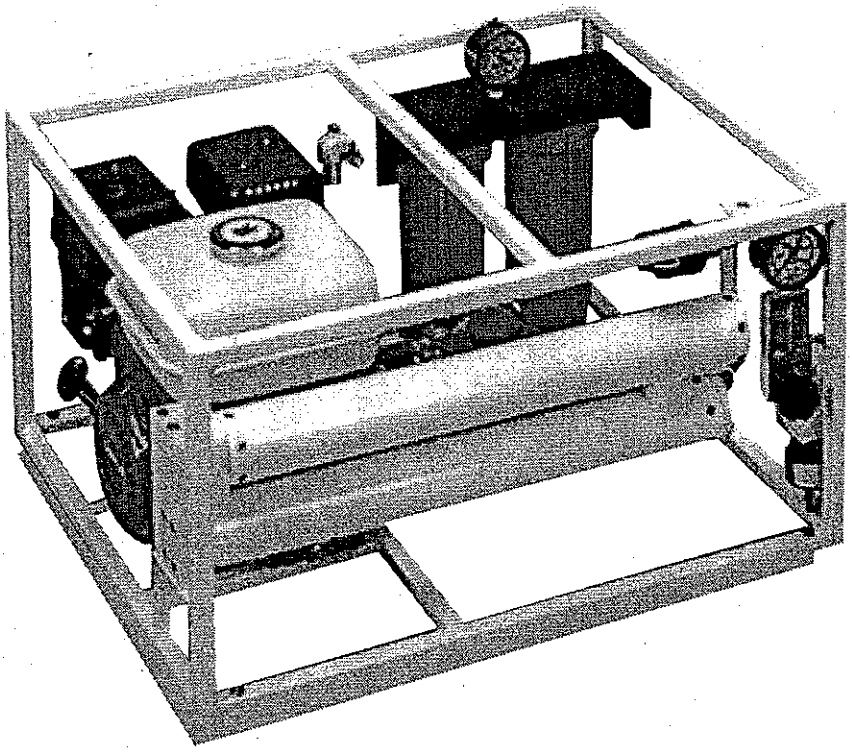
Sea Recovery®

REVERSE OSMOSIS DESALINATORS



SERVICE MANUAL

Aqua WaterPack™ 200/400

Gasoline Powered
Reverse Osmosis Desalinator

Post Office Box 2560, Gardena, CA 90247-0560, U.S.A.
Toll Free: 1-800-354-2000 • Telephone:1-310-637-3400 • Fax: 1-310-637-3430
E-Mail: <sea recovery@searecovery.com> • Website/Internet: <http://www.searecovery.com>

Sea Recovery®

SYSTEM IDENTIFICATION INFORMATION

INSTRUCTIONS: At the time of purchase of the Sea Recovery R.O. Desalinator, please complete the following information. In order to better serve you, this information may be requested by the Sea Recovery Service Department whenever contacting Sea Recovery for technical assistance or by the Sea Recovery Marketing Department whenever ordering parts.

System Information:

Model Number: _____ Serial Number: _____

Operating Voltage _____VAC; Cycles _____ Hz; Phase _____

Date Purchased: _____

The System is Equipped with the following Optional Equipment:

Feed Water Delivery Pump:	❑	
Pre Treatment:	❑	Specify _____
Post Treatment:	❑	Specify _____
Ultra Violet Sterilizer:	❑	
Remote Sound & Visual Alarm:	❑	
Remote Monitor:	❑	
Multi Media Filter	❑	
pH Neutralizing Filter	❑	
Other:	❑	Specify _____
Other:	❑	Specify _____

Dealer Information:

Dealer's Name: _____

Address: _____

City: _____

State: _____

Country: _____ Postal Code:_____

Dealer's Invoice Number:_____

Sea Recovery Corp.
P.O. BOX 2560, GARDENA, CALIFORNIA 90247-0560
U.S.A.

Sea Recovery®
WARRANTY REGISTRATION INFORMATION

INSTRUCTIONS: At the time of purchase of the Sea Recovery R.O. Desalinator, please complete the warranty information listed below. After completing this form please insert it into the supplied postage paid envelope and mail it to Sea Recovery Corp. Attn: Warranty Registration.

System Information:

Model Number: _____ Serial Number: _____

Date Purchased: _____

Dealer Information:

Dealer's Name: _____

Address: _____

City: _____

State: _____

Country: _____ Postal Code: _____

Dealer's Invoice Number: _____

Customer Information:

Customer Name: _____

Street Address: _____

City: _____

State: _____

Country: _____ Postal Code: _____

Mail to:

Sea Recovery Corp.
P.O. BOX 2560
GARDENA, CA 90247 U.S.A.
Attn: Warranty Registration

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HRO Systems Inc.™
P.O. BOX 2560
GARDENA, CALIFORNIA
90247-0560 U.S.A.
1-310-327-2600 OR 1-800-366-4476

1 INTRODUCTION

1.1 GENERAL DESCRIPTION

This manual describes the Horizon Reverse Osmosis (HRO) Waterpack Portable desalinators that provide up to 400 gallons per day of drinkable water from sea water. The systems covered by this manual are:

- **HRO System WP/200**
- **HRO System WP/400**

The system weighs under 100 pounds and is designed for dockside operation or aboard a marine vessel. The Waterpack is the first portable, gasoline driven watermaker for the Marine and RV industry. Manufactured by Standard Communications, these portable units are ideal for providing fresh drinking water aboard your boat, in remote locations, or wherever pure water is desired.

No installation is required. Simply secure the lightweight unit adjacent to the feed water source. The intake hose is placed into the ocean and the fresh water hose into your fresh water tank. The brine dump hose is routed overboard. Waterpack's compact design allows easy storage when not in use.

Each system consists of:

- **A pre-filtration assembly consisting of two housings with replaceable filters, vacuum gauge, and fittings;**
- **High-pressure pump integrated with a dependable Honda gasoline engine;**
- **Pressure-vessel assembly consisting of a tubular housing for the membrane element, and a manifold for flow direction and instrumentation attachments.**

1.2 IMPORTANT CONSIDERATIONS

Desalination is performed in the system by a process known as reverse osmosis. This process, the principles of which are described in Section 3.1, is simple and safe. However, when the system is installed on marine vessels, it generally becomes the primary source of potable water, and not a backup source. In effect, it becomes a life-support system. Because of this, it is extremely important that the system operator understand the basics of reverse osmosis and the specific means by which the process is performed, monitored, and controlled.

Because of its simplicity, it is easy to take for granted that safe water will always be available on demand. However, this is not the case; filters must be changed periodically, pump lubricant levels must be maintained, the membrane that performs the osmotic process must be kept from freezing, oil contamination or drying out, and must be protected with biocide if the system is shut down for a long time. One of the most important measures that can be taken to assure continued proper performance is to periodically evaluate the system's performance with its initial performance recorded when the system was first installed and checked out. By understanding the function and normal operation of each component in the system, the operator can easily diagnose problems. When such problems first develop, they may usually be corrected by minor maintenance. But if left unresolved, a problem in one component will affect the rest of the system and lead to an expensive major repair. Nevertheless, the most serious consequence of neglect can be that the system will not be available when needed.

HRO Systems Inc.™
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1-310-327-2600 OR 1-800-366-4476

2 SPECIFICATIONS

2.1 GENERAL

Performance specifications are nominal, unless otherwise indicated, and are subject to change without notice. If the membrane is used and maintained in accordance with this manual, the system should continue to provide water with 98.5% of the salts removed. Although membrane life cannot be specified due to variations in use, average life can be approximately five years if the system is used and maintained in accordance with this manual. Feedwater temperature has a significant effect on membrane performance, and must be considered when evaluating system productivity. A graph depicting the effects of temperature on the system is given in Section 2.4. Production is directly proportional to feedwater temperature.

