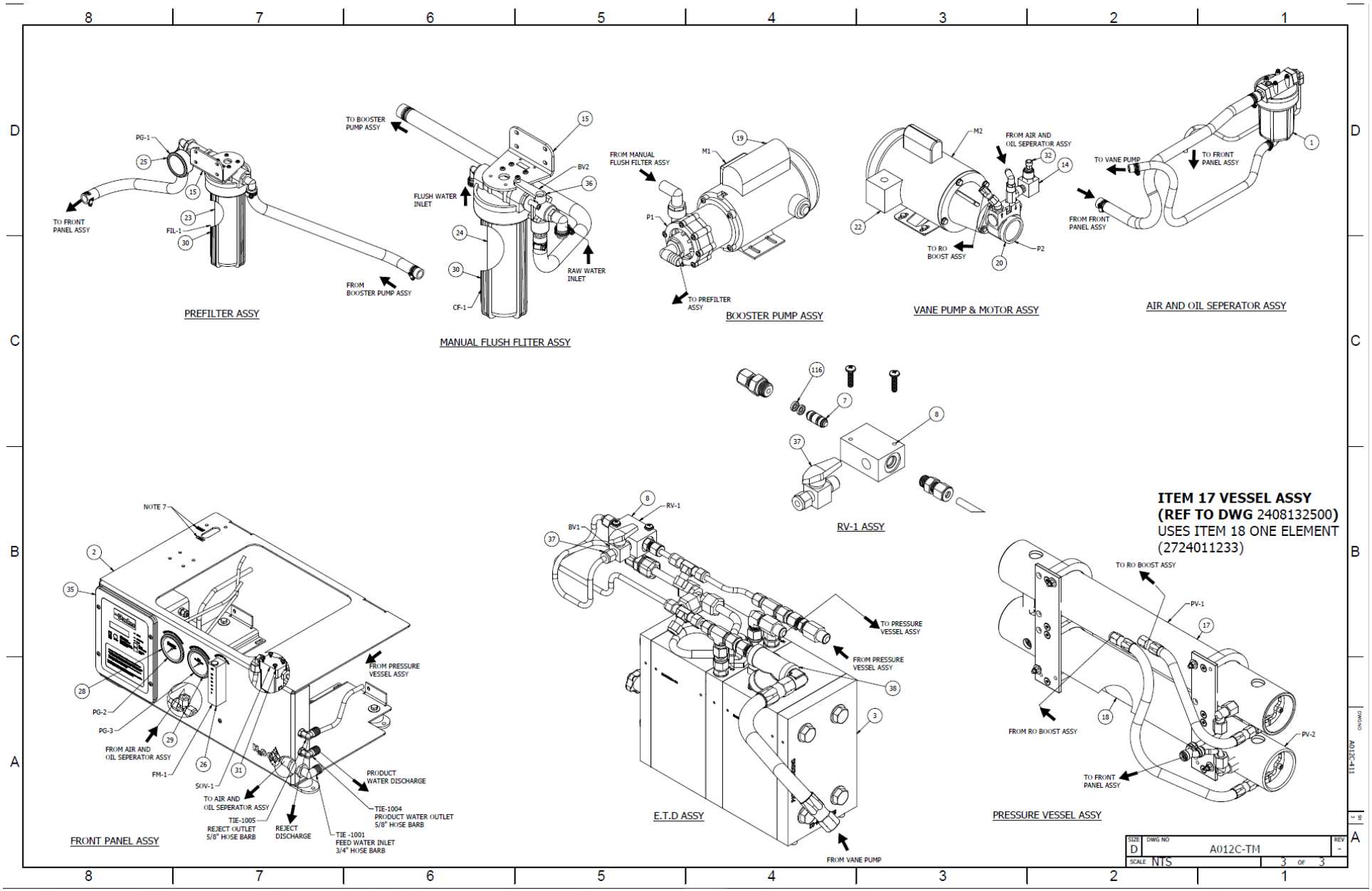


Figure 8.5: GENERAL ARRANGEMENT DRAWING

6- All Spare Parts List:

