TECHNICAL MANUAL FOR

REVERSE OSMOSIS DESALINATOR MODEL PW3000 – PW18000

DESCRIPTION, INSTALLATION, OPERATION AND MAINTENANCE

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Reverse Osmosis Purification Systems

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TABLE OF CONTENTS

1.0	**SYSTEM DESCRIPTION**	**1**
1.1	SPECIFICATIONS	1
1.1.1	PERFORMANCE CHARACTERISTICS	1
1.1.2	PHYSICAL CHARACTERISTICS	2
1.1.3	UTILITY REQUIREMENTS	2
1.1.4	ENVIRONMENTAL REQUIREMENTS	3
1.2	EQUIPMENT REQUIRED FOR OPERATION	3
1.2.1	CONSUMABLES	3
1.2.2	TEST EQUIPMENT	4
2.0	**PREPARATION FOR USE, INSTALLATION AND INITIAL ADJUSTMENT**	**5**
2.1	UNPACKING AND HANDLING	5
2.2	LOCATION	5
3.0	**GENERAL THEORY OF OPERATION**	**9**
3.1	REVERSE OSMOSIS THEORY	9
3.2	APPLICATION OF REVERSE OSMOSIS	10
3.3	PRODUCT WATER QUALITY STANDARDS	11
3.4	FACTORS AFFECTING PERMEATE PRODUCTION	11
3.4.1	VARIATIONS IN TEMPERATURE, PRESSURE AND SALINITY	11
3.4.2	TEMPERATURE CORRECTION FACTOR	12
3.5	OPERATIONAL DESCRIPTION	14
3.5.1	FILTRATION SYSTEM	14
3.5.2	REVERSE OSMOSIS SYSTEM	15
3.5.3	PRODUCT MONITORING SYSTEM	15
3.5.4	MEMBRANE CLEANING SYSTEM	16
3.6	WATER QUALITY MONITOR	16
3.6.1	PUSHBUTTONS	16
3.6.2	DISPLAYS AND LIGHTS	16
3.7	CONTROLS AND INSTRUMENTATION	17
4.0	**OPERATION**	**19**

4.1	INITIAL START-UP PROCEDURE	19
4.2	NORMAL START-UP PROCEDURE	21
4.3	SHUTDOWN PROCEDURES	23
4.3.1	SHUTDOWN PROCEDURE (SHORT TERM)	23
4.3.2	SHUTDOWN PROCEDURE (EXTENDED)	23
4.3.3	FRESH WATER FLUSH PROCEDURE	24
5.0	**MAINTENANCE INSTRUCTIONS**	**25**
5.1	GENERAL	25
5.2	RAW WATER STRAINER INSPECTION	26
5.3	FILTER ELEMENT CLEANING OR REPLACEMENT	26
5.4	DRIVE BELT INSPECTION AND REPLACEMENT	27
5.5	RO MEMBRANE CLEANING	28
5.5.1	CLEANING CHEMICALS	29
5.5.2	WHEN TO CLEAN	29
5.6	RO ELEMENT PRESERVATION	32
5.7	RESTARTING UNIT AFTER PRESERVATION	33
5.8	HIGH PRESS7URE PUMP OIL CHANGE	33
5.9	HIGH PRESSURE PUMP MOTOR LUBRICATION	33
5.10	INSPECTION LOG	34
6.0	**DISASSEMBLY AND REPAIR**	**37**
6.1	SCOPE	37
6.2	WATER MONITOR AND MASTER PANEL	37
6.3	PRESSURE VESSEL	37
7.0	**PRESERVATION FOR STORAGE**	**41**
8.0	**TROUBLESHOOTING**	**41**
9.0	**SYSTEM DRAWINGS AND DIAGRAMS / PARTS LIST**	**42**

LIST OF FIGURES

- Figure 2.0 - Recommended Installation (Below Water Line).....5
- Figure 2.1 - Proper Installation (Above Water Line).....6
- Figure 3.0 - Simple (Reverse) Osmotic System.....9
- Figure 3.1 - Simplified Schematic of an RO System.....10
- Figure 5.0 - Maintenance Task Chart.....25
- Figure 5.1 - Sample Operational Log.....35
- Figure 5.2 - Sample Discrepancy Report.....36
- Figure 6.0 - Pressure Vessel End Plug.....37
- Figure 6.1 - Brine Seal Orientation.....38
- Figure 6.2 - End Plug Installation Aid.....39

LIST OF TABLES

- Table 1.0 - Performance Specification.....1
- Table 1.1 - Unit Dimensions.....2
- Table 1.2 - Unit Weights.....2
- Table 1.3 - Unit Horsepower.....2
- Table 1.4 - Utility Requirements.....2
- Table 1.5 - Design Flow Requirements (without/with Cyclone Separator).....3
- Table 1.6 - Nominal Operating Conditions.....3
- Table 1.7 - Consumables.....4
- Table 1.8 - Recommended Test Equipment.....4
- Table 3.0 - WHO Drinking Water Standards.....11
- Table 3.1 - Factors Affecting Permeate Quality.....12
- Table 3.2 - Temperature Correction Factors (TCF).....13
- Table 3.3 - Instrumentation and Controls.....18
- Table 4.0 - Valve/Switch Line Up - Initial Start-up.....19
- Table 4.1 - Valve/Switch Line Up - Normal Operation/Start-up.....21
- Table 5.0 - Filter Tank Parts List.....26
- Table 5.1 - Chemical Requirements.....28
- Table 5.2 - Lubrication Requirements.....34

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.

1.0 SYSTEM DESCRIPTION

The Village Marine Tec. (VMT) Seawater Desalinator is a single-pass purification system that uses reverse osmosis (RO) as its method of seawater desalination. This unit produces potable (drinking) quality water with salt concentrations of < 500 ppm by removing approximately 99% of the dissolved salt in seawater.

This manual covers the following models: PW3000, PW4000, PW5000, PW6000, PW7000, PW8000, PW10000, PW12000, PW16000 and PW18000. The principle of operation is the same for all models. Specific differences are noted, where applicable.

1.1 SPECIFICATIONS

1.1.1 PERFORMANCE CHARACTERISTICS

Parameter	**Specification**
Raw water temperature range:	1-40°C (33-108ºF)
Design RO element pressure:	800 psi
Max. RO element pressure:	1000 psi
Max. feedwater residual chlorine:	< 0.1 ppm
pH range (short term for cleaning):	4-10 (3-11)
Membrane type:	Thin film composite
Nominal product water production: (2)	
• PW3000	2.1 gpm
• PW4000	2.8 gpm
• PW5000	3.5 gpm
• PW6000	4.2 gpm
• PW7000	4.9 gpm
• PW8000	5.6 gpm
• PW10000	6.9 gpm
• PW12000	8.3 gpm
• PW16000	11.1 gpm
• PW18000	12.5 gpm

(2) Raw water temperatures less than 25°C (77ºF) will result in less than rated product water output. Conversely, higher raw water temperatures will result in higher than rated output.

Table 1.0 - Performance Specification

1.1.2 PHYSICAL CHARACTERISTICS

	PW3000-5000	PW6000	PW7000-12000	PW16000-18000
Length	84"	84"	84"	84”
Width	34"	44"	48"	48”
Height	35"	35"	35"	43”

Table 1.1 - Unit Dimensions

	PW3000	PW4000	PW5000	PW6000	PW7000
Weight	800 LB	900 LB	1000 LB	1050 LB	1500 LB

	PW8000	PW10000	PW12000	PW16000	PW18000
Weight	1600 LB	1800 LB	1900 LB	2200 LB	2250 LB

Table 1.2 – Unit Weights

1.1.3 UTILITY REQUIREMENTS

See the nameplate attached to top of the unit for power requirements.

	PW3000	PW4000	PW5000	PW6000	PW7000
Motor HP	10	10	15	15	15

	PW8000	PW10000	PW12000	PW16000	PW18000
Motor HP	20	20	25	25	30

Table 1.3 – Unit Horsepower

Utility	Connection	Design Pressure Minimum (psi)	Design Pressure Maximum (psi)
Raw water inlet *	1 ½” ANSI Flange	0 / 25	30 / 50
Reject discharge	1 ½” ANSI Flange	0	30
Product water discharge	1” ANSI Flange	0	15
Flush water inlet	1 ½” NPT	20	40

* Pressures with / without optional boost pump on RO skid

Table 1.4 - Utility Requirements

Unit	Raw water inlet (gpm)	Reject discharge (gpm)	Product water discharge (gpm)
PW3000	14/18	12	2.1
PW4000	14/18	11	2.8
PW5000	20/25	16	3.5
PW6000	20/25	16	4.2
PW7000	20/25	15	4.9
PW8000	24/30	19	5.6
PW10000	30/37	23	6.9
PW12000	36/44	28	8.3
PW16000	36/44	26	10.4
PW18000	39/47	26	12.5

Table 1.5 - Design Flow Requirements (without/with Cyclone Separator)

1.1.4 ENVIRONMENTAL REQUIREMENTS

Parameter	Specification
Ambient temperature:	1-40°C (33-108ºF)
List (permanent):	15º
Trim (fore and aft):	+ 30º
Pitch:	± 10º (6 sec cycle)
Roll:	± 30º (12 sec cycle)

Table 1.6 - Nominal Operating Conditions

1.2 EQUIPMENT REQUIRED FOR OPERATION

1.2.1 CONSUMABLES

The following is the normal quantity of equipment consumed during 6 months of standard unit operation:

NOTE

Only Village Marine Tec™ approved filters and chemicals should be used.

Description	QTY		VMT Part No.
	PW3000-6000	PW7000-18000	
Cleaning Chemical #1, 5 lbs	6	8	85-0042
Cleaning Chemical #2, 5 lbs	5	6	85-0043
Preservative Chemical #3, 5 lbs	4	5	85-0044
Filter, 100 ft^2, 5 Micron	6	6	33-5100
Filter, 100 ft^2, 20 Micron	6	6	33-2100
Flushing Filter	2	2	See Parts List
Oil, HP Pump, Quart	20	20	85-0050

Table 1.7 - Consumables

1.2.2 TEST EQUIPMENT

The following table lists the basic equipment recommended to perform most types of verification testing and system maintenance. The salinity meter allows the operator to perform routine sampling of the RO membranes:

Description	VMT Part No.
Kit, pH Test, 0-14 (10 strips):	90-0135
Meter, Handheld, 0-5000 ppm:	40-5000
10X Range Extender for Meter:	40-5001
Solution, Calibration, 300 ppm:	90-1300
Solution, Calibration, 30,000 ppm:	90-1301

Table 1.8 - Recommended Test Equipment

2.0 PREPARATION FOR USE, INSTALLATION AND INITIAL ADJUSTMENT

2.1 UNPACKING AND HANDLING

Remove unit from shipping crate and inspect for shipping damage.

CAUTION
Do not allow unit or any components to be exposed to freezing temperatures. If it is anticipated that the unit may be exposed to freezing temperature, please contact VMT in advance for technical assistance.

2.2 LOCATION

The RO unit should be installed in a dry, sheltered location protected from direct sunlight. Some type of drainage should be provided beneath the RO unit to allow standing water to drain when performing maintenance or repair (see system diagram in Section 9.0 for skid size, interface locations and minimum maintenance envelope requirements).

For units without a pressurized feed, it is recommended that the RO unit be mounted in a location below the vessel's waterline. This will ensure a flooded suction to the unit at all times.

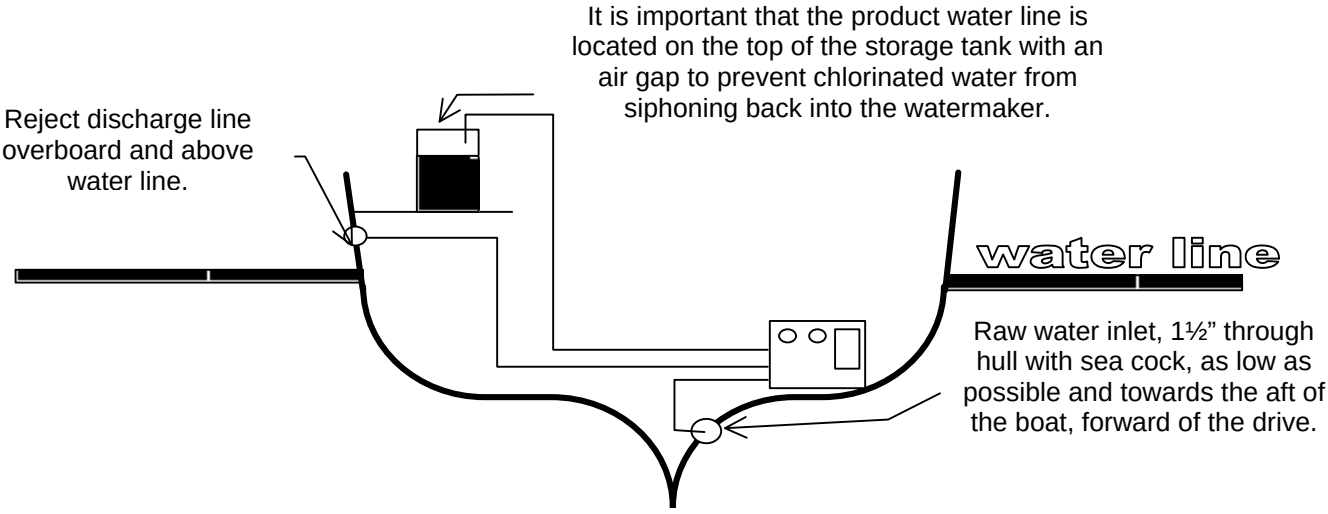


Figure 2.0 - Recommended Installation
(Below Water Line without Pressurized Feed)

If it is not possible to mount the watermaker below the water line, the boost pump can lift to a maximum height of 15 feet (5 feet for 50 Hz units, or units with cyclones) above the water line with the boost pump installed outside the RO frame. A check valve might be required in the suction line to maintain adequate system priming. Locating the system any more than 15 feet above the water line requires installation of external pumps to maintain a pressurized feed.

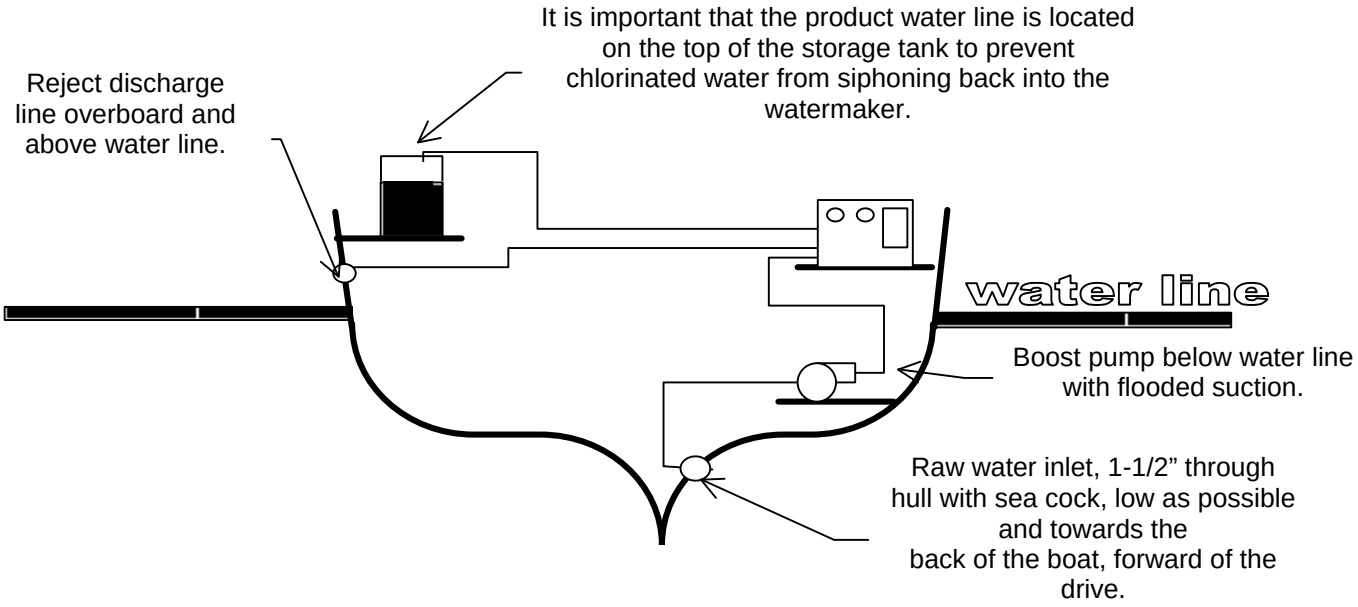


Figure 2.1 - Proper Installation
(Above Water Line)

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) Place the RO unit in an appropriate location and use existing holes or drill a minimum of four holes through the frame and mounting base. When drilling holes always check to make sure that the drill bit will not pass through to any component of the watermaker or cause any other kind of damage to the mounting area. Mount the RO unit securely, making sure that the base of the unit is continuously supported.

2) Make the following plumbing connections to the RO unit's piping interfaces (refer to Section 9.0 for the exact piping interface locations):

a) Connect the raw water supply (1½" flange connection inlet) to a clean seawater source.

CAUTION

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 produces rust that will irreversibly foul the membrane and void the RO unit warranty.

NOTE

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.

b) Connect the reject discharge 1½" flanged connection to an unobstructed line connected to an appropriate drain. If the reject is discharged overboard, ensure the discharge port is above the waterline. If the reject must be discharged below the water line please contact the Village Marine technical department for installation advice. If the reject goes down more that 10 feet to its outlet, install a vacuum breaker or vent to prevent any negative pressure at shutdown.

CAUTION

The use of galvanized steel for product piping should be avoided as significant amounts of rust may form that can be drawn back into the RO when the system is off.

c) Connect the product water discharge 1" flanged 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 normally accomplished by teeing the product into a tank vent or tank fill line.

d) Connect the flush water inlet to the pressurized fresh water system on the vessel. Do not exceed 40 psi pressure.

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:

NOTE

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. This will assure proper voltage even if power supply voltage is slightly less than required. Never connect the RO unit to a line that services another electrical device. The RO unit should have it's 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.

a) Connect the correct voltage/power supply to the three-phase or single phase supply point in the Motor Starter Box.

IMPORTANT NOTE

Three phase power supplies will spin the motors and pumps either rotation direction, depending on the phase sequence of the three hot legs. Both high and low pressure pumps are clearly marked with a direction of rotation. It is very important not to rotate the low pressure pump backwards. Even "bumping" the motor for one second can cause significant damage. The high pressure pump will not be damaged from running backwards for short periods of time. Either use a phase meter to determine the rotation, or use the high pressure pump only to check rotation and adjust the input power legs accordingly prior to checking the low pressure pump. If the low pressure pump is inadvertently "bumped" backwards, open the pump and check the impellor is secured on the motor shaft and spins freely prior to starting it again.

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

c) Connect any external signals as shown in the electrical drawings in Section 9.