2.2 NEW MEMBRANE PERFORMANCE

2.2.1 Test Conditions

System Pressure (psi) 800
Feedwater Temperature (°F/°C) 77/25
Feedwater Salinity (ppm) 35,000
Ph 8

2.2.2 Rated Performance

Potable Water Production Capacity
(U.S. gallons per hour + /- 15%):
SYSTEM WP/200 . . . . . 8 gph
SYSTEM WP/400 . . . . . 16 gph
Minimum Salt Rejection 98.5%
Total Dissolved Solids (TDS)
in Product Water (micro mhos/cubic cm) 1050
(approximately 800 ppm NaCl) . . . . . + /- 10%

2.3 GENERAL SPECIFICATIONS

Potable Water Conductivity
(micro mhos + /-10%) 1600
(approximately 800 ppm NaCl)

Automatic High Pressure Shutdown . . . . 900 psi

Feedwater Temperature Range . . . . . 33 to 120°F
. . . . . (1 to 48.5°C)
Product Water Temperature = Feedwater + 2°

Fuel Consumption . . . . . 1gal regular unleaded
. . . . . for three hours running time
Pre-Filtration . . . . (2) Pleated Polyester-20 micron

2.3.1 Total System Weight (Lbs)

System WP/200 91
System WP/400 98

2.3.2 Dimensions (in inches)

	Width	Depth	Height
Frame Dimensions	27	21	15.5

2.3.3 Water Connections:

Feedwater Inlet . . . . . 3/4" I.D. Hose
Brine/Product Dump . . . . . 1/2" I.D. Hose
Product Water Outlet . . . . . 1/4" I.D. Hose

CAUTION

Do not operate the system in an area where heavy contamination from oil or other chemical or industrial wastes are likely to be brought in contact with the membrane.

2.4 EFFECTS OF TEMPERATURE CHANGES

The operator of a reverse-osmosis system must be aware that feedwater temperature has a significant effect on system performance. The effects of feedwater temperature, whether constant or fluctuating, are predictable. Figure 2-1 is a graph relating feedwater temperature to system productivity at a constant pressure setting. The graph is based on a new system processing water of varying temperatures. The same relative performance can be expected in systems as they age. System performance will, of course, also be affected by worn or dirty components. Referring to the graph for an example, at a feedwater temperature of 77°F, (25°C), and an operating pressure of 800 psi, the operator can expect 100 percent, + /-15 percent, of the rated flow of 200 or 400 gallons per day (gpd). For another example, feedwater temperature is 68 °F (20 °C), and the operating pressure is again 800 psi. Referring to the graph, the operator can expect 85 percent, + /-15 percent, of the rated flow, or 170 gpd (System WP/200) or 340 gpd (System WP/400).

To arrive at the seawater temperature for use on the graph, add 2 degrees to the actual temperature taken of the seawater or recorded in Table 4-2. This is because friction and pressure add 2 degrees to the feedwater temperature before it reaches the membrane.

2.5 OPTIONAL EQUIPMENT

The following are available from the factory or HRO Dealers as optional equipment and accessories (see Section 8.2 for ordering):

a. Total Dissolved Solids (TDS) Meter, Part Number 111002006A. Allows testing of product water.

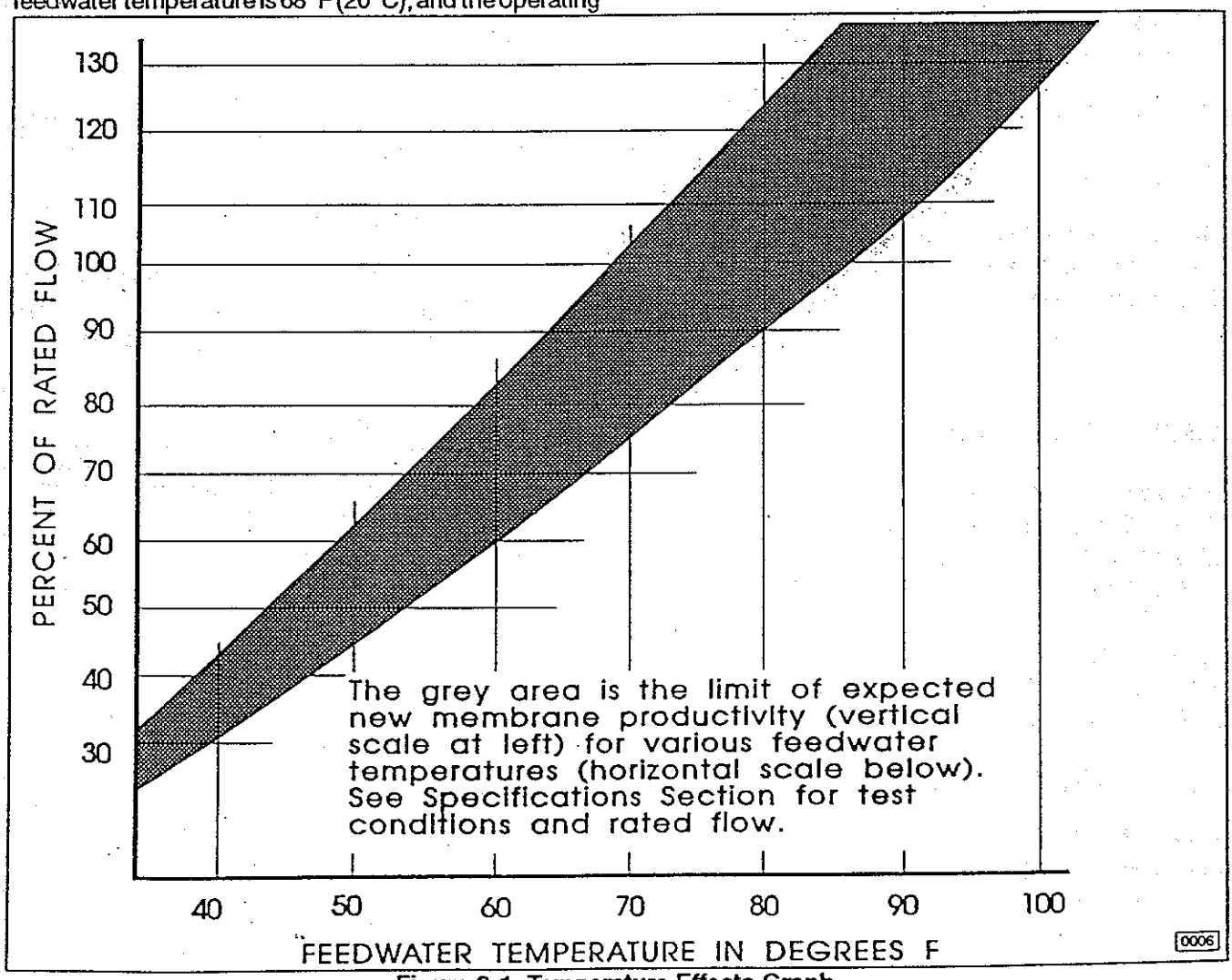


Figure 2-1. Temperature Effects Graph

2.6 CONSUMABLE SUPPLIES

The following items are available from the factory or HRO Dealers for system maintenance:

a. HRO CCK2 Membrane Cleaning Kit. Contains acid and alkaline cleaning compounds for membrane maintenance.

b. HRO PMK8/9 Maintenance Kit. Contains filter elements, acid and alkaline cleaning compounds and biocide for membrane maintenance, and oil for the high-pressure pump.

c. HRO SC Storage Chemical Kit. Contains biocide chemicals for three membrane storage cycles.

d. High-pressure pump lubricant, 21-ounce bottle, Part Number 603001001A. Note that 1 bottle is provided with the system, 3 bottles in HRO PMK8/9 kit, and that the crankcase holds 10 oz.

e. Filter elements (the system uses two), Part Number 593001006A.