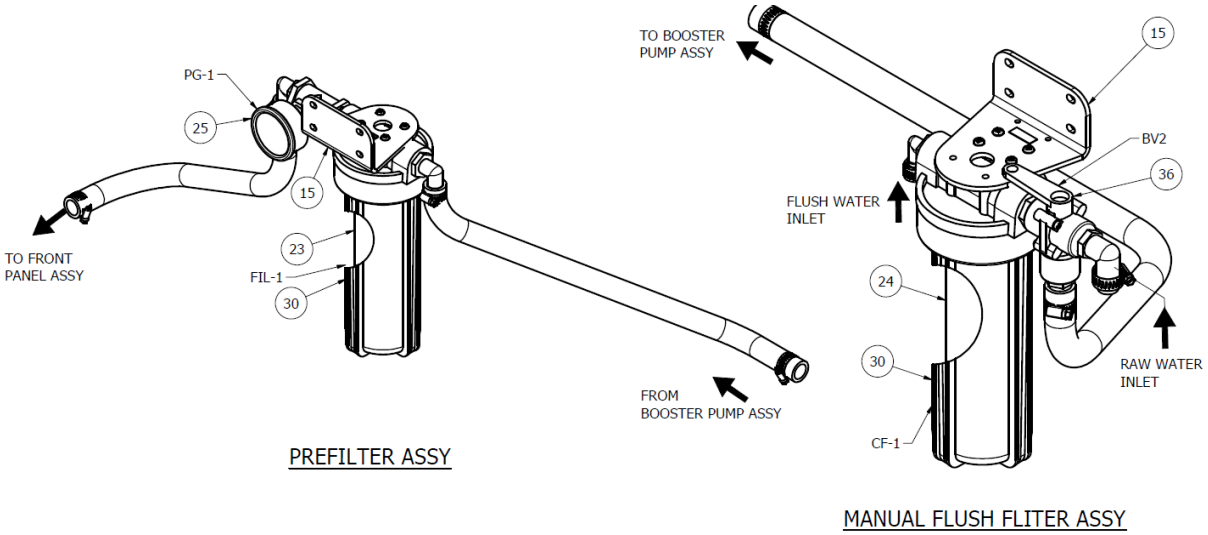


Figure 8.5: PREFILTER AND MANUAL FLUSH ASSY

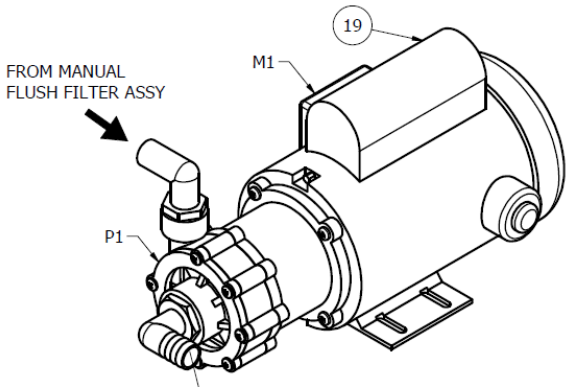


Figure 8.6: BOOSTER PUMP ASSY