3.0 GENERAL THEORY OF OPERATION

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 particular substance). Every fluid has an inherent potential that is directly related to the type and amount 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 an osmotic system, the less concentrated solution will attempt to equalize the concentrations of both solutions by migrating across the semi-permeable membrane. When enough pure solution migrates across the membrane such that the inherent potential difference between the solutions in 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 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.

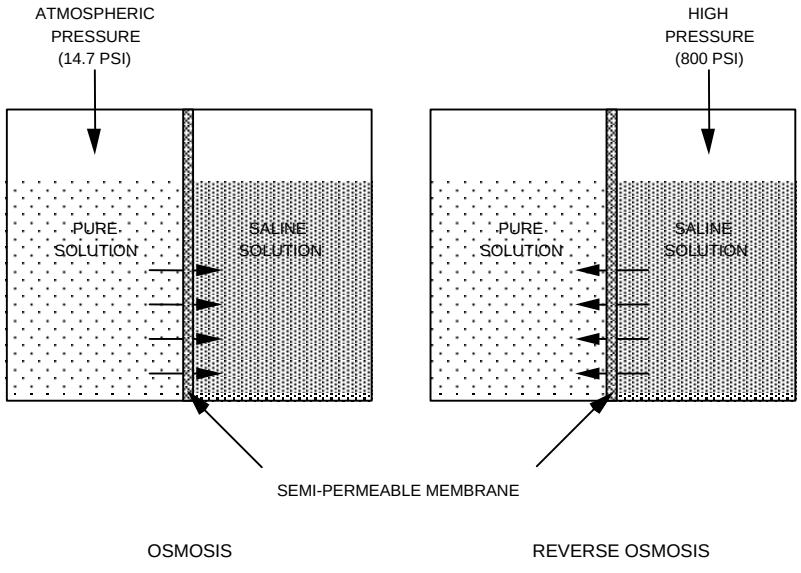


Figure 3.0 - Simple (Reverse) Osmotic System

3.2 APPLICATION OF REVERSE OSMOSIS

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 amount of dissolved solids in water.

In a Reverse Osmosis desalination system, most of the dissolved solids do not pass through the membrane but are instead carried along the membrane surface. This rejected water, referred to as *brine*, becomes increasingly more concentrated as it flows across the surface of the membranes and is eventually piped to drain. The product water that flows through the membrane is referred to as *permeate*. The percentage of feedwater that enters the unit converted to permeate is called the *recovery rate* and is normally somewhere between 10% and 30%. For example, a unit with a 29% recovery rate will produce 29 gallons of permeate for every 100 gallons of feedwater with the remaining 71 gallons discharged to waste as brine. A higher than optimal recovery rate (which can be obtained by increasing the back pressure on the unit above the recommended range) results in greatly increased membrane fouling rates and a significant decrease in the operational life of the membranes.

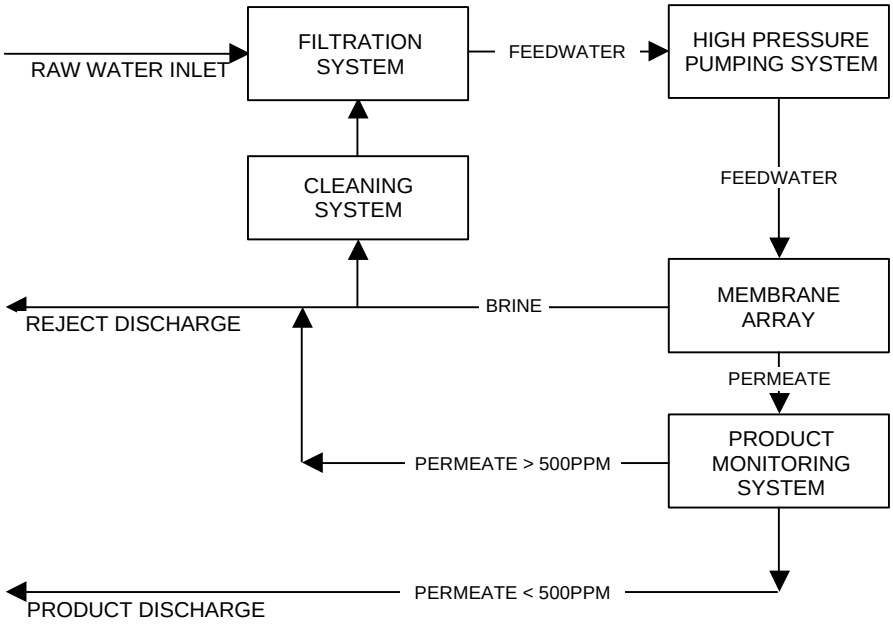


Figure 3.1 - Simplified Schematic of an RO System

It should be noted that no system is capable of removing all of the dissolved solids from seawater. The system is actually 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%.

3.3 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 WHO specifications for acceptable drinking water quality are as follows:

Constituent Ion/Molecule	**Maximum Limits (ppm)**
Nitrate	10
Fluorine	.1
Chlorine	250 (per USPHS 1962)
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
pH	7.5 - 8.5 (per USPHS 1962)
Bacteria - E Coli (per 100 ml)	0

Table 3.0 - WHO Drinking Water Standards

3.4 FACTORS AFFECTING PERMEATE PRODUCTION

3.4.1 VARIATIONS IN TEMPERATURE, PRESSURE AND SALINITY

The following table illustrates how the quality and quantity of permeate produced in by 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. 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, V3, located in the system brine piping. For long pump life and low membrane fouling, VMT 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.

3.4.2 TEMPERATURE CORRECTION FACTOR

As previously described, the output capacity of any RO unit is highly dependent on feedwater temperature. In order to quantify this relationship, operational data has been utilized to develop Temperature Correction Factors (TCF). The TCF (which is compensated to 25°C/77°F) is used to determine what part of any change in system output flow is due to variations in feedwater temperature alone. This, in turn, allows the operator to establish the baseline flow for a given temperature, allowing more accurate troubleshooting. The procedure for calculating the TCF and the temperature compensated flow is as follows:

1) Measure raw water temperature and determine the corresponding correction factor from Table 3.2 based on the measured temperature.

2) Note the product flow rate at the *Product Flow* meter. Multiply the product flow meter flow rate by the correction factor from Table 3.2 to give true system output under standard conditions (25°C).

Example:
Raw water temp: 15°C
TCF: 1.47
Product flow: 113.5 (gph)
Calculation: 113.5 x 1.47 = 167 (gph)
Corrected flow: 167 (gph)
(this is the normal flow for a PW4000)

°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 OPERATIONAL DESCRIPTION

3.5.1 FILTRATION SYSTEM

Seawater supplied to the intake of the Village Marine Tec™ RO desalination unit will initially flow through the **raw water strainer, ST1,** which removes large particulate matter. Once through the strainer, the raw water is supplied to the **low pressure boost pump, P1,** which raises the pressure of the water in order to provide enough positive feed pressure to flow through the filtration system and into the suction of the high pressure pump.

For units equipped with a (optional) **Cyclone Separator, CTS**:

- When a unit operates in areas where the raw water source has a high relative grit and silt concentration, VMT recommends installing a **cyclone separator**. The cyclone separator, when installed in line between the LP boost pump and the cartridge filters, removes a large percentage of heavier suspended solids that are present. This will reduce the load on the micron filters, which results in a significant reduction in the filter cleaning and replacement frequency. The cyclone separator under-flow with the separated solids is discharged directly into the reject line.

For units equipped with a (optional) **Media Filtration System**:

- When a unit operates in areas where the raw water source is rich in turbidity or organic materials (such as plankton), VMT recommends installing a **media filtration system**. The media pump and filter, is installed upstream of the watermaker and will remove particles as small as 10 microns in diameter. The filtration media is comprised a multiple layers of three specific materials that are specifically designed to remove suspended particulate matter from the raw water stream. The benefit is to significantly reduce the cleaning and replacement frequency for the micron filters. When the media filter is fully loaded (indicated by high filter differential pressure), the operator initiates a fresh water cleaning cycle designed to flush trapped particulate matter out of the filter and into the system drain. This "back flush" can be initiated automatically (optional) on certain custom installations.

The raw water next passes through the **micron filter array, F1 & F2,** which is designed to reduce raw water turbidity to a nominal 5 microns in diameter. The micron filter array consists of one 20 micron filter cartridge and one 5 micron filter cartridge.

Each filter housing contains one (1) filter element with an effective filtering area of 100 ft^2 and is equipped with an integral **air/oil separator** bleed. Air or oil is continuously discharged to the reject header through a dedicated overflow line with a check valve.

The discharge pressure from the filter housings is monitored by a "low" **pressure gauge, PG1,** and **pressure switch, PS1,** that allow the operator to determine when the filter elements require cleaning or replacement.

3.5.2 REVERSE OSMOSIS SYSTEM

The clean and filtered raw water (now referred to as *feedwater*) is then supplied to the inlet of the **high pressure pump, P2**. This pump raises feedwater pressure to between 800 psi, the nominal pressure required for optimal system recovery. The pressurized feedwater then flows directly into the **membrane array**. The membrane array is a fixed arrangement of fiberglass pressure vessels each containing a RO membrane element.

The pressurized feedwater flows along the membrane surface where reverse osmosis takes place (see Section 3.1). The feedwater flow is divided into two streams - the high purity product stream (referred to as the *permeate*) and the increasingly concentrated reject stream (referred to as the *brine*).

After exiting the membrane array, the brine (which contains large concentrations of salts and other impurities) flows through the **back pressure regulator valve, V3**. This manually operated valve is used to control the back pressure through the membrane array. Since membrane array back pressure is directly related to system pressure, the back pressure regulator is also used to set and adjust overall system pressure. After passing through the back pressure regulator, the brine flows through the **reject flow meter, FM1** and exits the RO unit.

3.5.3 PRODUCT MONITORING SYSTEM

The product water stream (or permeate) 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 close the **2-way product diversion valve, V6**. This causes permeate system pressure to rise until it equals the activation set point of the **permeate relief valve, V7**. With the relief valve open, the poor quality water is diverted to the reject stream and away from your storage tanks. A **product pressure gauge, PG3** is supplied to enable accurate adjustment of the product relief valve.

If the permeate has < 500 ppm TDS, indicating good quality (drinking) water, a signal is sent to the product diversion valve to open. The relief valve then shuts which causes the permeate to pass through the **product flow meter, FM2** and then on to your storage tank(s).

3.5.4 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 filter housings (which also function as mixing tanks), the pumps, a cleaning valve and a high pressure bypass valve, the membranes can be chemically cleaned in place. Complete information and cleaning procedures can be found in Section 5.5.

3.6 WATER QUALITY MONITOR

The Water Quality Monitor (MON) monitors and displays permeate salinity, temperature and accumulated unit operating hours. It also provides operational mode control of the system product valve.

3.6.1 PUSHBUTTONS

- Temperature – allows the operator to display permeate temperature (as opposed to the normal permeate salinity display). By changing a jumper located on the back of the monitor, the temperature can be displayed in ºF or ºC.

- Salinity Alarm Set Point – allows the operator to display and vary (via a control knob located on the back of the monitor) the salinity alarm set point.

- Mode – allows the operator to bypass the normal automatic operation and manually close (dump) the product valve (for instance during cleaning).

3.6.2 DISPLAYS AND LIGHTS

- Normal Operation – a green light is illuminated when the product valve is energized and permeate is flowing through the product valve.

- Dump/Cleaning – a yellow light is illuminated when the product valve is de-energized and the product valve is closed.

- Salinity Alarm – a red, flashing light indicates that permeate quality is above the salinity set point.

3.7 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 Section 9.0 – System/Equipment Drawings and Diagrams.

Call Out	Description	Function
F1	20 Micron Pre-filter	Filters all particles ≥ 20 microns in diameter.
F2	5 Micron Pre-filter	Filters all particles ≥ 5 microns in diameter.
CTS(1)	Cyclone Turbidity Separator	Removes particles with a specific gravity of ≥ 2.7 and a diameter of ≥ 6 microns.
FM1	Reject Water Flow Meter	Indicates the amount of reject water (i.e. feed water not converted into permeate) discharged from the RO unit.
FM2	Product Water Flow Meter	Indicates the amount of permeate produced by the RO unit.
MON	Water Quality Monitor	See Section 3.6 for detailed description.
MS1	LP Pump Magnetic Starter	Provides ON/OFF control of LP pump.
MS2	HP Pump Magnetic Starter	Provides ON/OFF control of HP pump.
P1	Low Pressure (LP) Boost Pump	Pressurizes raw water to provide adequate suction pressure to the High Pressure Pump.
P2	High Pressure (HP) Pump	Pressurizes feed water to supply the membrane array at proper (high) pressure.
PG1	Pre-Filter Pressure Gauge	Indicates filter array inlet and discharge pressure.
PG2	High Pressure Gauge	Indicates membrane array inlet and discharge (brine side) pressure.
PG3	Product Water Discharge Pressure	Indicates membrane array (permeate side) discharge.
PG-CTS(1)	Cyclone Separator Feed Pressure	Indicates Cyclone Separator supply pressure.
PS1	Low Pressure Switch	Will initiate warning message “Check Filtration” when HP Pump inlet pressure is less than 0 psi.

SR1	Product Conductivity Sensor	Provides conductivity signal to water monitor (MON).
ST1	Raw Water Strainer	Removes large particulate matter from the raw water stream to prevent system fouling.
SW1	LP Boost Pump Start Pushbutton	Allows operator to START the LP boost pump.
SW2	LP Boost Pump Stop Pushbutton	Allows operator to STOP the LP boost pump.
SW3	HP Pump Start Pushbutton	Allows operator to START the HP pump.
SW4	HP Pump Stop Pushbutton	Allows operator to STOP the HP pump.
V1	Filter Array Gauge Selector Valve	Allows operator to select and read filter array inlet or discharge pressure on the gauge face.
V2	RO Membrane Array Selector Valve	Allows operator to select and read RO membrane array inlet or discharge pressure on the gauge face.
V3	HP Regulating Valve	Maintains and controls system back pressure.
V4	HP Bypass Valve	Allows operator to bypass the HP Regulating Valve during start-up, shutdown and cleaning.
V5	Cleaning Valve	Used to re-circulate the brine during cleaning and preservation procedures.
V6	Product Diversion Valve	Based on its salinity, directs permeate to either the potable water tank(s) or to drain.
V7	Product Water Relief Valve	Relieves product water pressure when Product Diversion Valve is shut. Factory set at 25 psi.
V8	Filter Bleed Check Valve	Prevents reject flow from back flowing through the filter housings into the feed water stream.
V9	Trim Valve	Adjust to get quiet operation at regulator
V10	Flush Valve	3-way feedwater valve used to flush system
CS-V1[(1)]	Cyclone Valve	Controls the differential pressure across the cyclone separator (20 psi minimum)

(1) For units equipped with (optional) Cyclone Separator installation

Table 3.3 - Instrumentation and Controls

4.0 OPERATION

4.1 INITIAL START-UP PROCEDURE

NOTE

The HP Pump should rotate in the clockwise direction (when facing the protruding end of the shaft).

These instructions apply when the VMT™, RO unit is being started for the first time or if the unit is being started after an extended period of shut-down:

1) Verify system is de-energized.

2) Check the HP pump oil level by observing sight gauge located on the pump.

3) Check the drive belt tension by removing the panel on left front of the RO unit to gain access to the belt. See Section 5.4 for detailed procedure.

WARNING

De-energize (lock out or disconnect) the electrical supply to RO unit before attempting to check or adjust drive belt tension. Serious injury to personnel can result if the RO unit is started while checking drive belt tension.

4) Check tightness of all lines and fittings.

5) Place the RO unit's valves and switches in the positions shown in Table 4.0.

ID	Description	Position
V3	HP Regulating Valve	Factory set to 800 psi
V4	High Pressure Bypass Valve	Cleaning (open)
V5	Cleaning Valve	Normal Flow
V10	Flush Valve	Seawater Feed

Table 4.0 - Valve/Switch Line Up - Initial Start-up

CAUTION

Failure to open the *High Pressure Bypass Valve* (which is required to bleed any entrapped air) can result in hydraulic shock to the system.

6) Open the raw water source to the RO unit.

7) Verify electrical power is supplied to the RO unit.

CAUTION

The low pressure (LP) boost pump should not be operated if the feed system pressure as read on the inlet side of the *Pre-filter Pressure* gauge is more than 20 psi. Operate with only the HP pump if feed pressures is in excess of 20 psi to avoid damage to low pressure feed water system components.

8) If pressure on the inlet side of the *Pre-filter Pressure* gauge is < 20 psi, start the LP boost pump by pressing the green *LP PUMP START* button located on the front panel. With higher feed pressures, operate the watermaker without using the LP Pump, and use the HP Pump only.

9) Start the HP pump by pressing green *HP PUMP START* button located on the front panel. At least 0 psi must be indicated on the discharge side of the *Pre-filter Pressure* gauge.

10) Inspect all plumbing connections in the unit for leakage. Temperature variations during shipment may cause plumbing connections to seep when initially started on-site. Secure the unit and repair any leaks prior to proceeding. Once the leaks have been repaired, open the raw water source and re-start the unit.

11) When flow through the reject discharge flow meter appears to be free of air bubbles, place the *High Pressure Bypass Valve* in the *Reverse Osmosis* position by slowly turning the handle in the clockwise direction.

NOTE

When the *High Pressure Bypass Valve* is closed, the salinity of the initial permeate produced may be temporarily high and will probably be enough to energize the salinity alarm.

13) Observe the system pressure on the discharge side of the *RO Membrane Array Pressure* gauge. For seawater applications, indicated pressure should be preset to 800 psi. If the indication is other than 800 psi, adjust the nut on top of the back pressure regulator valve, V3, using a wrench until the discharge side of the *RO Membrane Array Pressure* gauge indicates 800 psi. In conjunction with adjustment of the regulator, adjust the trim valve, V9, to find the quietest operating point. For applications other than seawater purification, reference Section 3.4 and contact the VMT service department for technical assistance.

WARNING

Pressure, as indicated on the discharge side of the *RO Membrane Array* gauge, should never exceed 1000 psi.

14) Normally, during a start-up using seawater, the Salinity alarm (red) will remain lit for approximately 2 minutes. When the product water quality drops below 500 ppm TDS, the green lamp will light. The water quality monitor will then open the product diversion valve, which will direct the product water to the product water flow meter. If the green lamp does not light within 10 minutes, sample the product water.

NOTE

The system pressure required to produce equivalent amounts of permeate is lower for fresh water (approximately 200 psi) and brackish water (approximately 400 psi) than for seawater applications. Reduce system pressure as necessary to maintain system output at no more than 120% of rated capacity.

15) Observe the *Product Flow* meter. This flow meter indicates, in gallons per minute (gpm), the product water flow rate. Record the product flow after 5 hours of operation (use the sample log sheet provided in Figure 5.2). This indication will provide the baseline used to determine RO membrane cleaning requirements. Normally, a drop of 10-15% in the product water production rate indicates the need for RO membrane cleaning (see Section 3.4 for a more detailed information concerning variations in product flow).