3 DESCRIPTION

3.1 REVERSE OSMOSIS

The HRO System operates by drawing in sea water and forcing it through a semi-permeable membrane to remove salt. Sea water that does not pass through the membrane is discharged overboard and water that passes through the membrane is routed to fresh-water tanks, providing up to 200 or 400 gallons per day of potable water. The heart of the system is a synthetic, semi-permeable membrane. The term semi-permeable means that the membrane is penetrable by certain solutions and impenetrable by others. In natural osmosis, when an organic, semi-permeable membrane exists between two fluids of differing salinity or ionic composition, the fluid of lower salinity will pass through the membrane into the fluid of higher salinity. The process will continue until both fluids are of the same salinity or until the lower-salinity solution is expended. This will occur naturally, without requiring pressure on either side of the membrane. In fact, this natural osmosis is the reason that sea water cannot safely be consumed. The fluid in the organs of the body, being lower in dissolved salts than the ingested sea water, will migrate through the organ's membranes and into the seawater, leaving the organs dehydrated and unable to function. Reverse osmosis is not a naturally occurring process: high pressure is used to force fluid to flow over the surface of a synthetic membrane, causing some of the fluid to be stripped of its salt as it is forced to the low- pressure side of the membrane. Excess fluid and salt ions that cannot penetrate the membrane are discharged from the system as waste. The quantity of fluid processed, in this case water, depends on several factors. These include sea water salinity and temperature, acceptable product water salinity, feedwater pressure on the membrane, and membrane surface area.

3.2 BASIC SYSTEM DESCRIPTION

Proper operation of the membrane is critical to the success of a reverse osmosis process. The sea water must be filtered to protect the pump and to prevent debris from coming into contact with the membrane. Pressure inside the pressure vessel must be controlled to obtain a flow high enough to result in an adequate supply of processed water, yet low enough not to rupture the membrane or system plumbing. Because of the many variables involved in proper operation, the process must be simple to control, monitor, and maintain. All these requirements are met by the HRO System described in this manual. Although all components are interdependent, the system can be most easily operated and maintained if it is perceived as consisting of the following two subsystems:

- **Pre-filtration subsystem**
- **Pressurization subsystem**

The following paragraphs briefly describe the function of each subsystem.

NOTE

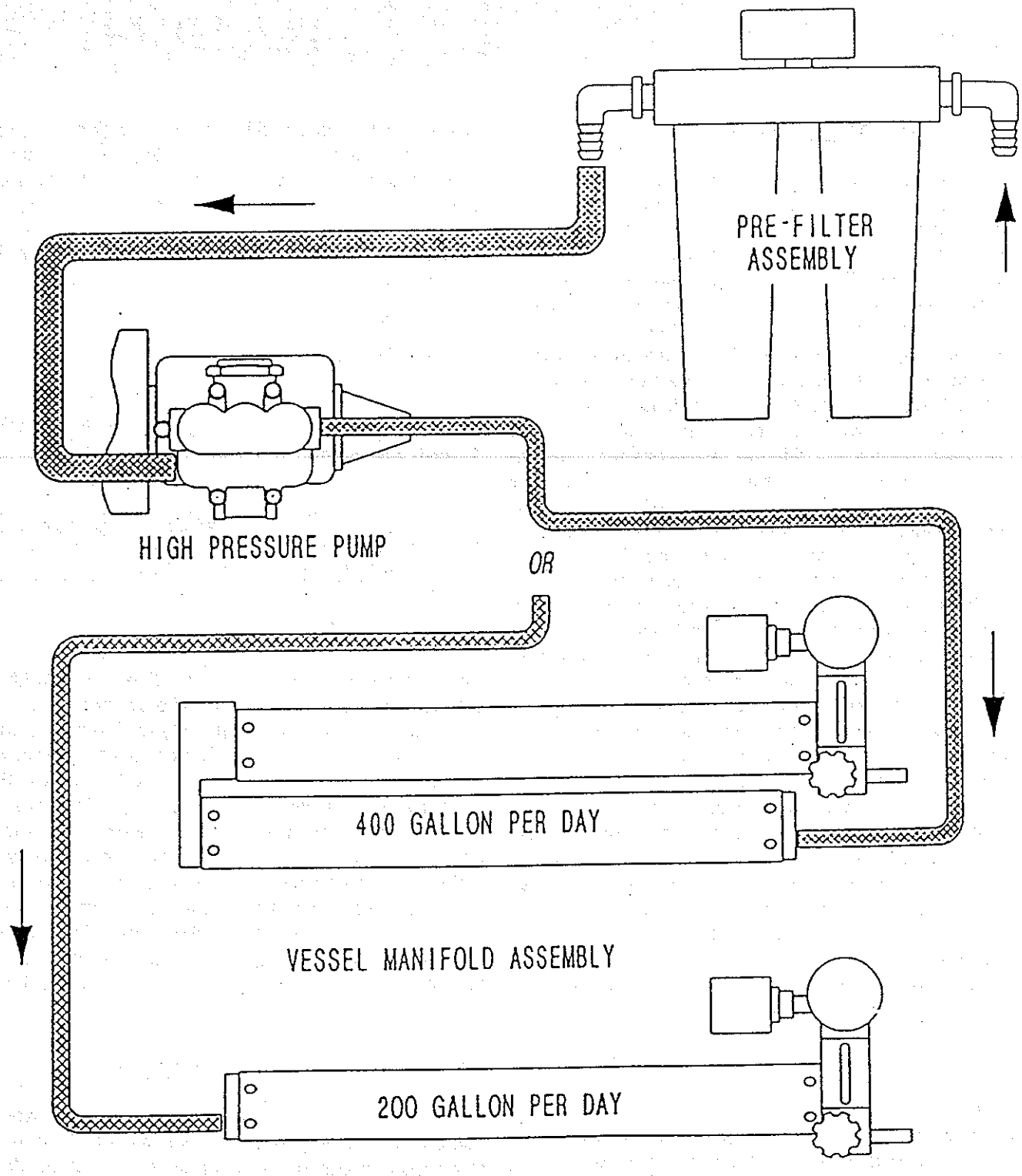
Controls and indicators to which the operator has access for normal operation are indicated in upper-case letters throughout this manual.

3.2.1 Pre-Filtration Subsystem

This subsystem consists of two filters, a VACUUM GAUGE, and plumbing. The two filters remove particles as small as twenty microns (twenty millionths of a meter). The VACUUM GAUGE indicates suction exerted by the high-pressure pump to pull sea water through the pre-filtration subsystem. Part of the vacuum is due to the height, if any, of the pump above sea level. The other part is due to all restrictions in the pre-filter subsystem, including size of piping, fittings, and filter conditions. After installation, vacuum will gradually increase as the filters become filled with trapped particles. This gradual change allows the operator to monitor the condition of the subsystem and determine when to change the filters.

3.2.2 Pressurization Subsystem

Reverse osmosis takes place in this subsystem, which consists of an engine-driven, positive displacement, high-pressure pump and a pressure vessel/manifold assembly. The pump/engine is an integrated unit that draws water into the system through the pre-filter subsystem at a constant rate. Pressure is maintained within the pump, inside the high-pressure side of the vessel, and in the hose connecting the pump and the vessel.