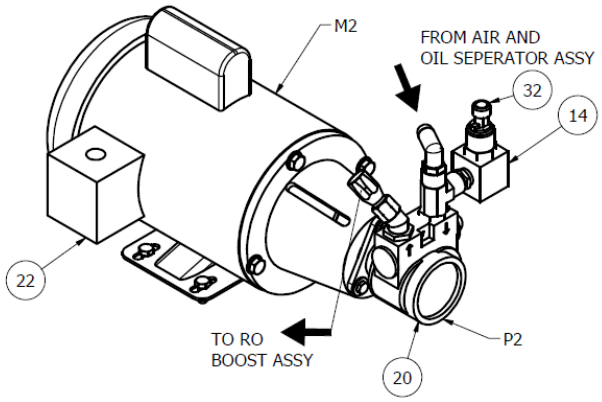


Figure 8.7: HP PUMP ASSY

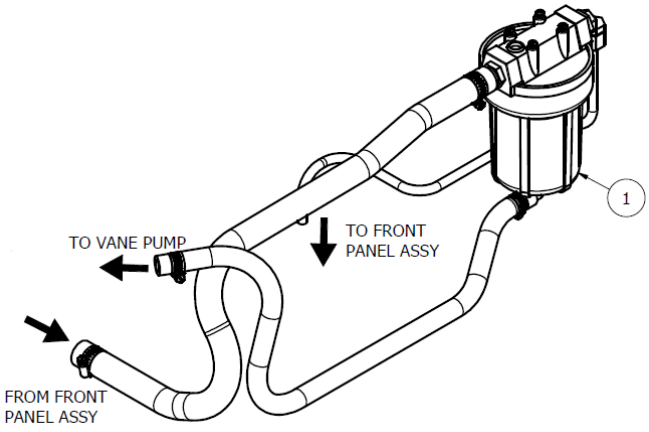


Figure 8.8: AIR & OIL SEPERATOR ASSY