16) Observe the *Reject Flow* meter. This flow meter indicates, in gallons per minute (gpm) the reject flow rate from the RO array. Record the reject flow after the first 5 hours of operation (use the sample log sheet provided in Figure 5.2).

4.2 NORMAL START-UP PROCEDURE

1) Place RO unit's valves and switches in positions indicated in Table 4.1.

ID	Description	Position
V3	HP Regulator	Factory set to 800 psi
V4	High Pressure Bypass Valve	Cleaning (open)
V5	Cleaning Valve	Normal Flow
V10	Flush Valve	Seawater Feed

Table 4.1 - Valve/Switch Line Up - Normal Operation/Start-up

2) Open the raw water source to RO unit.

3) Verify electrical power is supplied to the RO unit.

CAUTION

Failure to open the *High Pressure Bypass Valve* (which is required to bleed any entrapped air) will result in hydraulic shock to the system.

4) If pressure on the inlet side of the *Pre-filter Pressure* gauge is < 20 psi, start the LP boost pump by pressing the green *LP PUMP START* button located on the front panel.

5) Start the HP pump by pressing green *HP PUMP START* button located on the front panel. At least 0 psi must be indicated on the discharge side of the *Pre-filter Pressure* gauge.

6) When flow through the reject discharge flow meter appears to be free of air bubbles, place the *High Pressure Bypass Valve* in the *Reverse Osmosis* position by slowly turning the handle in the clockwise direction.

WARNING

Pressure as indicated on the discharge side of the *RO Membrane Array Pressure* gauge should never exceed 1000 psi.

NOTE

When the *High Pressure Bypass Valve* is closed, the salinity of the initial permeate produced will be temporarily high and will probably be enough to energize the salinity alarm.

NOTE

After the initial start-up, and when it is being operated on a daily basis, the unit may be started without first having to open, and then close, the *High Pressure Bypass Valve*. This allows the system to be fully operated from a remote location.

7) Depending on how long the unit has been secured prior to the start-up, the Salinity alarm (red) may remain lit for a short period of time. When the product water quality drops below 500 ppm TDS, the green lamp will light. The water quality monitor will then open the product diversion valve, which will direct the product water to the product water flow meter. If the green lamp does not light

within 5 minutes, sample the product water (see Section 5.11 - Water Quality Testing).

8) Observe the *Product Flow* meter. This flow meter indicates, in gallons per hour (gph), the product water flow rate. Record the product flow (use the sample log sheet provided in Figure 5.2). This indication will provide the baseline used to determine RO membrane cleaning requirements. Normally, a drop of 10-15% in the product water production rate indicates the need for RO membrane cleaning (see Section 3.4 for a more detailed information concerning variations in product flow).

9) Observe the *Brine Flow* meter. This flow meter indicates, in gallons per minute (gpm) the reject flow rate from the RO array. Record the reject flow (use the sample log sheet provided in Figure 5.2).

4.3 SHUTDOWN PROCEDURES

4.3.1 SHUTDOWN PROCEDURE (SHORT TERM)

1) Release the pressure from the system by turning the *High Pressure Bypass Valve* counter-clockwise to the *Cleaning* (open) position (NOTE: this step may be omitted if remote re-start of the unit is desired).

2) Secure the HP pump by pressing the red *HP PUMP STOP* button located on the front panel.

3) If required, secure the LP boost pump by pressing the red *LP PUMP STOP* button located on the front panel.

4) Secure the feedwater system by closing a feedwater valve upstream of the water maker. If the anticipated shutdown period will be 24 hours or more, flush the system as per Section 4.3.3 - Flushing Procedure.

4.3.2 SHUTDOWN PROCEDURE (EXTENDED)

Since bacteria and biologic growth increases significantly the longer stagnant water is in contact with the membranes, the fresh flushing procedure (Section 4.3.3) should be used whenever the unit will be secured for more than 1 or 2 days. Although they do not attack the membranes or other system components directly, high concentrations of biological matter can block enough of the product water channels to cause a reduction of as much as 40% of the total system capacity.

CAUTION

Failure to follow the extended shutdown procedure can result in irreversible damage to the RO membranes and will void the RO unit warranty.

Bacterial contamination can be avoided by following the following procedures:

- Flush the RO unit with **non-chlorinated** fresh water for 2 minutes.
- Reflush the RO unit for 5 minutes every 7 days.
- Or, Pickle the RO unit with a preservative solution. Refresh the preservative every 3 months. Follow the preservation instructions provided in Section 5.6.

4.3.3 FRESH WATER FLUSH PROCEDURE

Note: Fresh flushing water must be **non-chlorinated**. Exposing the membranes to chlorinated water may cause irreversible damage and will void the RO unit warranty. For this reason, a carbon block filter is provided on the freshwater inlet. It is designed to remove normal concentrations of free chlorine (0.5 to 1.0 ppm). Do not flush with highly chlorinated water and change the flushing filter after every 50 two minute flushes.

Once the watermaker is shut off and isolated, the flush procedure is:

1) Place the *HP regulating Valve* in the (open) position.

2) Turn the Flush Valve, V10, to the flush position to bring freshwater to the feed of the watermaker. The flush valve can be automated to give “one button” flush for extended non-operating periods. This is a customized auto flush option.

3) Start the LP boost pump by pressing the green *LP PUMP START* button located on the front panel.

4) Once you have observed fresh water flow through *Reject Flow* meter, run the system for an additional 2 minutes.

5) Secure the LP boost pump by pressing the red *LP PUMP STOP* button located on the front panel.

6) Return the Flush Valve, V10, to the seawater position and verify no seawater is flowing through the system because it is isolated upstream of the watermaker.

5.0 MAINTENANCE INSTRUCTIONS

5.1 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 as a whole. 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 2 to 3 years.

The table below details the specific recommended system maintenance requirements for the VMT™ Model PW3000-18000:

	Daily	Weekly	Monthly	Quarterly	Semi-Annually	Annually	As Required	Labor Hours (approximate)
Clean and inspect strainer basket		•						0.5
Clean and inspect micron filter(s)							•	0.5
Replace filter(s)							•	0.5
Clean membranes							•	2.0
Replace membranes							•	1.0
Inspect pump drive belt				•				1.0
Check pump oil level	•							0.1
Change pump oil(1)			•					1.0
Lubricate pump motors					•			1.0
Backflush media filter(2)							•	1.0

(1) After first 50 hours and every 500 hours thereafter

(2) For units equipped with the optional media filtration system.

Figure 5.0 - Maintenance Task Chart

5.2 RAW WATER STRAINER INSPECTION

1) Remove the strainer housing.

2) Remove the screen from the strainer bowl. Remove any debris from screen and inspect the screen closely for damage. Replace as required.

3) Lubricate the rubber gasket using glycerin or silicone lubricant. Place the gasket onto the strainer bowl mounting area. Install the screen in the bowl.

4) Thread the housing onto the strainer. The housing should be hand tightened only. Start the RO unit and inspect the strainer for leaks.

5.3 FILTER ELEMENT CLEANING OR REPLACEMENT

The filters should be replaced when the inlet pressure gauge reading drops below 5 psi. Each PW3000-18000 employs a filter array consisting of one (1) 20 micron, 100 ft^2 filter in series with one (1) 5 micron, 100 ft^2 filter. VMT filters can be washed and re-used 2-3 times provided it is not contaminated with oil or organic growth.

Description	**Qty**	**VMT Part #**
Micron filter, 20 micron, 100 ft^2	1(1)	33-2100
Micron filter, 5 micron, 100 ft^2	1(1)	33-5100
Lid, filter, 100 ft^2, flat	1	34-0102
O-ring, filter lid, 100 ft^2	2	32-0007
Filter, complete assembly, 100 ft^2	1	30-0101

(1) One each per filter housing

Table 5.0 - Filter Tank Parts List.

CAUTION

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

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

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

2) Loosen and remove the nuts that hold the filter tank lid in place. Remove the tank lid.

3) Remove the filter element. If required, first break the filter seal by rocking the filter from side to side.

4) The filter element may be cleaned by flushing it with water to remove foreign matter from both sides of the filter media. If the filter element appears oil-fouled or is damaged in any way, discard it and install a new element.

5) Reinstall the filter element. Be sure to install the filter element with the end marked "TOP" upwards. Ensure a proper seal by pressing the filter element down into place until it reaches the bottom and is fully seated.

6) Reinstall the filter tank lid. Tighten the nuts.

7) After the filter element has been changed, operate the RO unit and check for leaks.

5.4 DRIVE BELT INSPECTION AND REPLACEMENT

Proper adjustment of the HP pump drive belt(s) is essential for proper operation of the system. The drive belt(s) should be inspected for cracking, fraying and excessive wear. Replace the belts immediately it the inspection indicates that the belt(s) are damaged.

WARNING

Disconnect electrical supply to RO unit before attempting to check. Serious injury to personnel can result if RO unit is started when checking drive belt.

1) Remove the mounting screws that hold the left front panel in place and remove the panel.

2) Inspect drive belt carefully for wear and proper tension. The belt should not deflect more than ½ " when a force of 6-9 lbs is applied at a point halfway between the pulleys. Adjust the base plate as required to obtain proper belt tension.

3) If the drive belt is damaged or shows any evidence of excessive wear, replace the drive belt:

a) Locate the HP pump's mounting nuts on the adjustable pump base. Loosen the nuts.

b) Remove the old drive belt and install new one ensuring they are properly positioned in the pulleys.

c) Check the drive belt tension. Adjust the base plate as required to obtain proper belt tension.

(d) Be sure to properly align the pump and motor pulleys using a straight edge (at a minimum). After the belt has been sufficiently tightened and aligned, secure the HP pump by tightening the pump mounting nuts.

4) Replace the side panel on the RO unit

5.5 RO MEMBRANE CLEANING

This section is designed to guide the operator in the periodic care and cleaning of RO membrane elements used in the PW3000-18000 unit. The membrane elements require occasional service; therefore, it is recommended that the operator establish a regular maintenance program to assure lasting performance. The basic procedure for all cleaning and preservative treatments is the same - a specific chemical solution is circulated through the system for a pre-determined length of time.

	PW3000-6000	**PW7000-18000**
Cleaning Chemical #1	5 to 15 lbs (8 to 25 cups)	6 to 20 lbs (10 to 33 cups)
Cleaning Chemical #2	4 to 12 lbs (7 to 20 cups)	5 to 15 lbs (8 to 25 cups)
Preservative Chemical #3	4 lbs (6 cups)	5 lbs (8 cups)

Table 5.1 - Chemical Requirements

There is a large variance in the required amount of chemical due to several factors. If RO product water is used to flush the unit prior to cleaning, the quantity required will be on the lower side. If the fresh water flush is done with dock or city water that is hard, then the required amount will rise. If the unit is significantly fouled, the quantity also rises. The key is to use only enough chemical to achieve the desired pH (11 for #1 and 3 for #2). Don't use extra if the system is very dirty, since more extreme pH will damage the membranes. For the first cleaning of a system, use the lower quantities and measure the pH after circulating as described below. Keep adding chemical as needed until the cleaning solution maintains the desired level. Keep a record of the total chemical needed, so that on subsequent cleanings the correct amount can be used without the needed pH measurements and adjustments.

5.5.1 CLEANING CHEMICALS

The alkaline detergent (Cleaning Chemical #1) is used to remove oil, grease, biological matter and grime from the surface of the RO membranes. The acid cleaner (Cleaning Chemical #2) is used to remove mineral scale deposits. Additional chemical amounts beyond the requirements in the table above may be needed to maintain effective pH depending on the buffer properties of the fresh water used.

CAUTION

The use of chemicals or cleaning methods other than those outlined below will void the RO unit warranty. Non-ionic surfactants for membrane cleaning or other chemicals not approved in writing by VMT™ will void the RO unit warranty.

5.5.2 WHEN TO CLEAN

During normal operations, mineral scale and biological matter will foul the RO membranes. These deposits build up over time and will eventually cause a loss of product water output, salt rejection capability or both. The RO elements should be cleaned whenever the temperature corrected product water output drops by 10-15% from the initial baseline established during the first hours of operation. The RO elements should also be cleaned when the TDS level of the product water exceeds 500 ppm. Prior to cleaning the membranes, verify that any reduction in product output is not the result of a corresponding variation in raw water inlet temperature or salinity. See Section 3.4 for more detailed information.

NOTE

Product water output of the system is dependent upon feedwater temperature, RO feed pressure and feedwater salinity. Reductions in product water output due to these factors are normal and may not indicate the need for membrane cleaning. See Section 3.4 for more detail.

Use the following procedure to clean the RO elements:

1) Flush the watermaker per section 4.3.3, so it is filled with fresh water, not seawater.

2) Dissolve the appropriate amount of Cleaning Chemical #1 (see Table 5.1) in a pail of non-**chlorinated** product water. Make sure that that the chemical is completely dissolved (use warm water if necessary).

NOTE

Cleaning Chemical #1 is an alkaline detergent. See warning label on package and observe all safety precautions on label.

3) Verify the *High Pressure Bypass Valve* is in its *Cleaning* (open) position.

4) Place the Cleaning Valve in the *Cleaning Flow* position.

5) Remove the filter elements from both filter tanks and replace the 5 micron filter with a dedicated cleaning filter (5 micron). A dedicated cleaning filter should be used to prevent fouling of the operational filters. When the process is complete the dedicated cleaning filter can be cleaned and set aside until the next membrane cleaning is required. Pour the chemical solution into the empty, 20 micron filter housing and reinstall the micron filter housing lids.

6) Start the LP boost pump by pressing the green *LP PUMP START* button located on the front panel.

7) Start the HP pump by pressing the green *HP PUMP START* button located on the front panel. At least 0 psi must be indicated on the discharge side of the *Pre-filter Pressure* gauge.

   a) After the chemical solution has circulated for 3 minutes, secure the LP boost pump, remove the lid to the filter tank and manually take a sample. Measure the pH of the sample using test kit VMT# 90-0135..

   b) If the pH < 11 then add 10% more of the cleaning solution. Repeat this step until the pH = 11.

   c) Once a pH = 11 can be maintained, replace the filter tank lid, start the LP and HP pumps and allow the cleaning solution to circulate for an additional 30-40 minutes.

8) Secure the HP pump by pressing the red *HP PUMP STOP* button located on the front panel.

9) Secure the LP boost pump by pressing the red *LP PUMP STOP* button located on the front panel.

10) Place the Cleaning valve in the *Normal Flow* position.

11) Open raw water supply to the RO unit (external to the unit).

12) Start the LP boost pump and HP pump. Allow both pumps to run for 5 minutes to flush the chemical solution from the unit.

13) Secure the HP pump and the LP boost pump.

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

15) Flush the watermaker, so it is filled with fresh water, not seawater.

16) Dissolve the appropriate amount of Cleaning Chemical #2 (see Table 5.1) in a pail of **non-chlorinated** product water. Make sure that that the chemical is completely dissolved (use warm water if necessary).

NOTE

Cleaning Chemical #2 is an acid used for mineral scale removal. See warning label on package and observe all safety precautions on label.

17) Place the Cleaning Valve in the *Cleaning Flow* position.

18) Remove the lid from the 20 micron filter tank, pour the cleaning solution into the tank and replace the lid.

19) Start the LP boost pump by pressing the green *LP PUMP START* button located on the front panel.

20) Start the HP pump by pressing the green *HP PUMP START* button located on the front panel. At least 0 psi must be indicated on the discharge side of the *Pre-filter Pressure* gauge.

    a) After the chemical solution has circulated for 3 minutes, secure the LP boost pump, remove the lid to the filter tank and manually take a sample. Measure the pH of the sample using test kit VMT# 90-0135..

    b) If the pH > 3 add 10% more of the cleaning solution. Repeat this step until the pH < 3.

    c) Once a pH of less then 3 can be maintained replace the filter tank lid, start the LP and HP pumps and allow the cleaning solution to circulate for an additional 30-40 minutes.

21) Secure the HP pump by pressing the red *HP PUMP STOP* button located on the front panel.

22) Secure the LP boost pump by pressing the red *LP PUMP STOP* button located on the front panel.

23) Place the Cleaning valve in the *Normal Flow* position.

24) Open raw water supply to the RO unit (external to the unit).

25) Start the LP boost pump and HP pump. Allow both pumps to run for 5 minutes to flush the chemical solution from the unit.

26) Secure the HP pump and the LP boost pump.

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

28) Remove, set aside and retain the cleaning filter for future use. Replace the operational 20 and 5 micron filter elements in the filter housings and replace both housing lids.

29) Place the unit back into service using the procedure contained in Section 4.2 - Normal Start-up Procedure.

5.6 RO ELEMENT PRESERVATION / PICKLING

During periods when the RO unit is to be shut down for an extended period of time, it is necessary to circulate a preservative solution through the membranes to prevent the growth of biological organisms. Use the following procedure to preserve the RO elements:

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

2) Dissolve the appropriate amount of Cleaning Chemical #3 (see Table 5.1) in one (1) gallon of **non-chlorinated** product water. Make sure that that the chemical is completely dissolved (use warm water if necessary).

NOTE
Preservative Chemical #3 is a food-grade preservative. See warning label on package and observe all safety precautions on label.

3) Flush the watermaker, so it is filled with fresh water, not seawater.

4) Make sure the *High Pressure Bypass Valve* is in the *Cleaning* (open) position.

5) Place the *Cleaning Valve* in the *Cleaning Flow* position.

6) Remove one of the filter housing lids and pour in the preservative solution prepared in step #1. Reinstall the lid.

7) Start the LP boost pump by pressing the green *LP PUMP START* button located on the front panel.

8) Start the HP pump by pressing the green *HP PUMP START* button located on the front panel. At least 0 psi must be indicated on the discharge side of the *Pre-filter Pressure* gauge. Allow the chemical solution to circulate for 10 minutes.

9) Secure the HP pump by pressing the red *HP PUMP STOP* button located on the front panel.

10) Secure the LP boost pump by pressing the red *LP PUMP STOP* button located on the front panel.

11) The system is now properly conditioned and may be left idle for an extended period of time. This preservation procedure should be repeated at least every 3 months during the shutdown. In colder climates the interval between preservation cycles may be extended to 6 months.

5.7 RESTARTING UNIT AFTER PRESERVATION

Restart unit using the procedure contained in Section 4.1 - Initial Start-up Procedure.

5.8 HIGH PRESSURE PUMP OIL CHANGE

WARNING

Due to the proximity of the high pressure pump and the motor drive belt, disconnect the electrical supply to RO unit before proceeding.

See equipment literature in back of this manual for instructions for changing the oil on your particular pump.

5.9 HIGH PRESSURE PUMP MOTOR LUBRICATION

1) Locate the grease fitting located near the motor shaft. Use a clean cloth to wipe this fitting clean.

WARNING

Due to the proximity of the high pressure pump and the motor drive belt, disconnect electrical supply to RO unit before proceeding.

2) If applicable, remove the fill and drain plugs. Free the drain hole of any hard grease (use a piece of wire if necessary).

3) Add 2-3 strokes of grease using a low pressure grease gun (see Table 5.2 for grease type).