PRE-FILTER
ASSEMBLY
HIGH PRESSURE PUMP
OR
400 GALLON PER DAY
VESSEL MANIFOLD ASSEMBLY
200 GALLON PER DAY

3.2.2.1 Pressure Vessel/Manifold Assembly

The following components are attached to the manifold:

- **Pressure Vessel with enclosed Membrane**
- **Product Flow Controller**
- **0-1500 psi Pressure Gauge**
- **High-Pressure Switch**
- **Flow Meter**
- **Low-Flow Switch**

The first four items above are part of the Pressurization Subsystem; they are described in the following paragraphs. The last two items are part of the Monitoring and Diversion Subsystem and are described in Section 3.2.3.

3.2.2.2 Membrane

A replaceable membrane is enclosed in the pressure vessel. A brine seal is located on the end of the membrane nearest the feedwater inlet. The position of this brine seal is very important when replacing a membrane. If the membrane becomes damaged (such as by freezing or drying out), or fails to respond to the preventive or corrective measures described in Sections 5 and 6, it should be replaced.

3.2.2.3 Product Flow Controller

The PRODUCT FLOW CONTROLLER is a manually operated valve located on the front of the manifold below the FLOW METER. This valve directly affects pressure on the feedwater side of the membrane in the pressure vessel, and indirectly affects product water flow through the FLOW METER. Clockwise rotation closes the valve and increases pressure and product water flow; counterclockwise rotation opens it. Valve adjustment should be done slowly while monitoring the PRESSURE GAUGE. If the flow rate listed in the Specifications Section is not achieved by the time pressure reaches 800 psi, no further pressure increase should be applied. If the specified flow rate cannot be achieved within this range, first check the Temperature Effect Graph in Section 2 to determine flow rate vs temperature.

3.2.2.4 Pressure Gauge

The PRESSURE gauge is located on the pressure vessel manifold immediately above the FLOW METER. It is calibrated from 0 to 1500 psi, and indicates pressure on the feedwater side of the membrane in the pressure vessel. The gauge is filled with glycerine to dampen pulsations caused by the high-pressure pump. Pressure indicated is controlled by the PRODUCT FLOW CONTROLLER. Changes in pressure affect flow through the membrane and therefore through the FLOW METER. The PRODUCT FLOW CONTROLLER should be adjusted so that indicated pressure does not exceed 800 psi.

3.2.2.5 High-Pressure Switch

This switch is located on the left-hand side of the manifold. There are no field-adjustable controls for the switch; it is factory adjusted to shut down the system if pump output pressure reaches 900 psi.

3.2.3 Monitoring and Diversion Subsystem

This subsystem consists of the following:

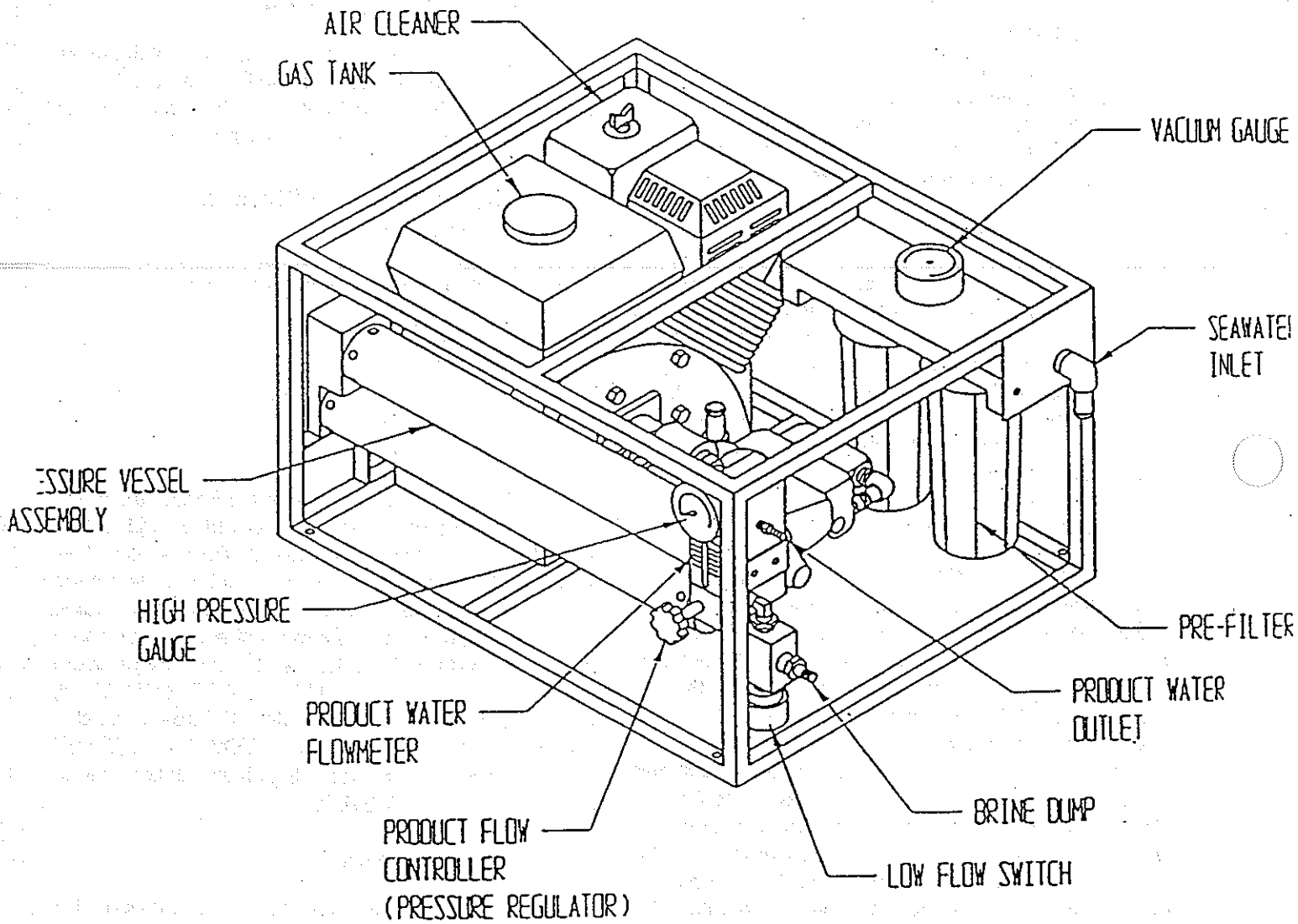
- **FLOW METER**
- **LOW-FLOW SWITCH**

3.2.3.1 Flow Meter

The FLOW METER is located on the front of the manifold. It consists of a vertical acrylic block with a free semi-floating ball in it that moves up with increased flow. Water in the meter has passed through the membrane in the pressure vessel and so is called product water. Flow through the meter is directly affected by pressure on the feedwater side of the membranes. This pressure is controlled by the PRODUCT FLOW CONTROLLER, located just below the FLOW METER. There is a delay between the time the PRODUCT FLOW CONTROLLER is adjusted and a corresponding change in flow is indicated by the FLOW METER.