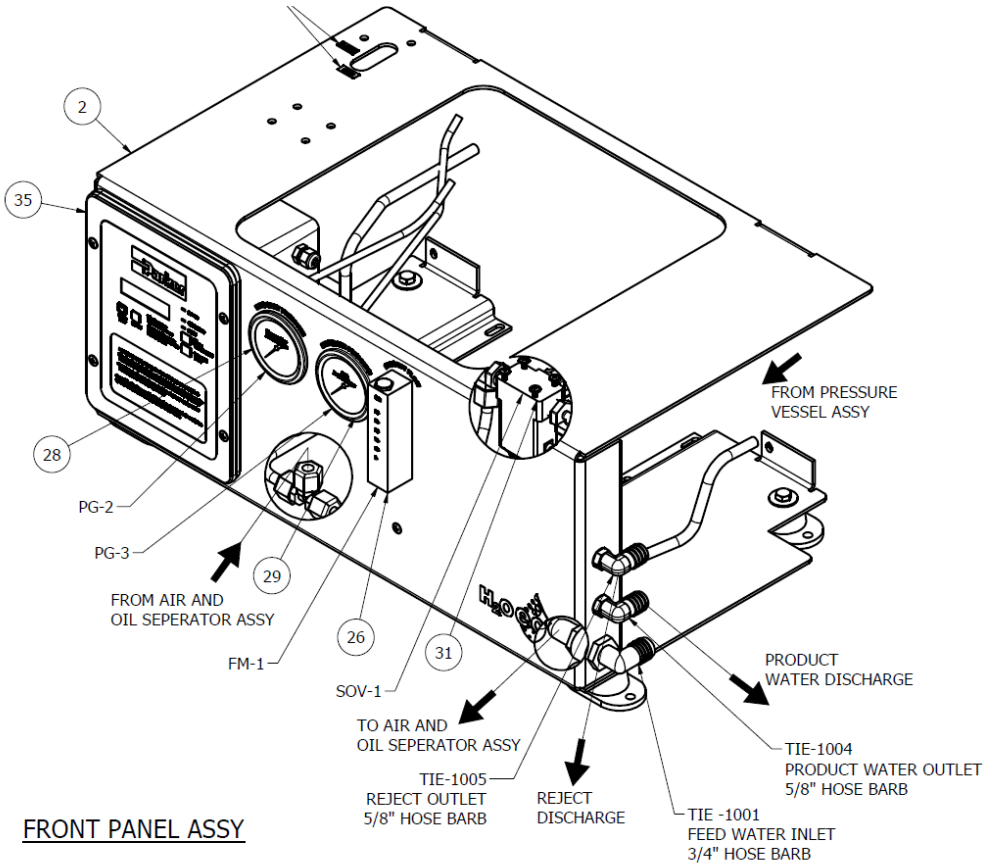


Figure 8.9: FRONT PANNEL ASSY

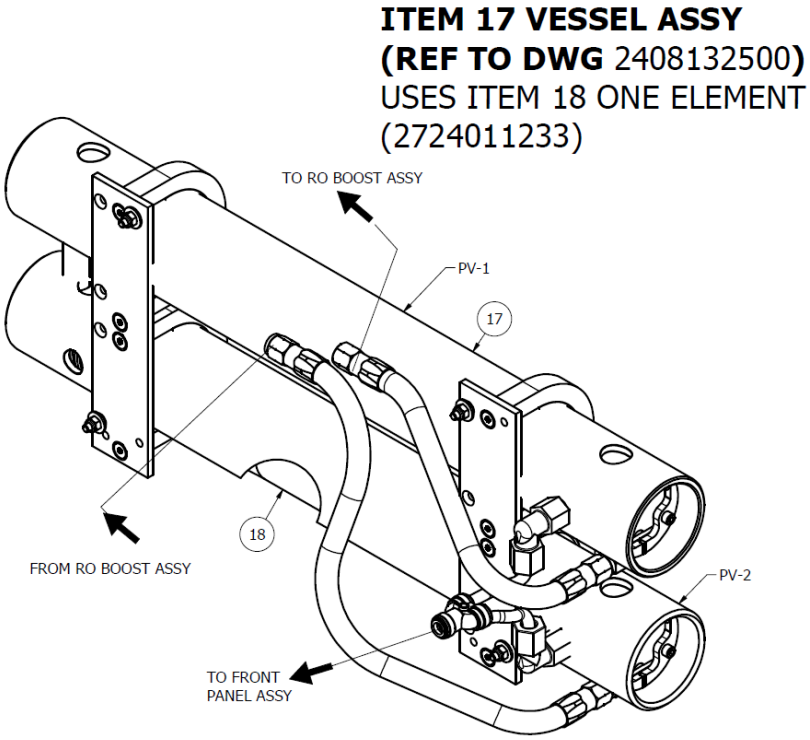


Figure 8.10: PRESSURE VESSEL ASSY

Parts List:

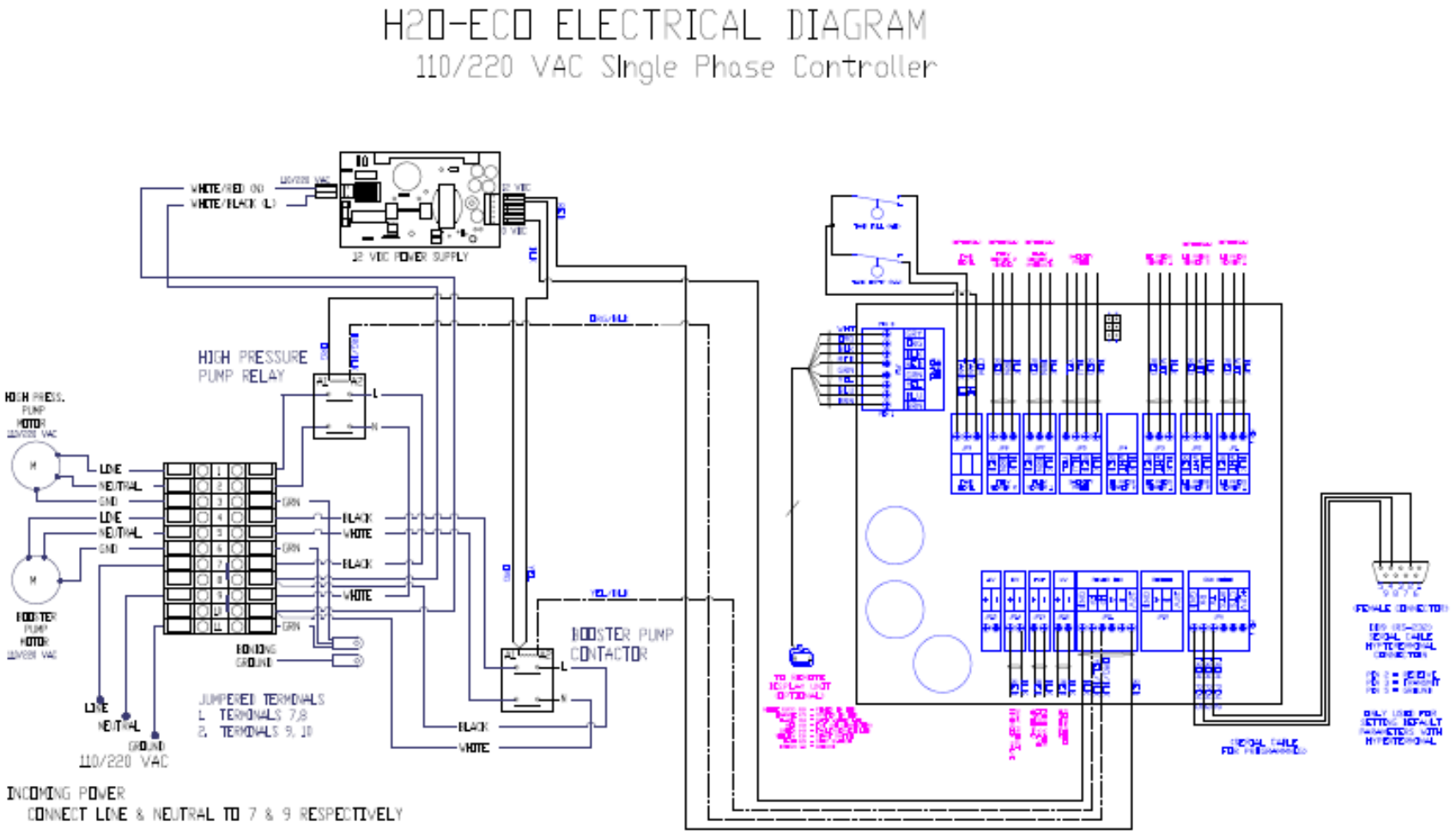
Callout	Description	Quantity	Part No.
1	FILTER ASSY,2.5X5,MODIFIED	1	90-1914
2	FRAME ASSY H2O ECO	1	0861084
3	RO-BOOST,LT WT,MANUAL RESET	1	81012014
7	VALVE,RELEASE,R.O. BOOST	1	81012014-12
8	CV BLOCK	1	81012014-13
14	HI-PRESSURE MANIFOLD	1	5353140903
15	BRACKET SINGLE FILTER	2	20200402102
17	VESSEL HIGH PRESSURE 450GPD	2	SEE TABLE
18	MEMBRANE 450GPD AW W-SEAL	2	SEE TABLE
19	BOOSTER PUMP & MOTOR ASSY	1	SEE TABLE
20	PUMP ROTARY VANE	1	SEE TABLE
22	HP MOTOR	1	SEE TABLE
23	FILTER, 5 MIC, 10 SQ FT, 2.5" H 9.75"	1	33-0117
24	FILTER,CARBON,5 MIC,2.5" X10"	1	33-0311
25	GAUGE, 0-60 PSI, 2.5" BACK	1	40-0300
26	FLOWMETER,30 GPH	1	40-1006
28	GAUGE 0-300 CBM.NPT	1	10181510CC
29	GAUGE 0-1400 CBM.NPT	1	10181524CC
30	FILTER HOUSING .75 X 10	2	0713020473
31	SOLENOID VALVE	1	1401095998
32	TRANSDUCER 0-200 PSI	1	2317100200
37	BYPASS VALVE	1	60-0069
38	STRAINER,Y	1	0101005
116	FILTER ASSY,2.5X5,MODIFIED	2	17012088