4) If the motor is equipped with a drain plug, start RO unit and let it run for approximately 20 minutes prior to replacing drain plug.

5) Secure the RO unit, wipe off any of the drained grease and replace the fill and drain plugs, as required. The motor is now ready to be placed back into operation.

Location	**Type**
High pressure pump oil	VMT pump oil #85-0050
High pressure pump motor grease	Shell Oil Dolium R Texaco Premium RB Exxon Mobil PolyrexEM Chevron SRI
O-rings & gaskets	Glycerin or silicone lubricant

Table 5.2 - Lubrication Requirements

5.10 INSPECTION LOG

Figure 5.2 depicts a sample operation log for the PW3000-18000 RO unit. The operator of the RO unit should establish a program for entering the required data on a regular basis. Maintaining accurate operational data is the first, and most important, step in determining preventative maintenance requirements and reducing system downtime. The data maintained in the log must be provided by the Purchaser to make any RO element warranty claim. Figure 5.3 depicts a sample discrepancy report that may be used for reporting and tracking problems with the RO unit.

Date	Total Operating Hours	PG1, Pre-filter Inlet Pressure	PG1, Pre-filter Discharge Pressure	PG2 RO Array Inlet Pressure	PG2 RO Array Discharge Pressure	FM1, Reject Flow	FM2 Product Flow	Product Water TDS (ppm)	Water Temp, (°C)	Report Attached? (Yes/No)

Figure 5.1 - Sample Operational Log

COMMENT/DISCREPANCY REPORT

Village Marine Tec™
RO Desalinator Model(s) PW3000-18000

Plant No: _____ Date: _____
Log Task No: _____ Time: _____
System Affected: _____ Technician : _____

Comment/Discrepancy:

_____
_____
_____
_____
_____
_____
_____
_____
_____

Corrective Action:

_____
_____
_____
_____

Action Taken:

_____
_____
_____
_____
_____

Date Completed: _____
Printed Name: _____
Signature: _____

Figure 5.2 - Sample Discrepancy Report

6.0 DISASSEMBLY AND REPAIR

6.1 SCOPE

This section provides instructions for removal, disassembly and repair of the Village Marine Tec™ Model(s) PW3000-18000 RO unit and its components.

6.2 WATER MONITOR AND MASTER PANEL

Only a professional service technician should perform repair of the water monitor. If repair is needed, contact your Village Marine Tec™ distributor or factory representative.

6.3 PRESSURE VESSEL

6.3.1 PRESSURE VESSEL DISASSEMBLY

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

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

2) 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.

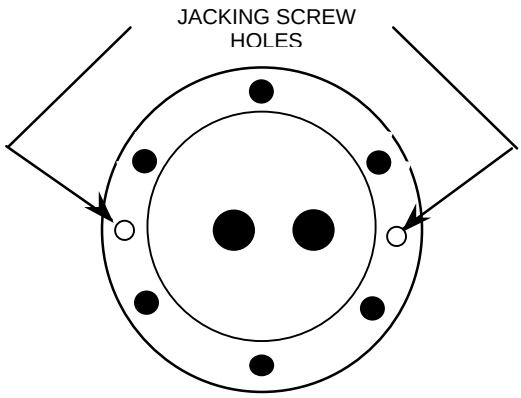


Figure 6.0 - Pressure Vessel End Plug

3) Locate the jacking screws on opposite sides of the end cap (see Figure 6.0). Place the appropriate size screwdriver in each slot. Screw in the correct size bolt until the end cap is pulled off.

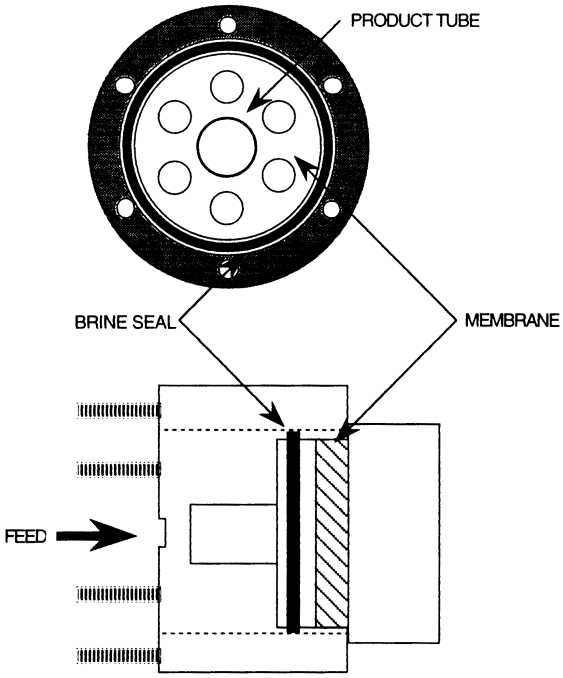


Figure 6.1 - Brine Seal Orientation

4) 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. See Figure 6.1 for proper orientation.

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.

5) 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.

6) Remove the product water o-rings and end plug o-ring from each end plug. The product water o-rings are internal o-rings located inside the center hole in the end cap.

6.3.2 PRESSURE VESSEL ASSEMBLY

1) 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 SAE flare fittings or other straight thread fittings such as those used on HP hose assemblies and their adapters.

2) Install new 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 studs on the pressure vessel while paying particular attention to the reference mark (see Section 6.3.1, Step 2). Apply pressure to the end plug until the nuts can be threaded onto the mounting studs. If the end plug will not slide into the pressure vessel sufficiently to allow installation of the nuts, see Figure 6.2 for an installation aid. Install and hand tighten the nuts.

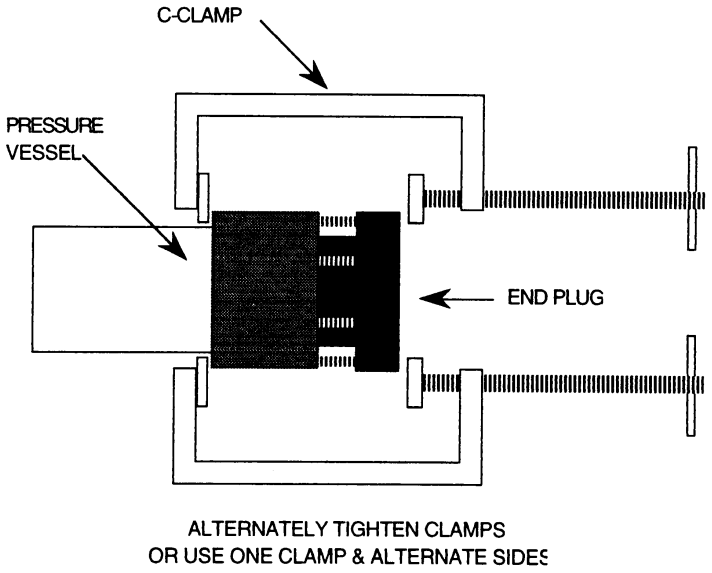


Figure 6.2 - End Plug Installation Aid

3) Lubricate the brine seal and product water tubes of RO membrane with glycerin or silicone 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.

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

5) Tighten the six nuts holding each end plug in place with a socket wrench. Torque nuts to 25 in-lbs.

6) Reconnect all plumbing connections to pressure vessel(s).

7.0 PRESERVATION FOR STORAGE

During periods when the Village Marine Tec™ RO unit is to be shut down for an extended period of time, it is necessary take steps to prevent the growth of biological organisms and to prevent the water in the RO unit from freezing. During extended shutdowns that do not exceed 6 months, it is necessary to circulate a preservative solution (see section 5.6). If a shutdown is longer than 6 months in duration, or if the unit will at any time be exposed to air temperatures of 32ºF (0ºC) or less, the membranes must be removed and the unit fully drained or the unit filled with an glycerin anti freeze solution.

8.0 TROUBLESHOOTING

No amount of trouble shooting advice can replace common sense and direct plant knowledge gained through the operation and maintenance of your unit. However our experience taking tech calls suggests some points to check.

1. Always verify proper valve configuration for each of the operational modes selected. Verify valve positions for valves within the unit and also external valves are open as required.

2. Always check for positive pressure at the HP pump suction. Many problems stem from low or erractic feed water supply. Check filters, strainer, seacock, boost pumps, etc to be sure of flooded suction to the HP pump.

3. Always check for loose connections or broken wires when inspecting electrical parts. Checking for continuity and solid contact can prevent hours of wasted effort.

4. Prior to cleaning or replacing membranes, verify that any reduction in product output is not the result of a corresponding variation in raw water inlet temperature or salinity. See Section 3.4 for more detailed information.

Call or email us at the Village Marine Tec™ Service Department for assistance. That is what we are here for.

9.0 SYSTEM DRAWINGS AND DIAGRAMS AND PARTS LIST

NOTES

1) PART NUMBERS FOR 60 HZ 3 PHASE UNITS SHOWN
PART NUMBERS FOR 50 HZ OR SINGLE PHASE UNITS – CONSULT FACTORY

2) *DIFFERENT MOTOR PULLEYS FOR PW8K AND PW10K. PART ITEMS NUMBERS ARE IDENTIFIED FOR 8K AND 10K RESPECTIVELY.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE, LEVEL 2	3/19/99	JM
A	ADDED PRESSURE SWITCH AND NEMA BOXES	11/5/99	JM
B	ADDED PW20000 INFORMATION	2/2/00	JM
C	3 PLUNGER 8000 & 10000	3/13/00	JM
D	P/N FOR MOTOR PULLEY CHANGED PW 4K	12/12/01	JM
E	UPDATED DRAWINGS, PART NUMBERS, AND VIEWS	08/20/04	BG
F	ADDED PWM VIEWS	11/02/04	BG
G	CORRECTED P/N FOR PC 8	12/08/04	BG
H	CORRECTED PWF DIMENSION DEPTH	06/07/05	BG

TABLE 1–1 PW3000–18000 PARTS MATRIX

QTY	PC NO	DESCRIPTION	PW3K–4K	PW5K–6K	PW7K	PW8–10K	PW12–16K	PW18K
1	44	FILTER, FLUSH	33–0315	33–0315	33–0315	33–0083	33–0083	33–0083
1	43	PULLEY, HP PUMP, 60Hz	70–0112	70–0112	70–0112	67–0189	67–0189	67–0189
1	42	BUSHING, MOTOR HP PUMP	70–0599	70–0244	70–0244	70–0035	70–0178	70–0178
1	39	RELIEF VALVE	60–7742	60–7742	60–7742	60–0047	60–0047	60–0047
1	38	FLOW METER, REJECT WATER	40–0014	40–0014	40–0014	40–0170	40–0170	40–0170
1	37	FLOW METER, PRODUCT WATER	40–0211	40–0211	40–0015	40–0015	40–0171	40–0171
1	35	SOLENOID VALVE, 110VAC	20–1141	20–1141	20–1141	20–1241	20–1241	20–1241
1	26	PULLEY, MOTOR, 60Hz	70–0040	70–0563	70–0563	*70–0262–8K *70–0406–10K	70–0182	70–0019
1	25	BELT, HP PUMP AND MOTOR	70–1448	70–1448	70–1448	70–1440	70–1440	70–1440
1	24	BUSHING, HP PUMP	70–0167	70–0167	70–0167	70–0142	70–0142	70–0142
1	23	PUMP, HIGH PRESSURE	70–2030	70–2030	70–2030	70–3000	70–3000	70–3000
1	22	MOTOR, HP PUMP, 60Hz	20–0062	20–2333	20–2333	20–0095	20–4103	20–1503
1	20	RELAY, LP PUMP MOTOR, 440VAC	20–1025	20–1025	20–1025	20–1025	20–1025	20–1025
1	20	RELAY, LP PUMP MOTOR, 220 VAC	20–0216	20–0216	20–0216	20–0216	20–0216	20–0216
1	20	CONTACTOR, LP PUMP MOTOR, 110 COIL	20–0264	20–0264	20–0264	20–0264	**20–0264**	**20–0264**
1	19	RELAY, HP PUMP MOTOR, 440VAC	20–0582	20–0373	20–0373	20–0373	20–0951	20–0951
1	19	RELAY, HP PUMP MOTOR, 220 VAC	20–0951	20–0951	20–0951	20–0374	–	–
1	19	CONTACTOR, HP PUMP MOTOR, 110 COIL	20–0581	20–0372	20–0372	20–0372	20–0372	20–0372
1	13	VALVE, TRIM, V9	60–0044	60–0044	60–0044	60–0106	60–0106	60–0106
–	7	MEMBRANE, SEA WATER	33–0440	33–0440	33–0036	33–0036	33–0036	33–0036
–	6	PRESSURE VESSEL ASSEMBLY	32–0444	32–0444	32–6040	32–6040	32–6040	32–6040
–	4	END CAP, PRESSURE VESSEL INCLUDING RING	32–4012	32–4012	32–6012	32–6012	32–6012	32–6012

QTY	PC NO	DESCRIPTION	P&ID #	MATERIAL	MAT'L SPEC	REMARKS	LOC
1	43	PULLEY, HP PUMP	–	VARIOUS	–	SEE TABLE	–
1	42	BUSHING, MOTOR HP PUMP	–	VARIOUS	–	SEE TABLE	–
6	41	VIBRATION ISOLATION MOUNT	–	VARIOUS	–	70–1595	–
1	40	SWITCH, LOW PRESSURE	PS1	316SS	–	20–0088	–
1	39	RELIEF VALVE, PRODUCT	V7	NYLON/PVC	–	SEE TABLE	–
1	38	FLOW METER, REJECT WATER	FM1	ACRYLIC	–	SEE TABLE	–
1	37	FLOW METER, PRODUCT WATER	FM2	ACRYLIC	–	SEE TABLE	–
1	36	VALVE, BY–PASS, HIGH PRESSURE	V4	316SS	–	60–0068	–
1	35	VALVE, SOLENOID, PRODUCT DIVERSION	V6	PVC	–	SEE TABLE	–
1	34	GAUGE, PRESSURE, 0–60 PSI, BACK CONN.	PG3	VARIOUS	–	40–0303	–
1	33	VALVE, SELECTOR	V2	316SS	–	60–0013	–
1	32	GAUGE, PRESSURE, 0–1000 PSI, BACK CONN	PG2	VARIOUS	–	40–0302	–
1	31	GAUGE, PRESSURE, 0–60 PSI, BACK CONN	PG1	VARIOUS	–	40–0309	–
1	30	VALVE, SELECTOR	V1	316SS	–	60–0013	–

QTY	PC NO	DESCRIPTION	P&ID #	MATERIAL	MAT'L SPEC	REMARKS	LOC
1	29	MONITOR, SALINITY	MON1	VARIOUS	–	40–4097	–
1	28	PUSH BUTTON, START/STOP	–	VARIOUS	–	20–0590	–
1	27	PUSH BUTTON, START/STOP	–	VARIOUS	–	20–0590	–
1	26	PULLEY, MOTOR	–	VARIOUS	–	SEE TABLE	–
1	25	BELT, HP PUMP AND MOTOR	–	VARIOUS	–	SEE TABLE	–
1	24	BUSHING, PULLEY HP PUMP	–	VARIOUS	–	SEE TABLE	–
1	23	PUMP, HIGH PRESSURE	–	TITANIUM	–	SEE TABLE	–
1	22	MOTOR, HP PUMP	–	VARIOUS	–	SEE TABLE	–
1	21	TRANSFORMER, 0.5 KVA, SPECIFY VOLTAGE	–	VARIOUS	–	20–1440 (3 PHASE ONLY)	–
1	20	RELAY, OVERLOAD, LP PUMP MOTOR	–	VARIOUS	–	SEE TABLE	–
1	20	CONTACTOR, LP PUMP MOTOR	–	VARIOUS	–	SEE TABLE	–
1	19	RELAY, OVERLOAD, HP PUMP MOTOR	–	VARIOUS	–	SEE TABLE	–
1	19	CONTACTOR, HP PUMP MOTOR	–	VARIOUS	–	SEE TABLE	–
1	18	PUMP, LOW PRESSURE W/ 60Hz MOTOR	P1	NI AL BRONZE	–	70–0027	–
1	17	ENCLOSURE, NEMA 4X	–	FIBER GLASS	–	20–1287	–
1	16	MANIFOLD, REJECT	–	NYLON	–	50–0027	–
1	15	PROBE, CONDUCTIVITY, 5 WIRE	SR1	VARIOUS	–	20–4096	–
1	14	MANIFOLD, PRODUCT	–	NYLON	–	50–0026	–
1	13	VALVE, TRIM	V9	316SS	–	SEE TABLE	–
1	12	VALVE, HP REGULATOR, 40 GPM	V3	316 SS	–	60–0040	–
2	11	HOUSING, FILTER, 100 SQ–FT	F1	316 SS	–	30–0101	–
1	10	FILTER, 100 SQ–FT, 20 MICRON	F1	VARIOUS	–	33–2100	–
1	9	FILTER, 100 SQ–FT, 5 MICRON	F2	VARIOUS	–	33–5100	–
2	8	VALVE, 3–WAY, 1–1/2", PVC, CLEANING	V5,V10	PVC	–	60–0023	–
–	7	MEMBRANE, SEA WATER	X	VARIOUS	–	SEE TABLE	–
–	6	PRESSURE VESSEL ASSEMBLY	X	VARIOUS	–	SEE TABLE	–
–	5	ADAPTOR, END CAP	–	TITANIUM	–	30–1110	–
–	4	END CAP, PRESSURE VESSEL INCLUDING RING	–	NYLON	–	SEE TABLE	–
–	3	HOSE, H/P, 3/4", SPECIFY LENGTH	–	VARIOUS	–	90–9016 (SPECIFY LENGTH)	–
–	2	VALVE, SAMPLE, MEMBRANE PRODUCT	–	BRASS	–	60–0375	–
1	1	STRAINER, Y TYPE, SCREEN ONLY	ST1	NYLON	–	99–5354	–

6	5	4	3	2	1	SH	REVISION STATUS OF SHEETS
H	H	H	H	H	H	REV	

DIMENSIONAL TOLERANCES – UNLESS OTHERWISE SPECIFIED

MACHINED			WELDMENT	
DIMENSION	DECIMALS		DIMENSION	TOLERANCE
	2 PL	3 PL	UNDER 24"	± .12
UNDER 6"	± .02	± .010	24" & OVER	± .25
6" TO 24"	± .03	± .015		
24" & OVER	± .06	± .030		
ANGULAR ± 0° 30'			ANGULAR ± 0° 30'	
125 UNLESS OTHERWISE NOTED			UNLESS OTHERWISE NOTED	

?
NEXT HIGHER ASSEMBLY
APPLICATION

DRAWING FILE NO. 11300.DWG

DRAWN JPM DATE 8/17/99
CHECKED DATE
APPROVED DATE
ISSUE DATE
CONTRACT NO.