3.2.3.2 Low-Flow Switch

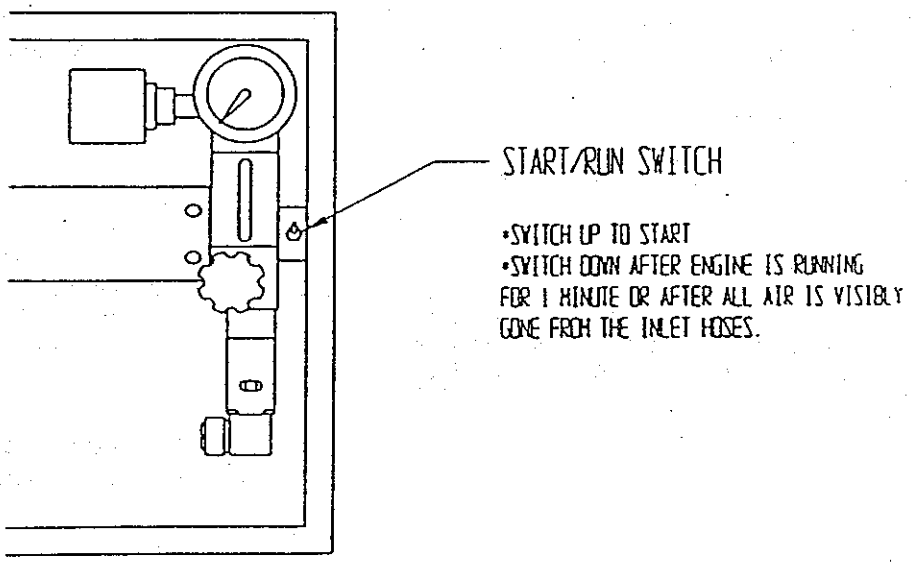
The low-flow switch is attached to the one port of a manifold block (the block forms a plumbing tee) whose output is connected to the discharge hose. The switch is connected via cable to the engine's oil switch circuit. Electrical contacts in the switch are normally open. When low flow occurs (approximately 2 gph), the contacts close, sending a signal to the engine to stop. Low flow could result from losses due to a ruptured hose, broken fitting, loose hose clamp, or an obstruction in the system flow path. A shutdown under these conditions protects the system.


AIR CLEANER
GAS TANK
VACUUM GAUGE
SEAWATE
INLET
ESSURE VESSEL
ASSEMBLY
HIGH PRESSURE
GAUGE
PRE-FILTER
PRODUCT WATER
OUTLET
PRODUCT WATER
FLOWMETER
BRINE DUMP
PRODUCT FLOW
CONTROLLER
(PRESSURE REGULATOR)
LOW FLOW SWITCH

4 OPERATION

Table 4-1. Normal Startup and Operation

1. Secure the Waterpack at or near water line. **Unit must not be higher than 5 ft. from feed water source.**
2. Place inlet hose and brine discharge hose into feed water source and product water hose into water tank.
3. Check engine oil and fuel levels for proper amounts.
4. Check pump oil level.
5. Turn the PRODUCT FLOW CONTROLLER fully counterclockwise. This opens the valve and lessens initial start-up load on the system.
6. Turn the fuel valve to the **"ON"** position.
7. Move the choke lever to the "CLOSE" position. **Do not use the choke if the engine is warm or the air temperature is high.**
8. Turn the engine switch to the **"ON"** position.
9. Position the start/run switch in the **"START"** position.
10. Pull the starter grip lightly until resistance is felt, then pull briskly.
11. As the engine warms up, gradually move the choke lever to the "OPEN" position.
12. Slowly turn the PRODUCT FLOW CONTROLLER until the flow specified in the Specifications Section is achieved, but do not exceed 800 psi on the PRESSURE GAUGE. If the flow is not correct, first check performance against the Temperature Effects Graph.
13. Position the Start/Run switch in the **"RUN"** position.



This Section contains instructions for normal system operation. Table 4-1 is the normal startup and operating procedure.

NOTE

Table 4-1 is for use only after the system has already been operated successfully at least once. Do not use the table for first-time operation. Instead, read, understand, and comply with the contents of this entire Operation Section.

4.1 SOURCE WATER

Make sure that the water source for the system does not contain the following:

- **Dirt, silt, or mud**
- **Solid matter (seaweed, floating debris, etc)**
- **Industrial waste.**

The membrane can reject some types of industrial waste. However, water containing such waste should be analyzed, and the results reported to an HRO distributor before an attempt made to use the system to remove it. If the source water has too great an iron content, for example, it will be unacceptable for use with a standard HRO system. Petroleum and fish oils cannot be cleaned from a membrane. For operation with brackish or low-salinity water, refer to Section 4.1.1.

4.1.1 Operation in Low-Salinity Areas

In addition to oceans, harbors, and inland seas, the system will operate in areas of lower salinity such as lakes, rivers and estuaries. Because of lower salinity, product water flow rates will be higher than for sea water. For low salinity operation, adjust flow rate by reducing pressure to obtain product water flow not to exceed 8 gph + /-15% (WP/200) or 16 gph + /-15% (WP/500).

CAUTION

Failure to observe this procedure will cause excessive recovery (the percentage of water in the system made potable by passage through the membrane) and will prematurely foul the membrane.

4.2 INITIAL STARTUP PROCEDURE

WARNING

The vessel/manifold assembly is filled with biocide prior to shipping. This keeps the membrane from drying out and inhibits biological growth. If the biocide is ingested, it may cause irritation of the gastrointestinal tract, colic, diarrhea, or other similar symptoms. Product water must be diverted overboard for 60 minutes in order to flush the system of the biocide. Refer to Sections 4.2.1 and 4.2.2 for procedures.

Skip this section and go to Section 4.4 (Normal Startup and Operation) if the following conditions have been met:

a. The system has been flushed of biocide;

b. The system has been operated at least one hour within the specifications of Section 2;

c. Initial operating data has been recorded in Section 4.4. If these conditions have not been met, perform all of Sections 4.2.1 through 4.3.

4.2.1 Pre-Operation Check

Before attempting to operate the system for the first time, perform the following checks:

1. Inspect the oil and fuel levels on the engine, be sure they are at proper levels.
2. Inspect all plumbing connections and verify that they are tight.
3. Inspect the oil level in the sight glass on the pump. It should be at the full indicator mark.

4.2.2 Flushing the System

CAUTION

Do not run the system dry for longer than 30 seconds. Check the brine dump outlet for a flow of water coming out of the system. If there is no flow within 30 seconds, stop the system and check for obstructions or leaks from components, tubing, or connections.

1. Prime the system by opening the pre-filter housings, filling each one with clean, filtered water, and closing them tightly.
2. Open the PRODUCT FLOW CONTROLLER by turning it fully counterclockwise.

3. Place the inlet hose and brine discharge hose into the feed water source. Insert the product water hose into the feed water source.
4. Turn the fuel valve to the **"ON"** position.
5. Move the choke lever to the **"CLOSE"** position.
6. Turn the engine switch to the **"ON"** position.
7. Position the Start/Run switch in the **"START"** position.
8. Pull the starter grip lightly until resistance is felt, then pull briskly.
9. As the engine warms up, gradually move the choke lever to the **"OPEN"** position.
10. Position throttle to full engine speed.
11. Check the VACUUM GAUGE for a reading of one to six inches of mercury.
12. After approximately ten seconds running time, increase the system pressure by slowly turning the PRODUCT FLOW CONTROLLER clockwise. Continue turning the valve until flow is initiated, but do not exceed 800 psi.
13. Position the Start/Run switch in the **"RUN"** position.

NOTE

There will be a delay from the time the PRODUCT FLOW CONTROLLER is adjusted to when the FLOW METER shows a change. This is a normal condition and is caused by a lag in water travel through the system, and by air trapped in the components or in the tubing.