Table 8.4: Parts List

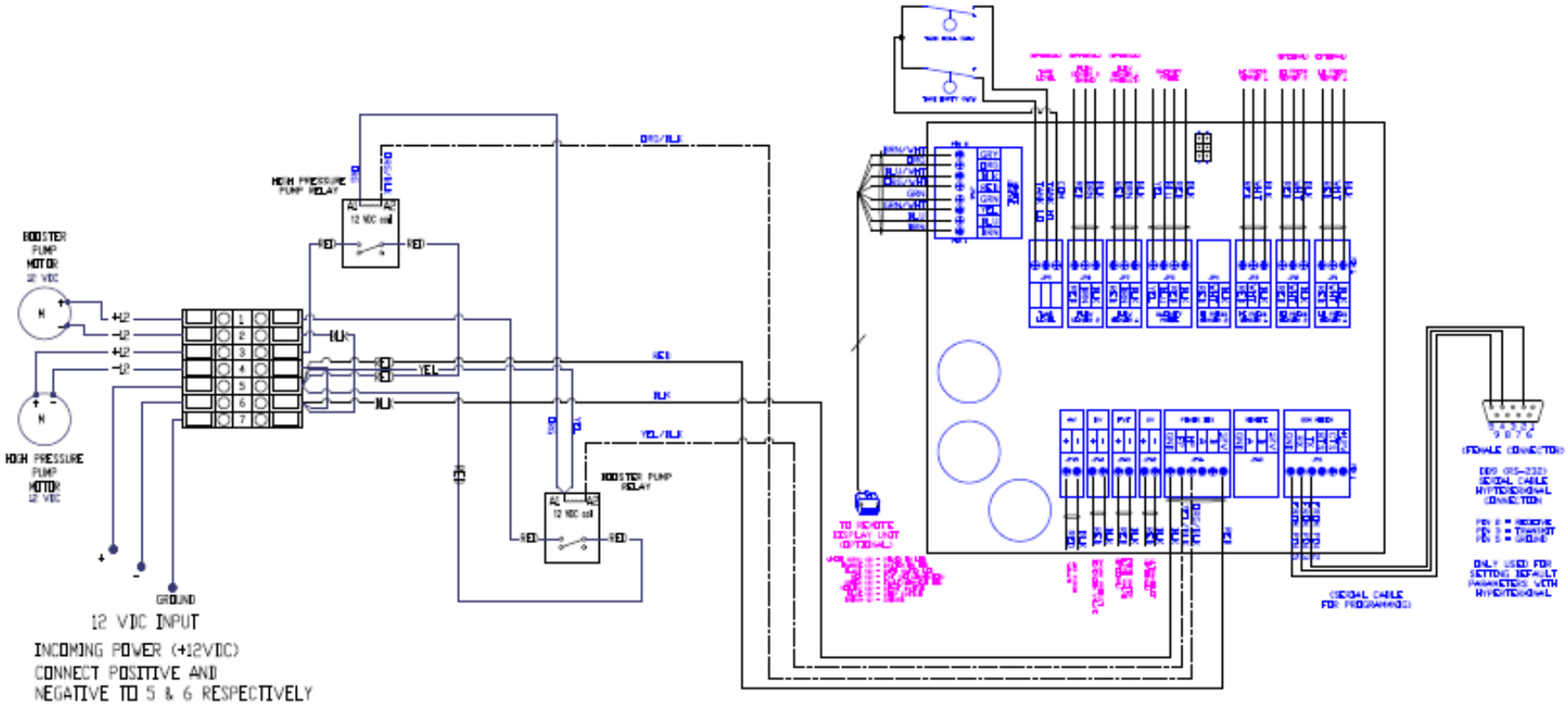
7- Specification table (Table 8.5)

PART NUMBER	Voltage	HP MOTOR	HP PUMP	BOOSTER MOTOR	MEMBERANE VESSEL QTY 2	MEMBERANE QTY 2	DRY WT lbs/kg	WET WT lbs/kg
A012C-111	12	15093110CF	12176402DP	1212380001	2408132500	2724011233	120 (54)	150 (68)
A012C-121	24	15103210CF	12176402DP	1212380002A	Q2408132500	2724011233	120 (54)	150 (68)
A012C-211	12	15153210LE	12176404DP	1212380001	2408132500	2724011233	168 (76)	210 (95)
A012C-221	24	15163210LE	12176404DP	1212380002A	2408132500	2724011233	168 (76)	210 (95)
A012C-311	110/1/50-60	15AG250912	12176402DP	70-1500	2408132500	2724011233	168 (76)	210 (95)
A012C-321	220/1/50-60	15AG250912	12176402DP	70-1500	2408132500	2724011233	168 (76)	210 (95)
A012C-411	110/1/50-60	1519071010	12176404DP	70-1500	2408132500	2724011233	180 (81)	222 (100)
A012C-421	220/1/50-60	1519071010	12176404DP	70-1500	2408132500	2724011233	180 (81)	222 (100)

8 - Wiring Diagrams .



H2O ECO
12 VDC Controller



H2O-ECO

24 VDC Controller

(WITH DIGITAL CONTROLLER)