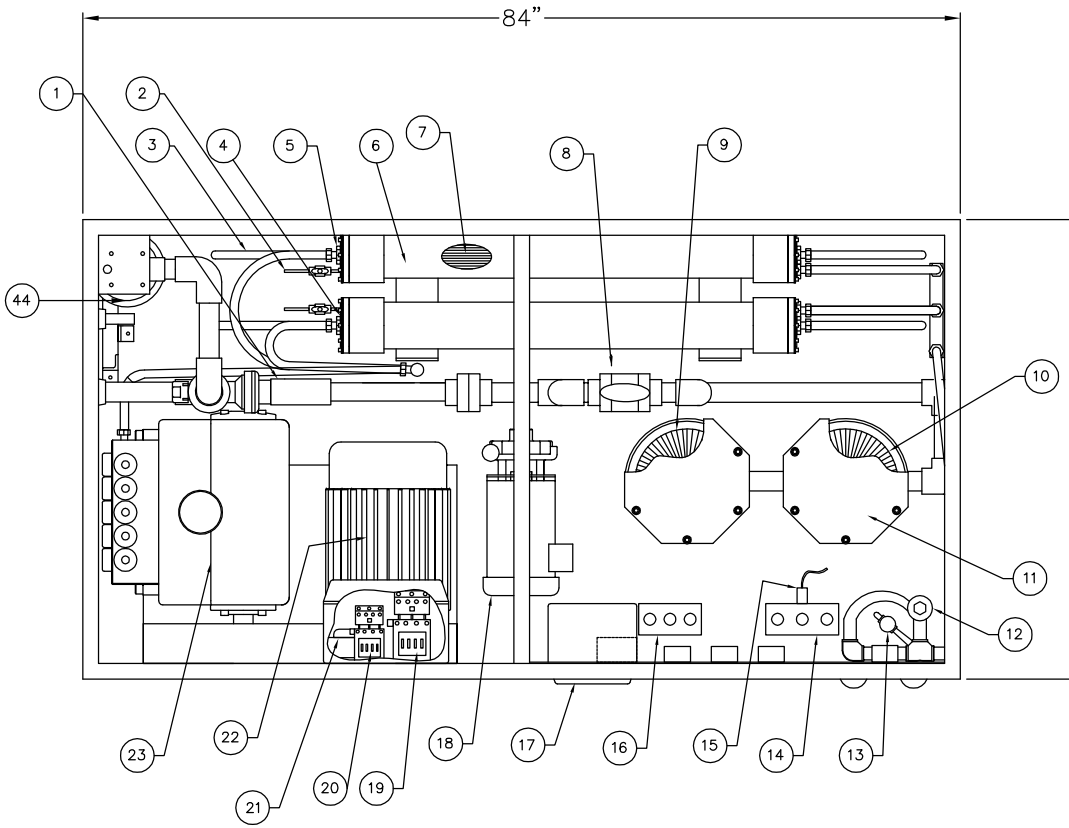
Village Marine Technology
2000 West 135th Street– Gardena – California 90249

PW3000–18000
GENERAL ARRANGEMENT & PARTS LIST

SIZE E | CAGE NO 62144 | DWG NO 11300 | REV H
SCALE ? | SHEET 1 OF 6

CAGE NO 62144 DWG NO 11300 REV H SHT 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE: LEVEL 2	3/19/99	JM
A	ADDED PRESSURE SWITCH AND NEMA BOXES	11/8/99	JM
B	ADDED PW20K INFORMATION	2/3/00	JM
C	3 PLUNGER 8K & 10K	3/13/00	JM
D	P/N FOR MOTOR PULLEY CHANGED PW4K	12/12/01	JM
E	UPDATED DRAWINGS, PART NUMBERS, AND VIEWS	08/20/04	BG
F	ADDED PWM VIEWS	11/02/04	BG
G	CORRECTED P/N FOR PC 8	12/08/04	BG
H	CORRECTED PWF DIMENSION DEPTH	06/07/05	BG

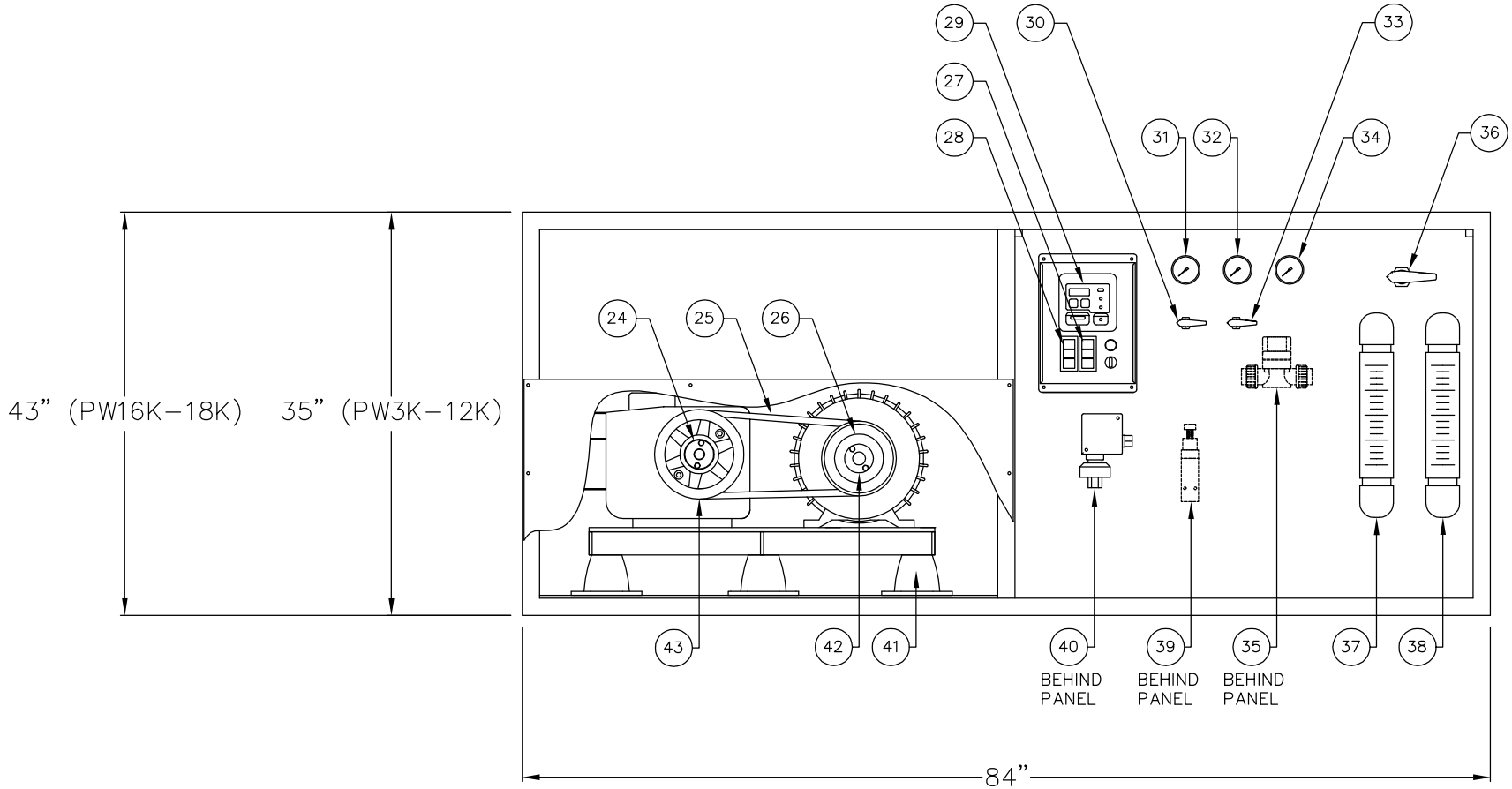


TOP VIEW

DRAWN JPM 8/17/99	SIZE E	CAGE NO 62144	DWG NO 11300	REV H
ISSUED ?	SCALE NONE			SHEET 2 OF 6

CAGE NO. 62144 DWG. NO. 11300 SHT 2 REV H

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE: LEVEL 2	3/19/99	JM
A	ADDED PRESSURE SWITCH AND NEMA BOXES	11/8/99	JM
B	ADDED PW20000 INFORMATION	2/3/00	JM
C	3 PLUNGER 8K & 10K	3/13/00	JM
D	P/N FOR MOTOR PULLEY CHANGED PW4K	12/12/01	JM
E	UPDATED DRAWINGS, PART NUMBERS, AND VIEWS	08/20/04	BG
F	ADDED PWM VIEWS	11/02/04	BG
G	CORRECTED P/N FOR PC B	12/08/04	BG
H	CORRECTED PWF DIMENSION DEPTH	06/07/05	BG



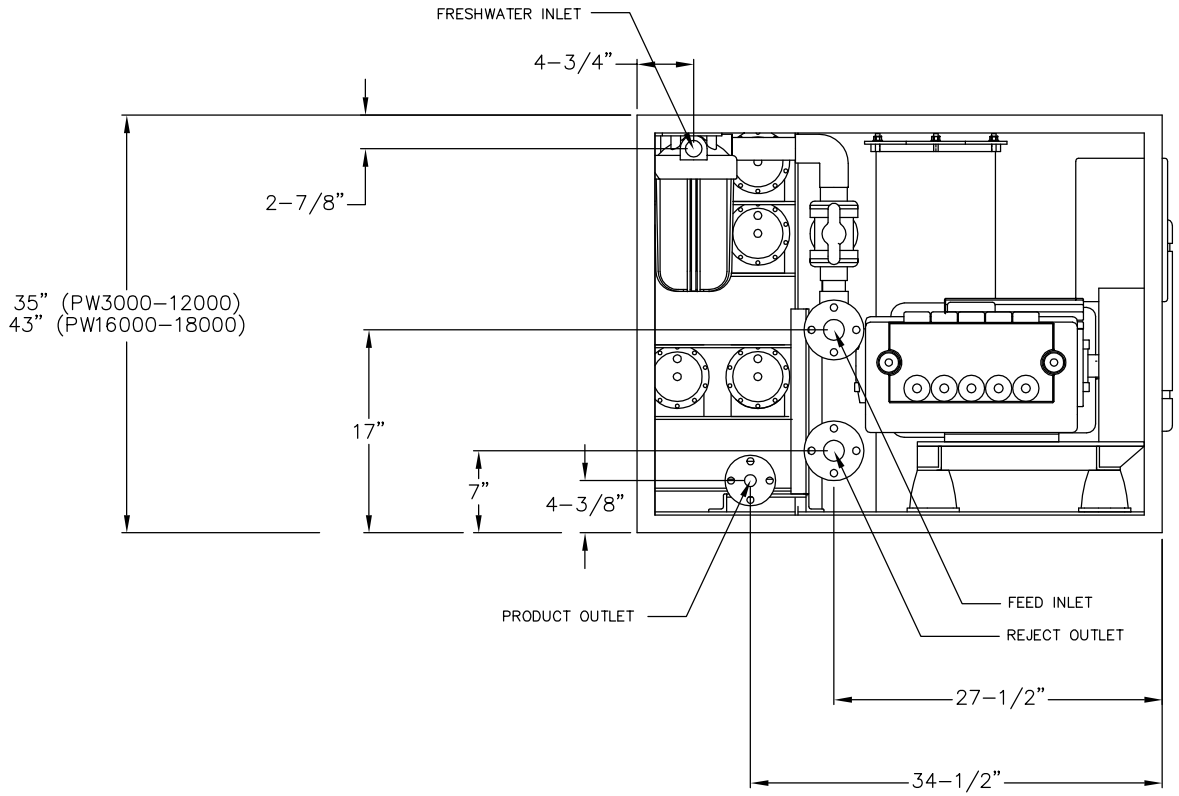
FRONT VIEW

DRAWN JPM 8/17/99	SIZE E	CAGE NO 62144	DWG NO 11300	REV H
ISSUED ?	SCALE NONE			SHEET 3 OF 6

CAGE NO. 62144 DWG NO. 11300 SHT 3 REV H

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE: LEVEL 2	3/19/99	JM
A	ADDED PRESSURE SWITCH AND NEMA BOXES	11/8/99	JM
B	ADDED PW20000 INFORMATION	2/3/00	JM
C	3 PLUNGER 8K & 10K	3/13/00	JM
D	P/N FOR MOTOR PULLEY CHANGED PW4K	12/12/01	JM
E	UPDATED DRAWINGS, PART NUMBERS, AND VIEWS	08/19/04	BG
F	ADDED PWM VIEWS	11/02/04	BG
G	CORRECTED P/N FOR PC 8	12/08/04	BG
H	CORRECTED PWF DIMENSION DEPTH	06/07/05	BG

SERVICE ENVELOPE
24" ABOVE UNIT
24" IN FRONT OF UNIT

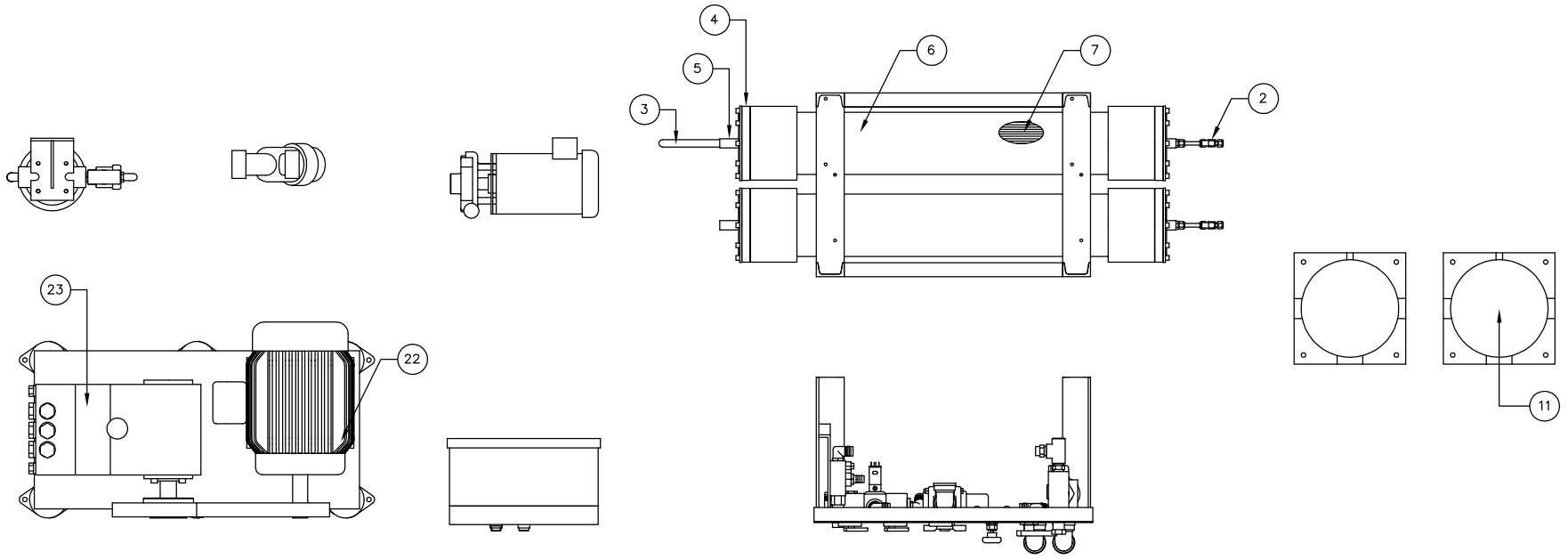


LEFT SIDE VIEW

DRAWN JPM 8/17/99	SIZE E	CAGE NO 62144	DWG NO 11300	REV H
ISSUED ?	SCALE NONE			SHEET 4 OF 6

CAGE NO 62144 DWG NO 11300 SHT 4 REV H

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE: LEVEL 2	3/19/99	JM
A	ADDED PRESSURE SWITCH AND NEMA BOXES	11/8/99	JM
B	ADDED PW20000 INFORMATION	2/3/00	JM
C	3 PLUNGER 8K & 10K	3/13/00	JM
D	P/N FOR MOTOR PULLEY CHANGED PW4K	12/12/01	JM
E	UPDATED DRAWINGS, PART NUMBERS, AND VIEWS	08/20/04	BG
F	ADDED PWM VIEWS	11/02/04	BG
G	CORRECTED P/N FOR PC 8	12/08/04	BG
H	CORRECTED PWF DIMENSION DEPTH	06/07/05	BG

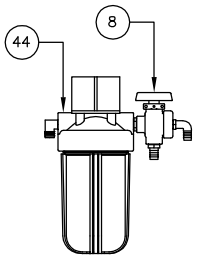


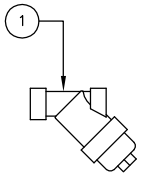
PWM – TOP VIEW

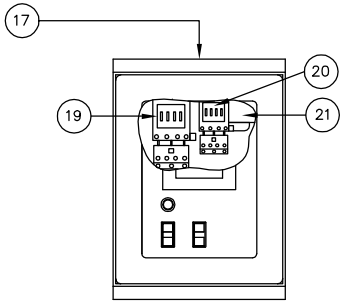
DRAWN JPM 8/17/99	SIZE E	CAGE NO 62144	DWG NO 11300	REV H
ISSUED ?	SCALE NONE			SHEET 5 OF 6

CAGE NO. 62144 DWG NO. 11300 SHT 5 REV H

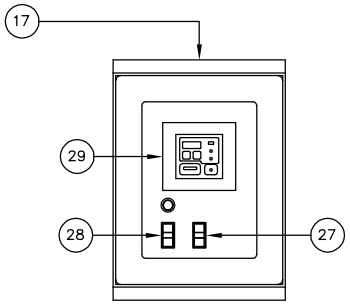
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE: LEVEL 2	3/19/99	JM
A	ADDED PRESSURE SWITCH AND NEMA BOXES	11/8/99	JM
B	ADDED PW20000 INFORMATION	2/3/00	JM
C	3 PLUNGER 8K & 10K	3/13/00	JM
D	P/N FOR MOTOR PULLEY CHANGED PW4K	12/12/01	JM
E	UPDATED DRAWINGS, PART NUMBERS, AND VIEWS	08/20/04	BG
F	ADDED PWM VIEWS	11/02/04	BG
G	CORRECTED P/N FOR PC 8	12/08/04	BG
H	CORRECTED PWF DIMENSION DEPTH	06/07/05	BG