14. When the product water flow stabilizes, after one to two minutes, readjust the PRODUCT FLOW CONTROLLER to achieve a flow rate not to exceed 8 gph + /-15% (WP/200) or 16 gph + /-15% (WP/400), but do not exceed 800 psi. Check the temperature chart of Figure 2-1 in the Specifications Section to verify that the flow is within the specified range. If leaks develop from any system component or connection, stop the system. After fixing the problem, restart the system, and slowly adjust the PRODUCT FLOW CONTROLLER until the correct flow is achieved. Always change the PRODUCT FLOW CONTROLLER slowly, allowing the water flow to react to the pressure change. Gradual adjustments will avoid over-pressurizing the system, which will cause it to shut down automatically. If this happens, turn the PRODUCT FLOW CONTROLLER slightly counterclockwise to decrease pressure, and restart the system.
15. Allow the system to run in this flush mode for one hour and then stop the system by turning the engine switch to the **"STOP"** position.
16. Insert the product water hose into the product water tank. This concludes the flushing procedure.

4.3 RECORDING INITIAL SYSTEM PERFORMANCE

After one hour of continuous operation within the specified flow range, record system performance data on the form provided in Table 4-2. Under normal conditions, the system will perform as indicated in Section 2, Specifications. Initial system performance in particular should correlate closely with those specifications. By making a record of the initial operating data, the operator can quickly determine what change has occurred, and which component is involved. Initial system performance records are the primary aid in diagnosing problems, recognizing system degradation, and in scheduling maintenance. Performance monitoring and scheduled preventive maintenance prevent costly repairs.

4.4 NORMAL START UP AND OPERATION

After the system has been satisfactorily operated at least once and operating pressure, vacuum, and flow rate have been recorded, the system may be started using the procedures given in Table 4-1 at the beginning of this Section.

4.4.1 Precautions

a. Turning the PRODUCT FLOW CONTROLLER clockwise closes the valve on the brine discharge side of the pressure vessel. This increases pressure in the vessel, thereby increasing flow through the membrane, FLOW METER, and into the freshwater tank. Pressure should be increased only until a flow of 8 gph + /-15% (WP/200) or 16 gph + /-15% (WP/400) is achieved and adjusted for the temperature effects charted Figure 2-1 of the Specifications Section. However, if the pressure required to achieve this rate would exceed 800 psi, this may be an indication of performance degra-

Table 4-2. Initial System Performance

Date:_____
Operator:_____
Vacuum: _____ Inches of Mercury
Product Water Flow: _____ Gallons/Hr.
System Pressure: _____ psi
Sea Water Salinity(if known): _____ ppm
Sea Water Temperature: _____

dation; the membrane may need maintenance (see Section 5.3.4). Higher pressures decrease the service life of the membrane.

b. System productivity is directly proportional to feedwater temperature. It is common to encounter water currents of different temperatures even at sea. Changes in flow may be due to feedwater temperature changes. Always check performance against the temperature effects chart of Figure 2-1.

c. Any abrupt change in system pressure, vacuum, or product water flow should be investigated. Attempt to determine whether the change is caused by a change in feedwater temperature, a clogged filter, or by fouling of the membrane.

d. The operator must be careful to keep the Pre-Filtration Subsystem clear of obstructions. A plugged Pre-Filtration Subsystem will diminish the flow rate and cause permanent damage to the high pressure pump due to cavitation if the system is allowed to continue running.

e. If the system is to be shut down for 30 days or more, follow the prolonged shutdown procedure using biocide as instructed in Section 5.4.

4.5 SHUTDOWN PROCEDURE

Prior to system shutdown, it is strongly recommended that the operator compare current system performance with the Initial System Performance data recorded in Table 4-2. Doing so will allow any deviations from normal operation to be identified and corrected prior to the next use of the system. This will assure a properly functioning system at all times.

1. Reduce the system pressure to less than 200 psi by turning the PRODUCT FLOW CONTROLLER fully counterclockwise. This reduces initial load on the engine for the next startup.
2. Position throttle fully to the right.
3. Turn the engine switch to the "OFF" position.
4. Turn the fuel valve to the "OFF" position.

4.6 AUTOMATIC SHUTDOWN

In order to protect the system from damage due to certain malfunctions, circuitry inside the System provides automatic shutdowns. Such a shutdown indicates a potential hazard to the system, and every effort should be made to locate the source of the problem prior to any attempt to restart the system.

4.6.1 High-Pressure Shutdown

Attempting to operate the system at pressures over 850 psi will cause the high pressure switch to stall the system. Decrease the pressure by turning the PRODUCT FLOW CONTROLLER counterclockwise to reduce system pressure.

4.6.2 Low Flow Shutdown

The low-flow switch will shut down the system if the amount of water pumped overboard drops below the pre-determined level. This switch not only protects the pump from cavitation due to inlet restrictions, but also prevents water from continuing to be pumped into the vessel when there are leaks from the inlet or outlet plumbing. The low-flow shutdown will function properly only if the Start/Run switch is in the proper position.

5 PREVENTIVE MAINTENANCE

5.1 INSPECTION PROCEDURE

Approximately every 100 hours of use, the system should be inspected as part of a preventive maintenance program. The following steps should be taken to prevent minor problems from becoming major ones.

5.1.1 Hardware

Since the system will be subject to vibration, all hardware should be inspected for tightness of screws, brackets, nuts, and bolts.

5.1.2 High-Pressure Pump

Check the level of the crankcase oil. Oil level should be at the level of the dot on the sight glass. The pump has a crankcase capacity of 10 fluid ounces, and requires HRO's H series lubricant, Part Number 603001001A. In an emergency, non detergent 30W or 40W hydraulic oil may be used.

5.1.3 Engine

Check the level of the oil in the engine as well as the oil in the reduction gear. The engine holds 20.16 ounces. The reduction gear holds 17 ounces. Use Honda 4-stroke oil or an equivalent high-detergent, premium quality motor oil certified to meet or exceed US automobile manufacturer's requirements for Service Classification SG.SF/CC.CD. Motor oils classified SG.SF/CC.CD will show this designation on the container. SAE 10W-30 is recommended for general, all-temperature use.

5.1.4 Tubes and Hoses

Check all plumbing connections for leaks. Also, check all tubing and hoses to make sure they are not rubbing or chaffing against any other surface, and that they are not in contact with heated surfaces.

5.2 SCHEDULING PERIODIC MAINTENANCE

Table 5-1 on the following page is a time schedule for basic preventive maintenance. The frequency of this type of maintenance depends on the regularity of usage, condition of the feedwater, and the cumulative running time. The Table is at best a fair estimate of the time intervals at which maintenance may be required on the various system components, based on data compiled from HRO system installations around the world. Use Table 5-1 only as a guide and a basis for compiling a more accurate maintenance schedule based on actual experience. If in doubt, discuss the scheduling with an HRO distributor, or contact the factory.

5.3 PERIODIC MAINTENANCE PROCEDURES

The following paragraphs give instructions, where necessary, for procedures described briefly in Table 5-1. Section 8 includes exploded parts views of all components in the system. These will assist an operator in disassembling and assembling components and in locating replaceable parts and identifying part numbers.

5.3.1 Precautions

a. If possible, avoid using chemicals or detergents to clean the internal wetted parts of the system. Where a mild detergent is used, be sure to rinse the parts thoroughly before reassembling them into the system.

b. Stored fresh water is generally susceptible to bacteria growth. Wash the water storage tank with 1/4 oz. of household bleach (5.25% by volume) for every 45 gallons of water. Then rinse with fresh water.