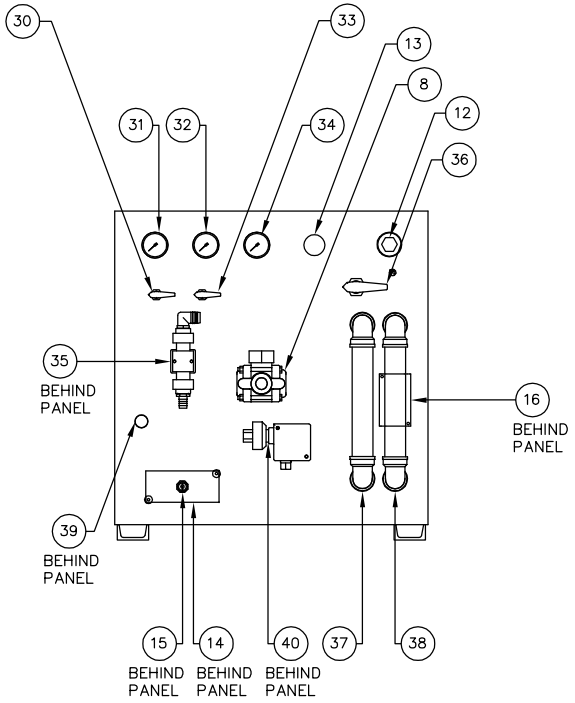


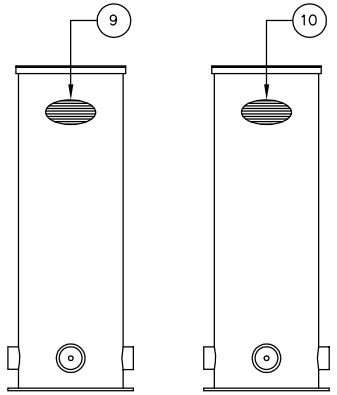


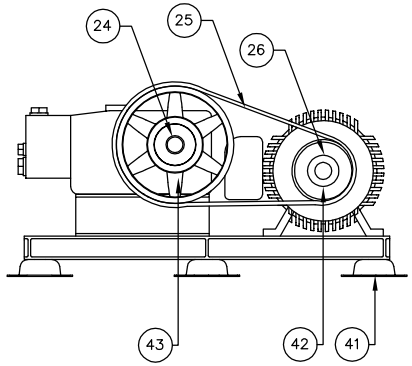
CONTROL BOX – INTERIOR

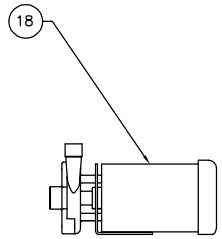


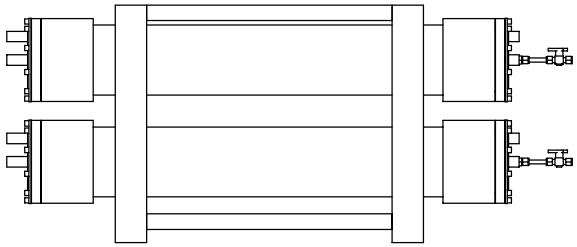
CONTROL BOX









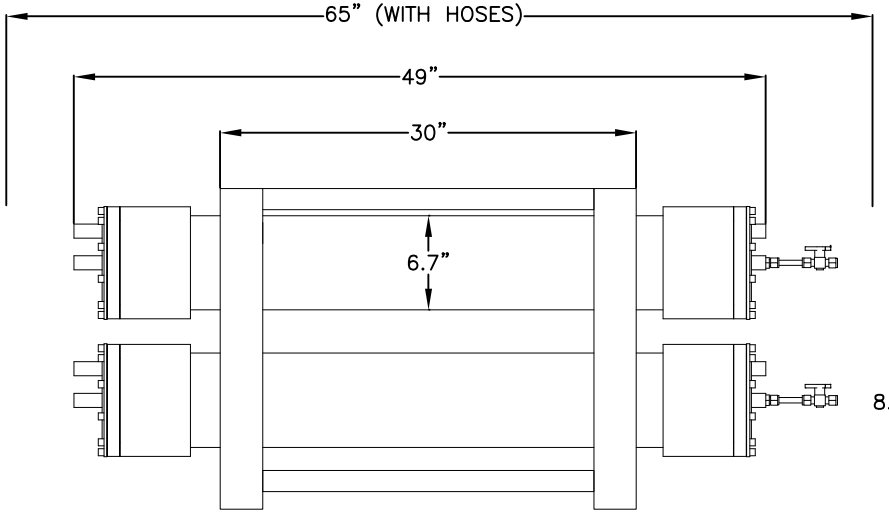


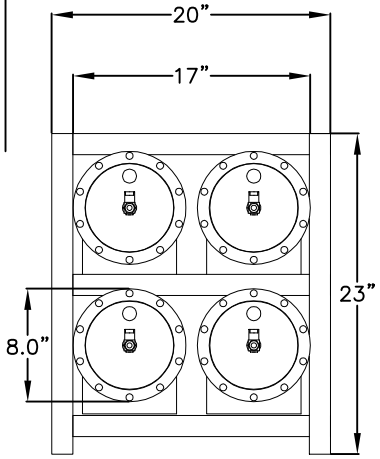
PWM – FRONT VIEW

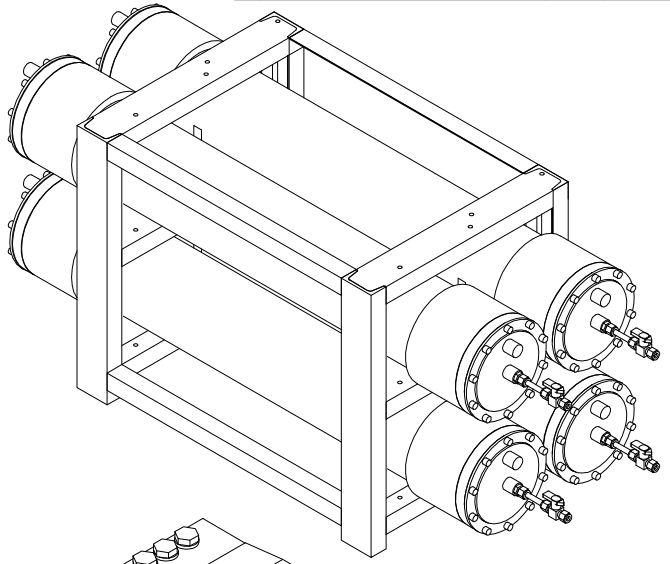
DRAWN JPM 8/17/99	SIZE E	CAGE NO 62144	DWG NO 11300	REV H
ISSUED ?	SCALE NONE		SHEET 6 OF 6	

CAGE NO 62144 DWG NO 11300 SHT 6 REV H

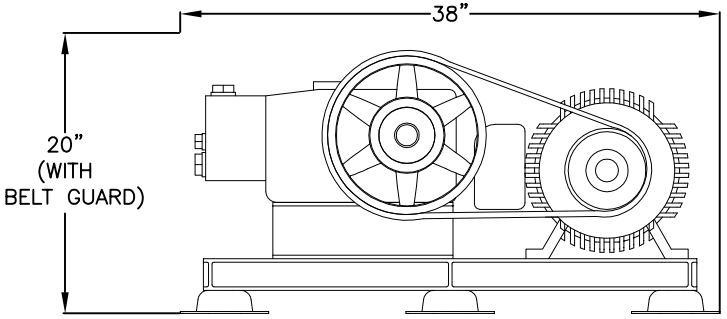
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	10/28/04	BG
A	ALIGNED PWM7K PRESSURE VESSEL ASSEMBLY VIEW	11/01/04	BG

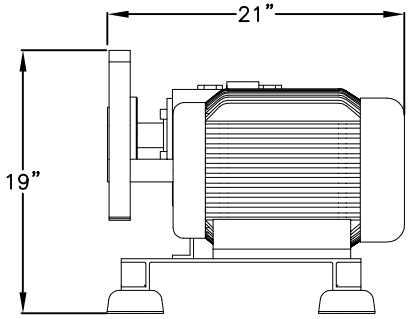


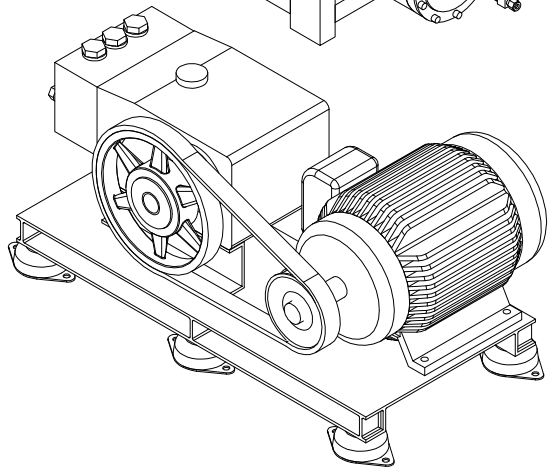




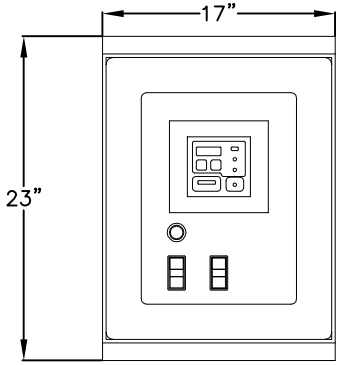
PRESSURE VESSEL ASSEMBLY

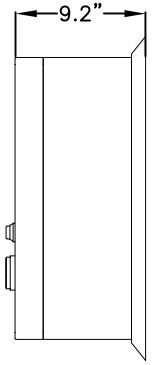


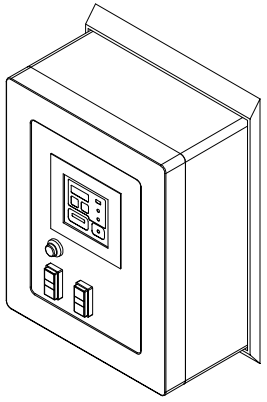




HIGH PRESSURE PUMP AND MOTOR







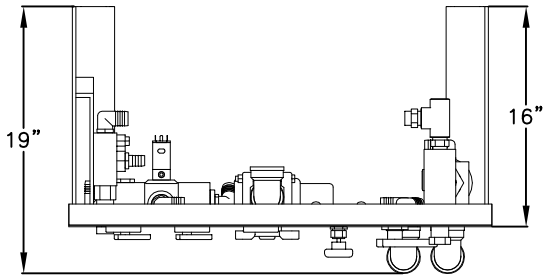
ELECTRONIC PANEL

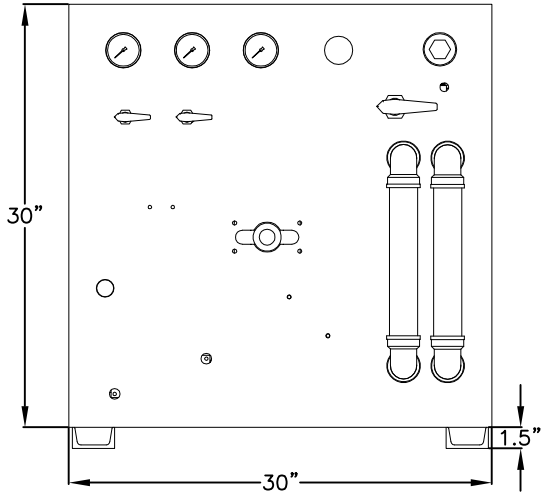
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	REVISION STATUS OF SHEETS
A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	

DRAWING FILE NO. 11303.DWG	Village Marine Technology, 2000 West 135th Street– Gardena – California 90249
DRAWN BG DATE 10-28-04	PURE WATER MODULAR
CHECKED DATE	GEN. ARRANGEMENT & DIM.
APPROVED DATE	PWM: 7000
ISSUE DATE	SIZE E · CAGE NO 62144 · DWG NO 11303 · REV A
CONTRACT NO.	SCALE – · SHEET 15 OF 30

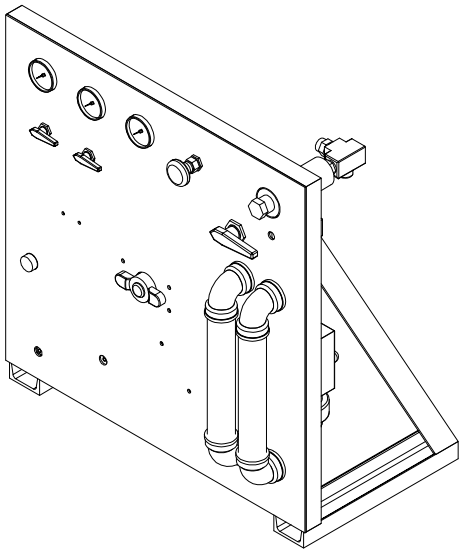
CAGE NO. 62144 DWG NO. 11303 REV. A SHT. 15

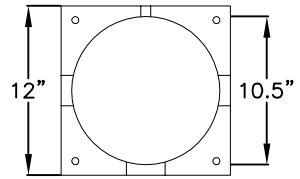
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	10/28/04	BG
A	ALIGNED PW7K PRESSURE VESSEL ASSEMBLY VIEW	11/01/04	BG

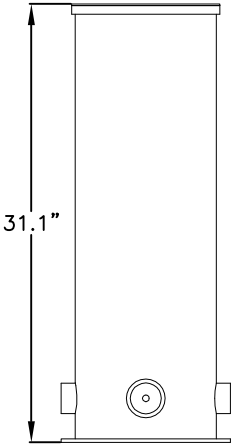


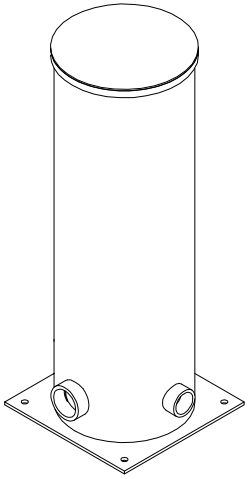


INSTRUMENT PANEL

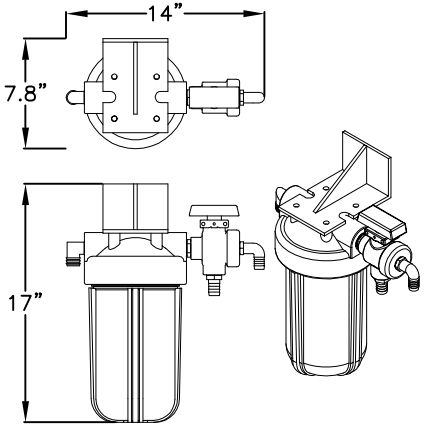




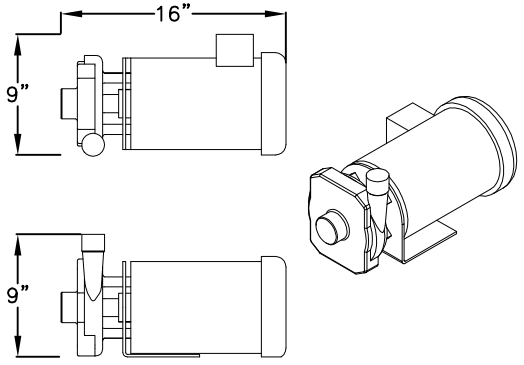




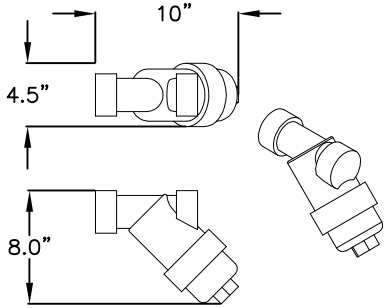
MICRON FILTER (2X) – 20 MIC AND 5 MIC



FLUSH FILTER



LOW PRESSURE BOOST PUMP



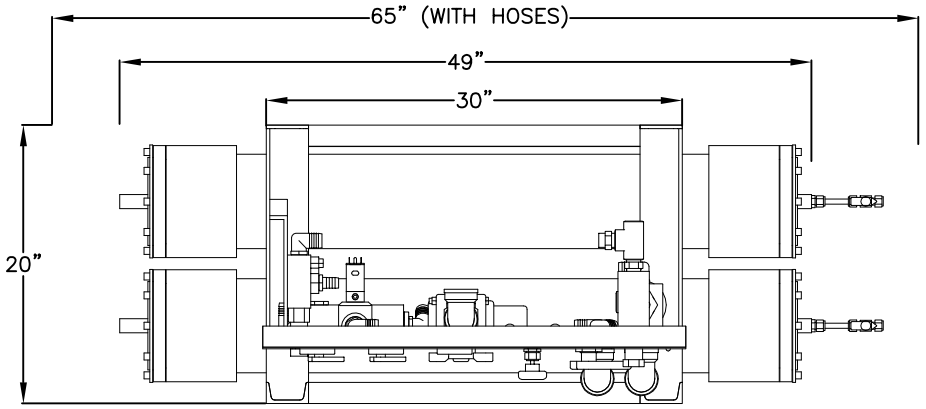
STRAINER (Y-TYPE)

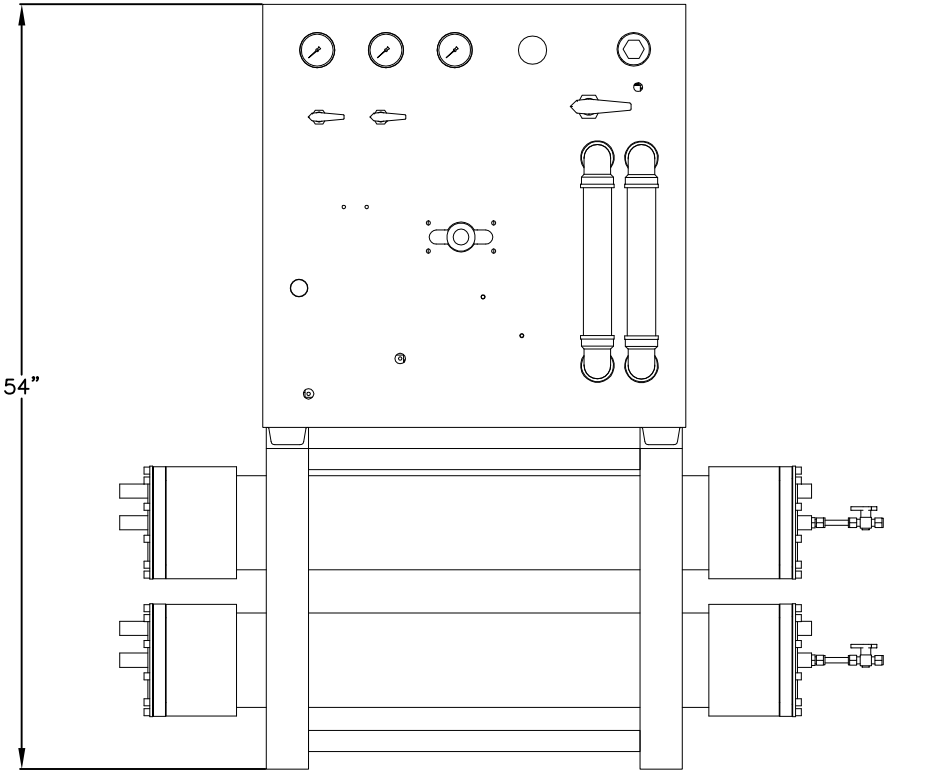
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	REVISION STATUS OF SHEETS
A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	

DRAWING FILE NO. 11303.DWG	Village Marine Technology, 2000 West 135th Street– Gardena – California 90249
DRAWN BG DATE 10-28-04	PURE WATER MODULAR GEN. ARRANGEMENT & DIM. PWM: 7000
CHECKED DATE	
APPROVED DATE	SIZE E · CAGE NO 62144 · DWG NO 11303 · REV A
ISSUE DATE	
CONTRACT NO.	SCALE – · SHEET 16 OF 30

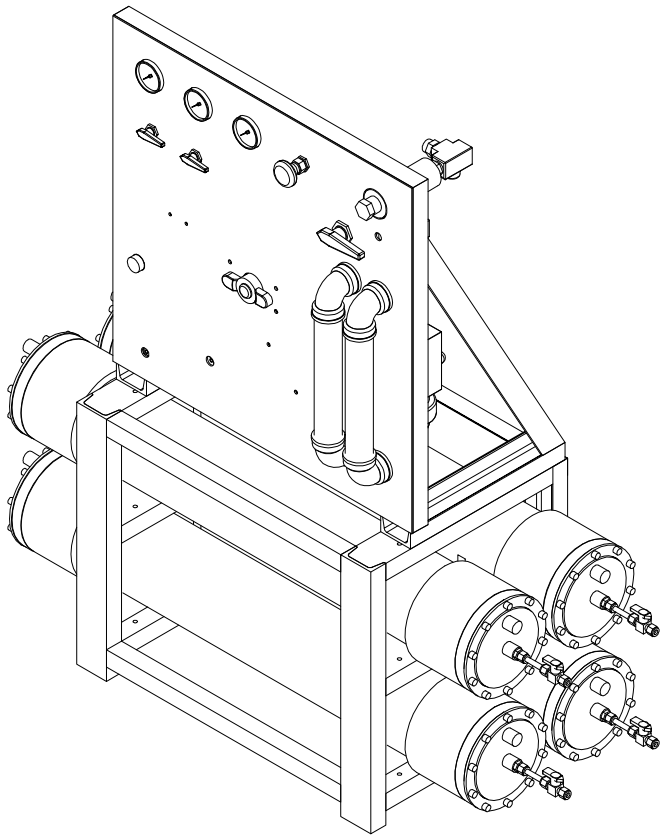
CAGE NO. 62144 DWG NO. 11303 REV A SHT 16

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	10/28/04	BG
A	ALIGNED PW7K PRESSURE VESSEL ASSEMBLY VIEW	11/01/04	BG





OPTIONAL CONFIGURATION



15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	REVISION STATUS OF SHEETS
A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	

CAGE NO. 62144 DWG NO. 11303 REV. A

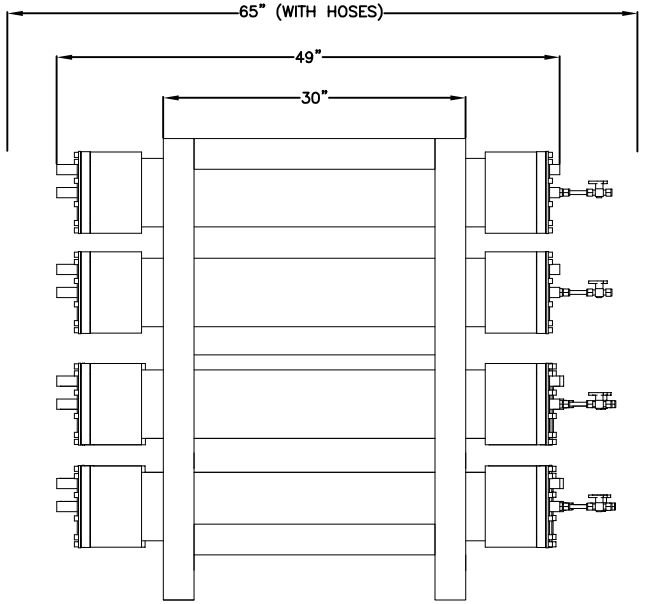
DRAWING FILE NO. 11303.DWG

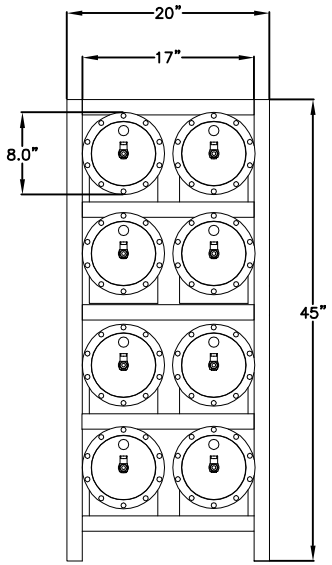
Village Marine Technology
2000 West 135th Street– Gardena – California 90249

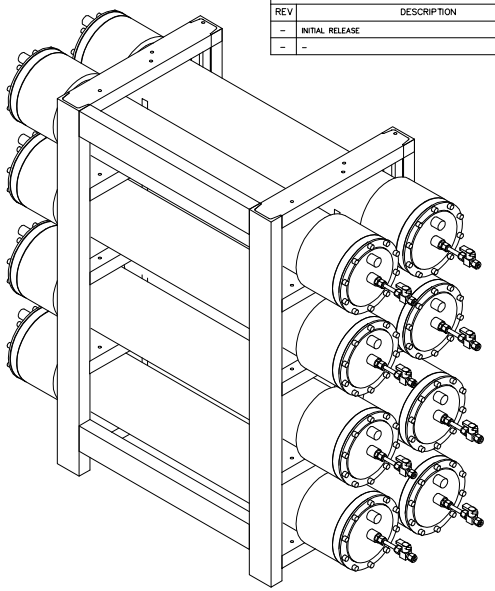
PURE WATER MODULAR
GEN. ARRANGEMENT & DIM.
PWM: 7000

DRAWN	BG	DATE	10-28-04	SIZE	E
CHECKED		DATE		CAGE NO	62144
APPROVED		DATE		DWG NO	11303
ISSUE DATE				REV	A
CONTRACT NO.				SCALE	–
				SHEET	17 OF 30

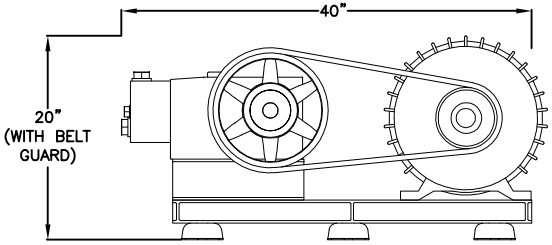
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	12/29/05	BG
–	–	–	–

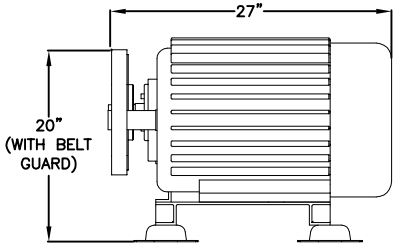


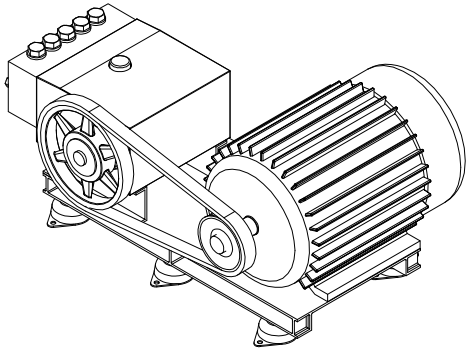




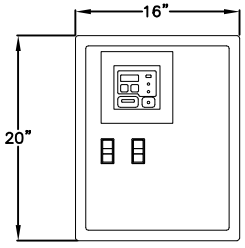
PRESSURE VESSEL ASSEMBLY

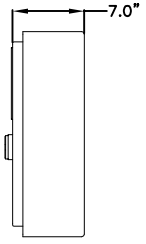


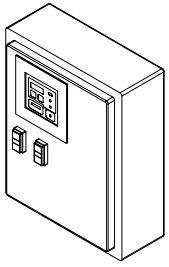




HIGH PRESSURE PUMP AND MOTOR







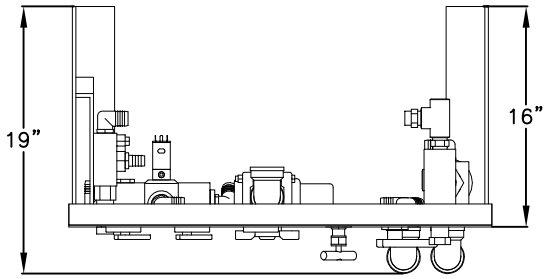
ELECTRONIC PANEL

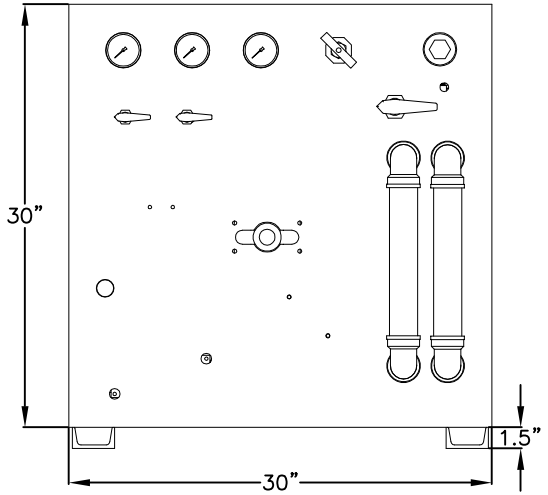
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	

CAGE NO. 62144 DWG NO. 11303 REV –

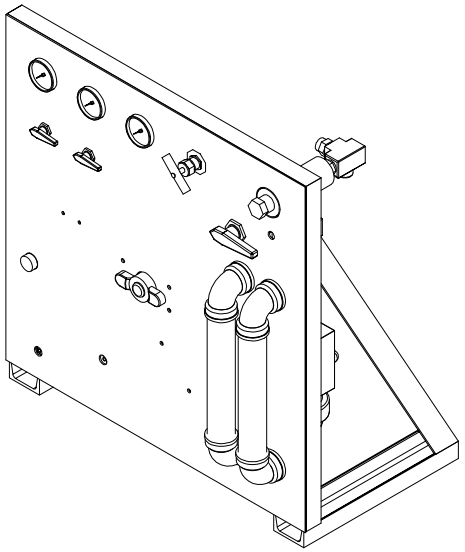
DRAWING FILE NO. 11303.DWG	Village Marine Technology 2000 West 135th Street– Gardena – California 90249
	PURE WATER MODULAR GEN. ARRANGEMENT & DIM. PWM: 16000–18000
DRAWN BG DATE 12-29-05	
CHECKED DATE	
APPROVED DATE	SIZE E · CAGE NO 62144 · DWG NO 11303 · REV –
ISSUE DATE	
CONTRACT NO.	SCALE – · SHEET 28 OF 30

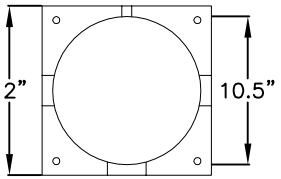
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	12/29/05	BG
–	–	–	–

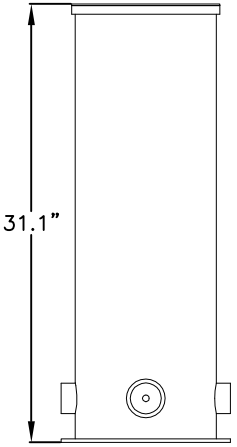


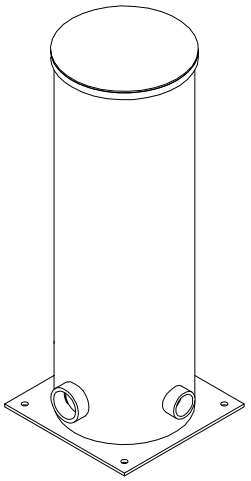


INSTRUMENT PANEL

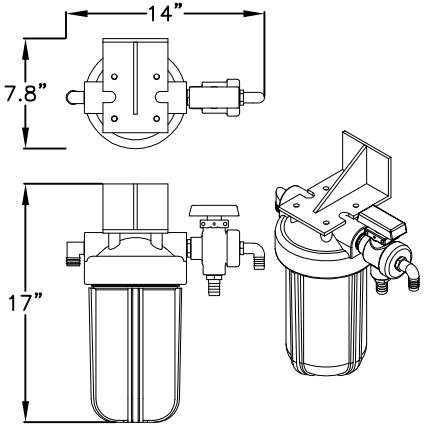




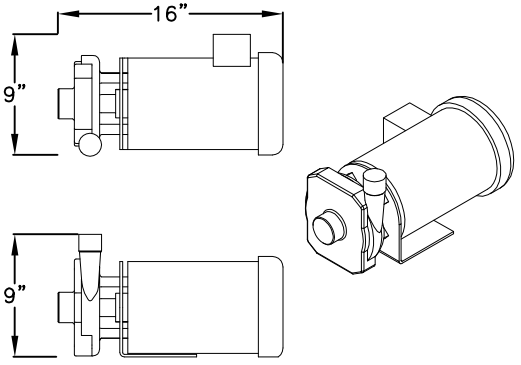




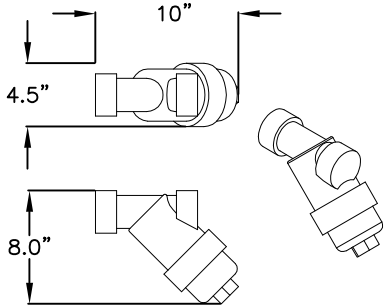
MICRON FILTER (2X) – 20 MIC AND 5 MIC



FLUSH FILTER



LOW PRESSURE BOOST PUMP



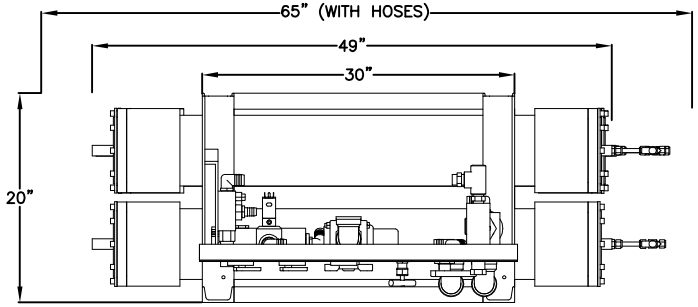
STRAINER (Y–TYPE)

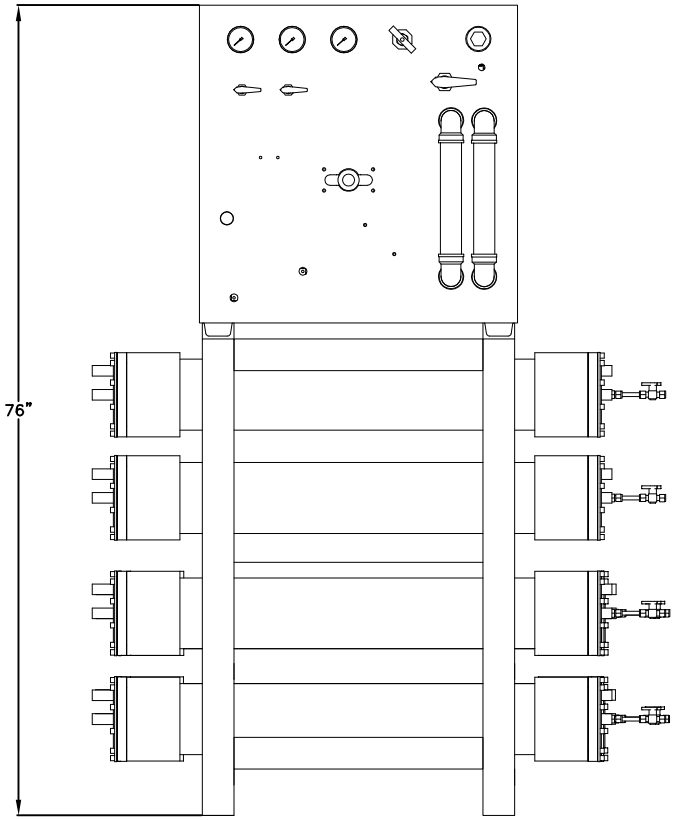
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	

DRAWING FILE NO. 11303.DWG	Village Marine Technology 2000 West 135th Street– Gardena – California 90249		
	PURE WATER MODULAR GEN. ARRANGEMENT & DIM. PWM: 16000–18000		
DRAWN BG DATE 12-29-05			
CHECKED DATE			
APPROVED DATE	SIZE E	CAGE NO 62144	DWG NO 11303 REV –
ISSUE DATE			
CONTRACT NO.	SCALE –		SHEET 29 OF 30

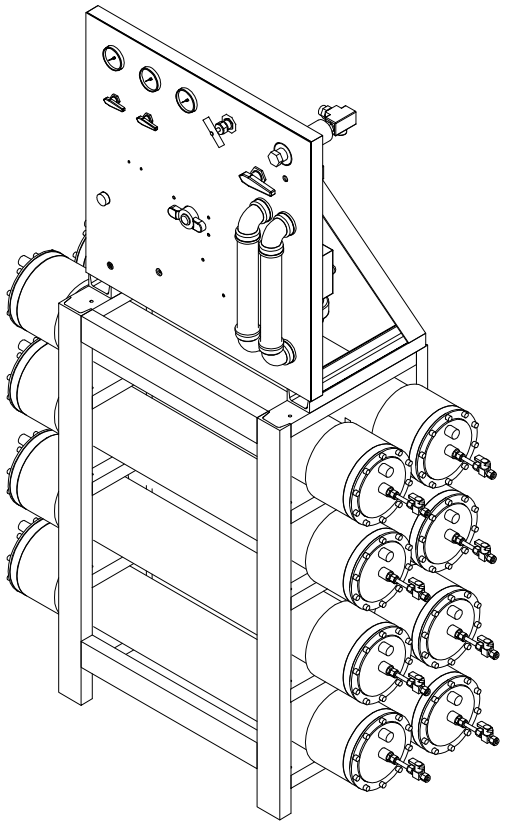
CAGE NO 62144 DWG NO 11303 REV – SHT 29

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	12/29/05	BG
–	–	–	–





OPTIONAL CONFIGURATION



15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	REVISION STATUS OF SHEETS
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	

CAGE NO. 62144 DWG NO. 11303 REV. A

DRAWING FILE NO. 11303.DWG

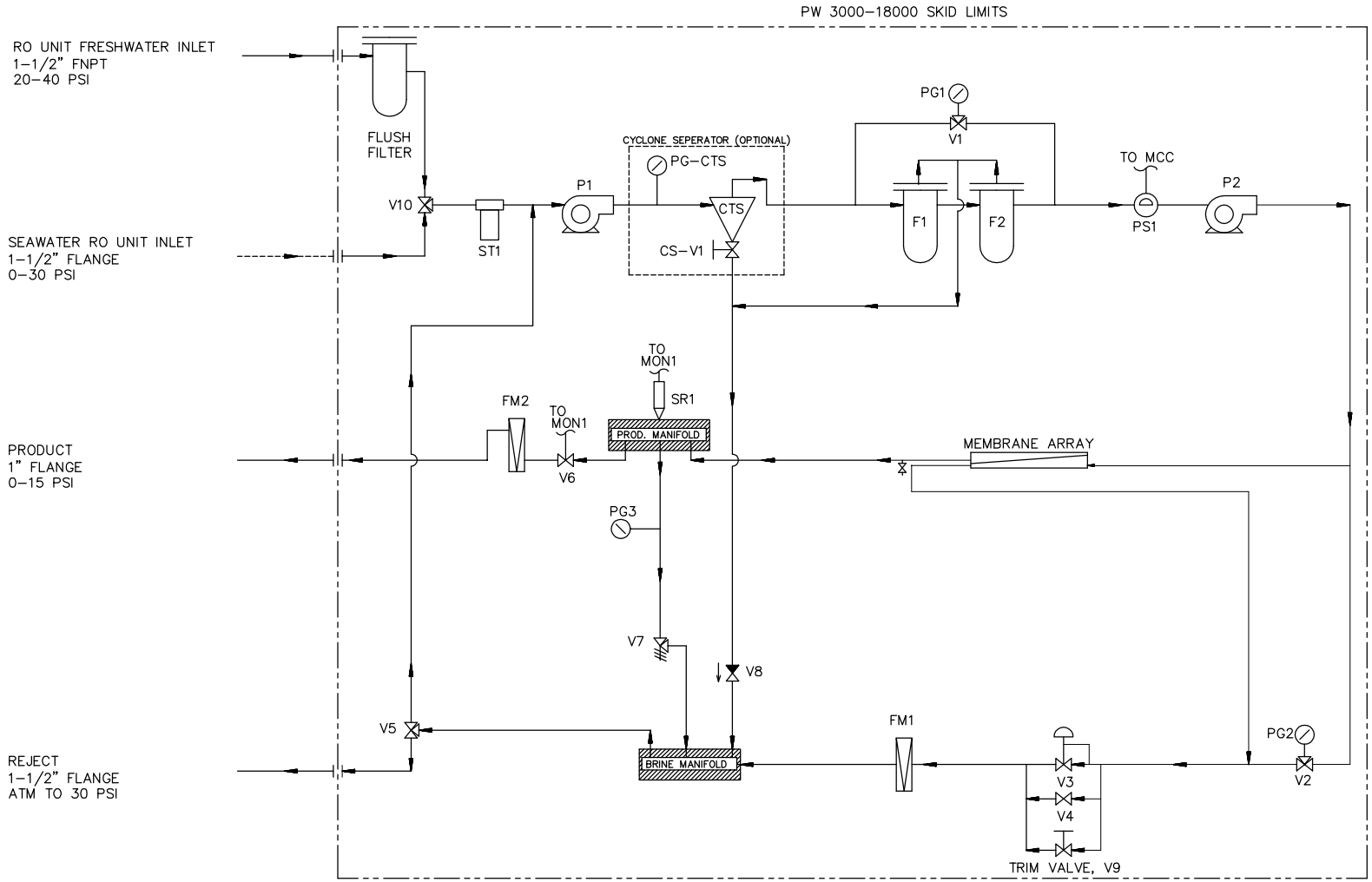
DRAWN BG DATE 12-29-05
CHECKED DATE
APPROVED DATE
ISSUE DATE
CONTRACT NO.