5.3.2 Pre-Filtration Subsystem Maintenance

5.3.2.1 Pre-Filter

Remove the two housings and set the O-rings aside. Clean the housings thoroughly and set aside. Replace the elements with HRO Part No. 593001006A. After clean filter elements are installed, set the O-rings in the housings and install the housings.

Table 5-1. Periodic Maintenance Table

A. PRE-FILTRATION SUBSYSTEM		
COMPONENT	MAINTENANCE REQUIRED*	TIME INTERVAL
Pre-filter	Replace element and clean housing	Whenever the vacuum gauge shows 6 inches of mercury.
B. PRESSURIZATION SUBSYSTEM:		
High Pressure Pump	Change crankcase oil.	Initial oil change at 20 hours of operation then 300 hours or three months whichever comes first.
Membranes	Clean	1000 hours or every three months.
Engine	Change oil.	Initial oil change at 20 hours of operation then 100 hours or 6 months whichever comes first
Reduction Gear	Change oil.	Initial oil change at 20 hours of operation then 300 hours or one year whichever comes first.
Air Cleaner	Clean	Every 3 months or 50 hours
Spark Plug	Check/Clean	Every 6 months or 100 hours.

5.3.3 Pressurization Subsystem

Pump Oil Changing Procedure

Slide a drain pan underneath the pump. Drain the oil by removing the drain plug located at the back end of the pump. When the crankcase is empty, replace and tighten the plug. Fill the crankcase until the oil level is in line with the dot on the sight glass. Use 10 fluid ounces of high-pressure pump lubricant, Part No. 603001001A, available from any HRO distributor (non detergent 30W or 40W hydraulic oil may be used in emergency).

Engine Oil Changing Procedure

Drain the oil while the engine is still warm to assure rapid and complete draining. Remove the oil filler cap and drain plug to drain the oil. Reinstall the drain plug when engine is empty of oil and tighten securely. Refill engine with 20.16 ounces of the recommended oil and check the oil level. Reinstall the oil filler cap.

5.3.4 Membrane Cleaning Procedure

It is normal for reverse osmosis membranes to become fouled by mineral deposits and organic growth over a

period of time. This will result in low product water output and/or an increase in salinity even with normal operating pressure. The membrane should be cleaned using Cleaning Kit HRO CCK2 whenever the product output drops below 6.4 gph (WP/200) or 12.8 gph (WP/400) with the pressure at 800 psi at 77 °F. Remember that product water flow will decrease with a feedwater temperature decrease, or if a system malfunction causes a decrease in system pressure. These conditions should be checked prior to initiating system cleaning. Paragraph 5.3.4.1 gives the membrane cleaning procedure for organic fouling. Paragraph 5.3.4.2 gives the membrane cleaning procedure for mineral deposits. BOTH PROCEDURES ARE IDENTICAL EXCEPT FOR THE CHEMICAL SOLUTIONS USED.

NOTE

Treatment for organic fouling and for mineral deposits each require 5 gallons of solution. Treatment with biocide requires 8 gallons of solution. For safety and convenience, a container capable of holding at least 10 gallons is recommended.

CAUTION

Water used for system maintenance must be free of chlorine (hypochlorite), iodine, quaternary compounds, and phenolic disinfectants. All will attack membranes and cause severe flow loss. Chlorine attack is even more damaging in the presence of high concentrations of calcium and magnesium.

5.3.4.1 Cleaning Treatment for Organic Fouling

This procedure uses an alkaline solution to clean organic deposits from the membrane. Except for the chemical solution used, the procedure is identical to the one for mineral deposits in Section 5.3.4.2.

WARNING

Mix with care. Wear a face mask, rubber apron, and rubber gloves. Alkaline cleaner can cause severe eye damage.

1. Position the Start/Run switch in the "START" position.
2. Obtain Chemical Cleaning Kit HRO CCK2. The kit contains separate 1.5 pound packages of alkaline and acid compounds for one treatment.
3. Add contents of the 1.5-pound alkaline package to the 5 gallons of water in the container and stir continuously until thoroughly dissolved.
4. Place the inlet, brine dump, and product water hoses into the container.
5. Start the system and recirculate the cleaning solution for at least 45 minutes at 0 pressure. If severe membrane fouling is suspected, the system may be operated for up to 15 hours with the cleaning solution. The solution will reach the proper temperature (100 to 110°F) by being recirculated through the system.

CAUTION

Do not allow the solution temperature to exceed 120°F. Maintain minimum product water flow by keeping the PRODUCT FLOW CONTROLLER valve fully counterclockwise throughout the process. Do not let the 10-gallon container run dry of cleaning solution. Add more water and cleaner if necessary. Be sure to use a full package of alkaline mixed with 5 gallons of water for any additional cleaning solution required.

6. Stop the system.
7. Discard the cleaning solution, diluting it with large quantities of water, then rinse the container thoroughly.
8. Return the hoses to their normal locations.
9. Restart the system.
10. Allow the system to flush with sea water for 10 to 15 minutes to remove cleaning solution residue.
11. Stop the system.
12. Change the filter elements in the pre-filter subsystem.

5.3.4.2 Cleaning Treatment For Mineral Deposits

This procedure uses an acid solution to clean mineral deposits from the membrane. The procedure is identical to the cleaning procedure of Section 5.3.4.1 for organic fouling except for the chemical solution used.

5.4 STORAGE USING BIOCIDE

The prolonged shutdown procedure may be avoided by operating the system for approximately one hour at least every three weeks.

Doing so will sufficiently flush out the system and minimize a build-up of harmful biological growth in the membrane. However, in all cases the membrane must

be kept from freezing or drying out. If the system is to be unused for three weeks or more, the following procedure must be performed. This procedure helps protect against a build-up of harmful biological growth in the membrane.

1. While the system is operating, lower the feedwater pressure to minimum by turning the PRODUCT FLOW CONTROLLER fully counterclockwise. This allows maximum flow past the membrane instead of through the membrane, thus flushing the membrane surface. After five minutes, shut the system down.
2. Mix a biocide solution in the 10-gallon container by dissolving one packet from the HRO SC Storage Chemical Kit in 8 gallons of fresh, unchlorinated water.
3. Place the inlet hose into the container.

WARNING

Handle the biocide with care. If ingested, it may cause irritation of the gastrointestinal tract, colic, diarrhea, or other similar symptoms. Prior to using the system after biocide has been installed, perform the initial operation procedures to flush the system.

4. Start the system and allow it to run until just before the container is emptied, and then stop the system.
5. On the pressure vessel manifold, disconnect the discharge lines and seal the openings with blank caps.
6. Using the appropriate size pipe plugs, plug the inlet port on the membrane assembly.
7. Discard any remaining biocide solution in the 10-gallon container, then rinse the container thoroughly.
8. The membrane must not be subjected to freezing conditions. If it is suspected that freezing temperatures will occur, perform the procedures of Section 5.5.2.

NOTE

Biocide has a useful life of six to nine months inside the pressure vessel.

5.5 MEMBRANE PROTECTION FROM TEMPERATURE EXTREMES

Both performance and service life are affected by the temperature of fluid in contact with the membrane inside the pressure vessel. Temperature excursions beyond prescribed limits will permanently damage the membrane. This Section describes protective measures against such excursions.

5.5.1 High Temperature Protection

The membrane must not be subjected to water temperature above 113°F (45°C). While not in operation, the system might be exposed to an environment that would raise the temperature of the internal standing water to that point. If so, the membrane should be kept cool by running cool feedwater through it. This is done by turning the PRODUCT FLOW CONTROLLER fully counterclockwise, opening the valve. System pressure will be minimum, flow through the flow meter will be negligible, and flow of brine water dumped overboard will be maximum.