Village Marine Technology
2000 West 135th Street– Gardena – California 90249

PURE WATER MODULAR
GEN. ARRANGEMENT & DIM.
PWM: 16000–18000

SIZE E | CAGE NO 62144 | DWG NO 11303 | REV A
SCALE – | SHEET 30 OF 30

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	12/22/97	JM
A	UPDATED DWG: ASSIGNED SERIES NUMBER	08/13/04	BG
B	REASSIGNED SERIES NUMBER	11/02/04	BG



NOTE

PREFERRED INSTALLATION IS TO USE DEDICATED PRODUCT LINE TO TANK AND DEDICATED REJECT LINE TO OVERBOARD ABOVE WATER LINE.

IF SERVICE MUST BE TEED INTO A COMBINED LINE, USE VALVES TO ISOLATE UNIT AND TO PREVENT ANY POSSIBLE CROSS CONTAMINATION.

ISOLATION VALVES MUST BE FULLY OPEN BEFORE UNIT IS STARTED!

1	SH	REVISION STATUS OF SHEETS
B	REV	

DRAWING FILE NO. 11311.DWG

DRAWN JM DATE 12/22/97
CHECKED DATE
APPROVED DATE
ISSUE DATE
CONTRACT NO.

Village Marine Technology
2000 West 135th Street– Gardena – California 90249

PURE WATER 3K–18K (PW 3K–18K)
PIPING & INSTRUMENTATION DIAGRAM

SIZE	CAGE NO	DWG NO	REV
E	62144	11311	B

SCALE NONE SHEET 1 OF 1

CAGE NO 62144 DWG NO 11311 REV B

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	11/02/04	BG
–	–	–	–

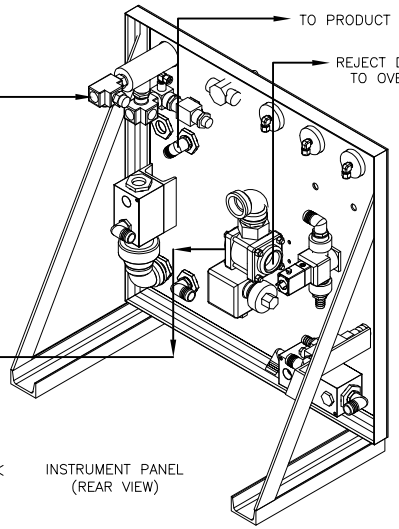
SEAWATER FROM DEDICATED INTAKE THROUGH–HULL AND SEACOCK

STRAINER

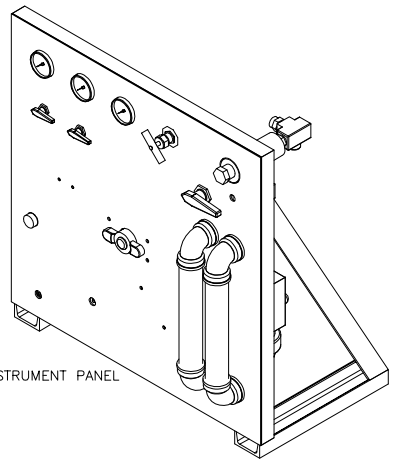
CONTROL PANEL

TO PRODUCT TANK

REJECT DISCHARGE TO OVERBOARD



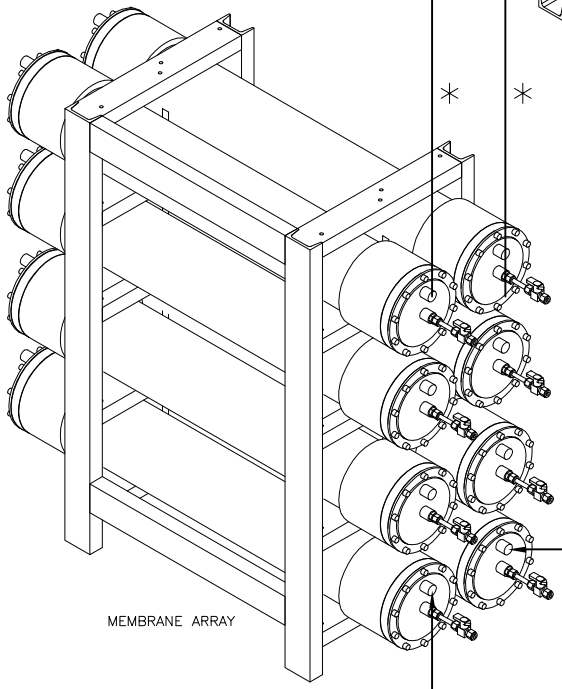
INSTRUMENT PANEL (REAR VIEW)



INSTRUMENT PANEL

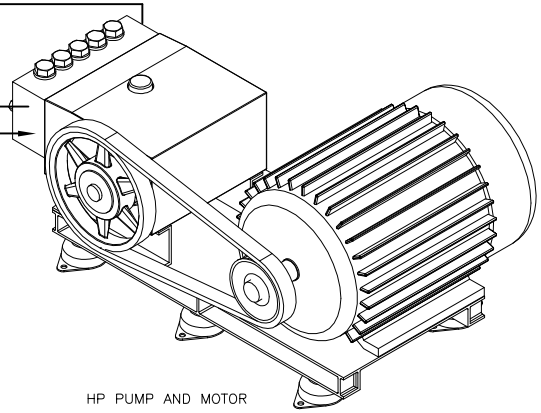
FRESHWATER FROM VESSEL'S ONBOARD SYSTEM, (UNDER PRESSURE – MAX. 35 PSI)

FLUSH SYSTEM

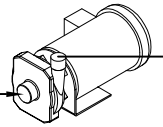


MEMBRANE ARRAY

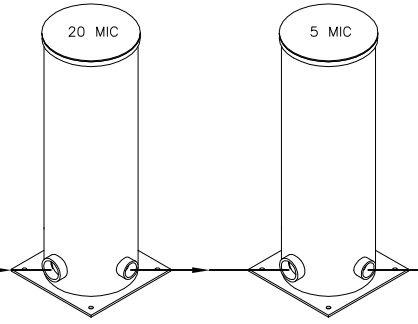
NOTE:
* PW 3000–8000 SINGLE HOSE
* PW 10000–18000 TWO HOSES



HP PUMP AND MOTOR



LP BOOST PUMP



MICRON FILTERS

1	REVISION STATUS OF SHEETS
–	

CAGE NO. 62144 DWG NO. 11323 REV –

DRAWING FILE NO. 11323.DWG

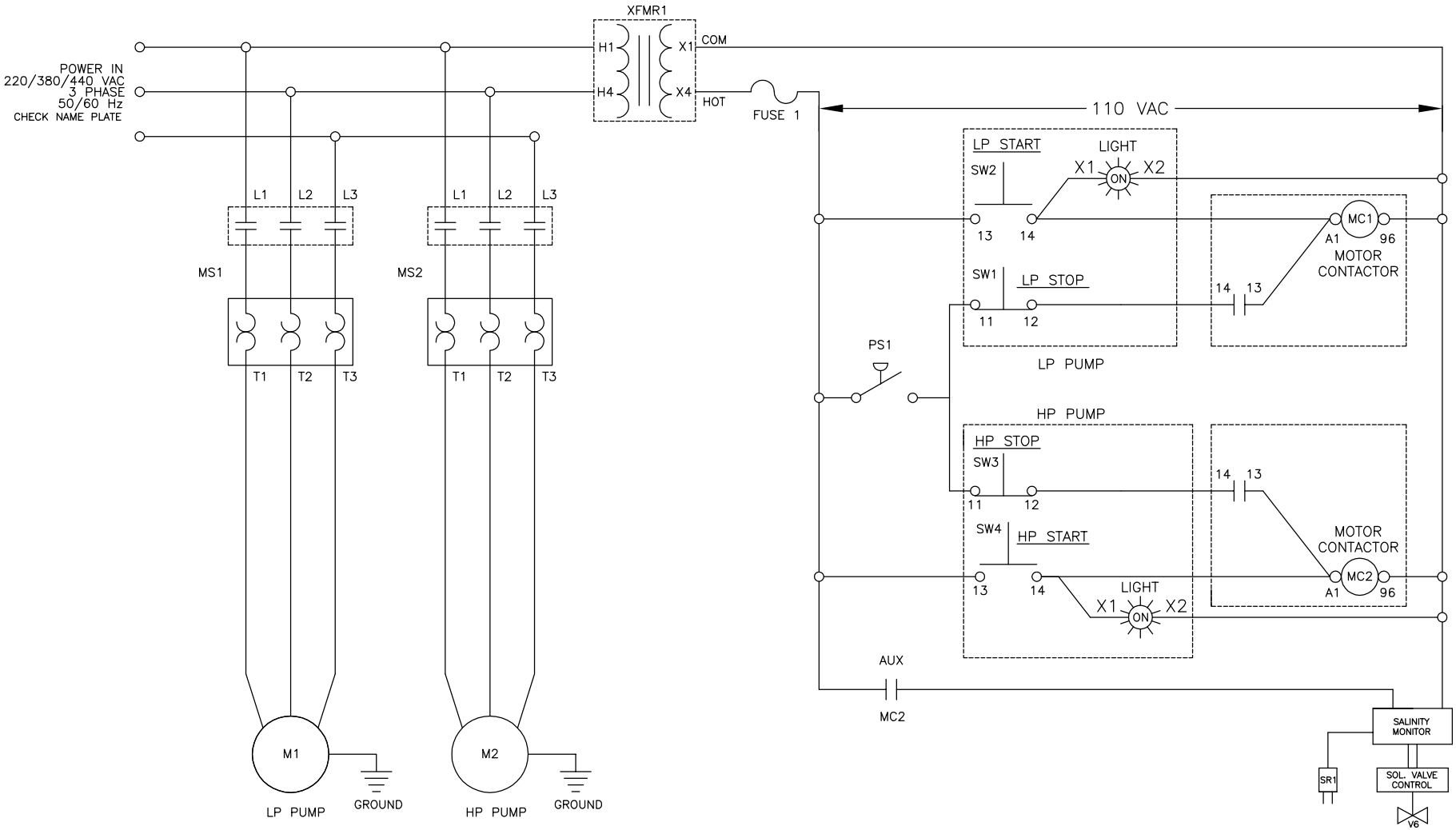
DRAWN BG DATE 12-29-05
CHECKED DATE
APPROVED DATE
ISSUE DATE
CONTRACT NO. ----------

Village Marine Technology
2000 West 135th Street– Gardena – California 90249

PURE WATER MODULAR
MODULAR CONFIGURATION
PW SERIES

SIZE E | CAGE NO 62144 | DWG NO 11323 | REV –
SCALE – | SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	07/19/99	JPM
A	INCLUDED MOTOR HEATERS	09/10/99	JPM
B	ASSIGNED SERIES NUMBER; REVISED VOLTAGES AND HP PUMP CONNECTION	07/20/04	BG

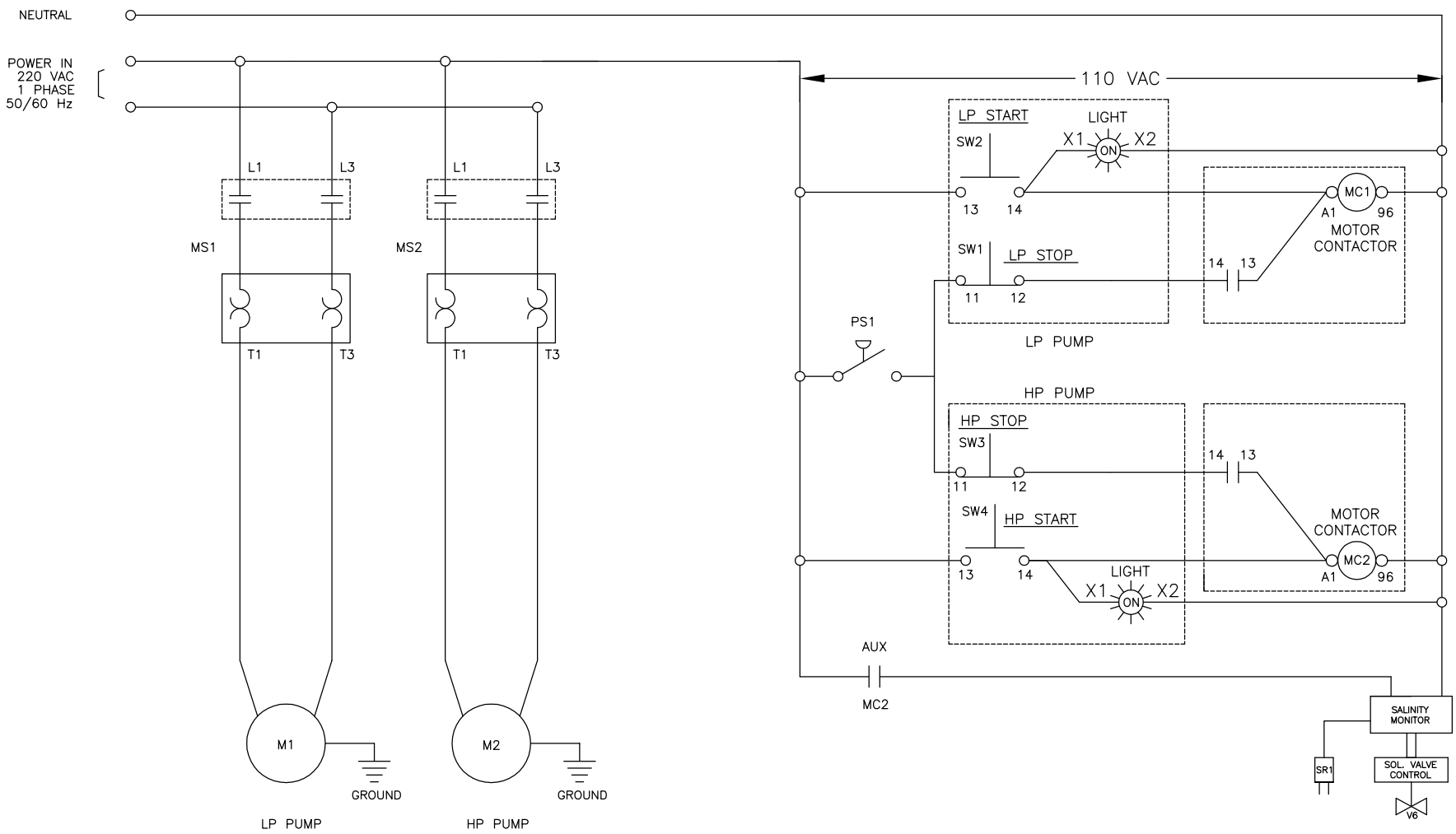


REVISION STATUS OF SHEETS		
2	1	
B	B	

CAGE NO. 62144 DWG NO. 11351 REV B

DRAWING FILE NO. 11351.DWG	Village Marine Technology 2000 West 135th Street– Gardena – California 90249		
	PURE WATER IND 3K–16K ELECTRICAL SCHEMATIC 220/380/440VAC 3PH 50HZ/60 HZ		
DRAWN JPM DATE 07-19-99			
CHECKED KOS DATE 09-10-99			
APPROVED DATE	SIZE E	CAGE NO 62144	DWG NO 11351 REV B
ISSUE DATE			
CONTRACT NO.	SCALE –		SHEET 1 OF 2

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	07/19/99	JPM
A	INCLUDED MOTOR HEATERS	09/10/99	JPM
B	ASSIGNED SERIES NUMBER; REVISED VOLTAGES AND HP PUMP CONNECTION	07/20/04	BG



2	1	REVISION STATUS OF SHEETS
B	B	

CAGE NO. 62144 DWG NO. 11351 REV B SHT 2 OF 2

DRAWING FILE NO. 11351.DWG	Village Marine Technology 2000 West 135th Street– Gardena – California 90249	
DRAWN JPM DATE 07-19-99 CHECKED KOS DATE 09-10-99 APPROVED DATE ISSUE DATE CONTRACT NO.	PURE WATER IND 3K–16K ELECTRICAL SCHEMATIC 220/1PH/50HZ OR 60HZ	
	SIZE E / CAGE NO 62144 / DWG NO 11351 / REV B SCALE – / SHEET 2 OF 2	

10.0 MANUFACTURER'S LITERATURE AND OPTIONS