5.5.2 Low Temperature Protection

Water in the pressure vessel will rupture the membrane if allowed to freeze. If freezing is possible during a brief shutdown period (less than 30 days), the pressure vessel must be removed from the system, capped, and stored in a non-freezing environment. If the shutdown period in a freezing environment will be more than 30 days, follow the procedure described in this section.

1. Perform Steps 1 through 8 of Section 5.4 to put biocide into the pressure vessel.
2. Disconnect the tube between the high pressure pump outlet and the pressure vessel manifold. Do not remove the fitting from the manifold.
3. At the pressure vessel manifold, disconnect the product water tubing (small diameter) and brine discharge tubing (larger diameter). Do not remove the fittings. Seal the open inlets and outlets with blank caps.
4. Remove the screws holding the pressure vessel/manifold assembly in place and remove the assembly from the mounting bracket.
5. Store the pressure vessel/manifold assembly in a non-freezing environment.

NOTE

Freeze point for the biocide solution used in the procedures of this Section is the same as for water. Biocide with a lower freeze point may be obtained by combining 6 gallons of water, 2 gallons of propylene glycol or glycerine, and one-ounce bottle of biocide from the HRO SC Storage Chemical kit.

6 TROUBLESHOOTING

Table 6-1 is a system troubleshooting guide. It lists several common problems and provides an initial response to attempt to solve the problem. Wherever the term "specified" is used, refer to the Specifications section of this manual to determine the correct value. Some system problems may be caused by faults in more than one subsystem. Where this is indicated in the table, the possible faults are listed in order of most likely cause. Refer to the Honda engine Owner's Manual included with your system to troubleshoot the gasoline engine.

ABNORMAL CONDITION	POSSIBLE CAUSE	REPAIR PROCEDURE
Greater than normal vacuum gauge reading.	Watermaker is installed too far above water level.	Move watermaker closer to water level.
	Feedwater foot valve is plugged.	Clear debris from the feedwater foot valve.
	Pre-Filter is plugged.	Remove the bowl and replace the filter elements.
The system is unable to produce potable water. The PRODUCT FLOW CONTROLLER is turned clockwise, and the system pressure is within the proper range. The vacuum gauge maintains the specified indication, and the FLOW METER reads.....		
a. Much higher than specified flow.	Failed membrane or blown o-ring.	Replace the o-ring or membrane.
b. Lower than specified flow.	Worn or fouled membrane.	Clean the membrane.
c. Pulsating pressure.	Air leak in inlet plumbing	Check all fittings and hose clamps.
d. Low system pressure.	Feedwater foot valve is clogged.	Clean more frequently.
	Fouled or dirty pump inlet or discharge valves.	Clean inlet and discharge valve assemblies on pump.
	Worn pump inlet/discharge valves or leaky discharge hose.	Replace worn pump valves, valve seats, and/or discharge hose.
Pump runs extremely rough, pressure low.	Restricted inlet, or air entering the inlet plumbing.	Check for air-tight seal.
	Stuck pump valves.	Clean out foreign material. Clean/replace valves.
Water leakage from under the pump manifold.	Worn pump seals.	Install new seals.
Pump oil leak between crankcase and pumping section.	Worn crankcase piston rod seals.	Return to factory or to an HRO distributor.
Pump oil leaking in area of crankshaft.	Worn crankshaft seal or improperly installed oil seal retainer o-ring.	Return to factory or to an HRO distributor.

ABNORMAL CONDITION	POSSIBLE CAUSE	REPAIR PROCEDURE
Pump oil leaking in area of crankshaft.	Bad bearing.	Return to factory or to an HRO distributor.
Water in pump crankcase or pump oil appears milky.	May be caused by humid air condensing into water inside the crankcase.	Change crankcase oil at 3-month or 500-hour intervals.
	Leaking packing seals.	Replace packing seals.
Oil leaking from underside of pump crankcase.	Worn crankcase seals.	Return to factory or to an HRO distributor.
Oil leaking at the rear section of crankcase.	Damaged or improperly installed crankcase rear cover o-ring or drain plug o-ring.	Return to factory or to an HRO distributor.
Oil leakage from pump drain plug.	Loose drain plug or worn drain plug o-ring.	Tighten drain plug or replace o-ring.
Loud knocking noise in pump.	Broken or worn bearing.	Return to factory or to an HRO distributor.
Frequent or premature failure of pump seals.	Damaged or worn pump plungers.	Return to factory or to an HRO distributor.
	Abrasive material in the fluid being pumped.	Check pre-filter subsystem.
	Excessive temperature of fluid being pumped.	Check fluid inlet temperature. Be sure that it is within specified range.
	Pump running dry.	Do no allow pump to run without water.
Strong surging at the pump inlet, and low pressure at the discharge.	Foreign particles in the inlet or discharge valves, or worn inlet and/or discharge valves.	Clean or replace valves.
Product water flow is less than specified. Membrane cleaning is not effective.	Under-pressurization.	Increase the system pressure, but do not exceed 800 psi.
	Fouled membrane.	Replace the membrane.
	Seawater temperature has decreased.	This is not a problem requiring repair. Adjust the product flow, but do not exceed 800 psi.
Product water flow is higher than specified.	Over-pressurization.	Decrease system pressure.
	seawater temperature has increased	Decrease system pressure.
	Defective membrane.	Replace membrane.

7 CORRECTIVE MAINTENANCE

7.1 INSPECTION PROCEDURE

The periodic maintenance procedures scheduled in Section 5 are intended to keep the system in good running condition at all times. The instructions in that section are mostly for simple cleaning and filter element replacement made necessary by normal operation of the system. If the system components or any of their parts break or begin to malfunction, the operator has the option of ordering the replacement part to do the repair on location, or replacing entire components. Refer to the exploded views in Section 8 if repairs are to be made on location. These views show replaceable parts and how the parts are assembled. If the system is installed according to the instructions in the Installation Section, then started and operated according to the instructions in the Operation section, and it begins to function incorrectly, the operator should determine the cause of the problem and fix it as soon as possible. When the cause is not obvious, use whatever indicator there is of a malfunction to refer to Table 6-1, the Troubleshooting Chart in the previous section. The chart assists in diagnosing causes of problems, and suggests repair procedures. When more irregular and involved repairs are needed on any system components, it is recommended that the components be replaced at the factory or by an authorized dealer. However, some procedures are simple enough that they may be done on location using the procedures of this section.

7.2 SERVICING PUMP VALVES

Refer to the exploded parts view of the high pressure pump in Section 8 for identification of parts while following the procedures. Complete each numbered step in the procedure, in order, until it is determined that the cause of the pump malfunction has been corrected.

7.2.1 Disassembly

NOTE

The inlet and discharge use the same retainers, springs, valve seats, and valves. The O-rings and valve spacers/adapters are different. Keep parts in order as they are removed.

1. Remove the four socket-head bolts and spring washers from end of manifold.
2. Support the discharge manifold from the underside and tap with a soft mallet from the inlet manifold.
3. With valve chambers up, carefully place discharge manifold on a working surface.
4. From the 3 smaller diameter and shallow inlet chambers, remove the inlet valve adapters with inner and outer O-rings. These adapters are not held securely in position and may fall out as the discharge manifold is removed.
5. Next, remove the valve seats, valves, springs and retainers from the inlet chambers.
6. From the 3 larger diameter and deeper discharge chambers, remove the discharge valve spacers with O-rings. These spacers generally remain with the discharge as it is removed. A reverse pliers fitted into the center bore and hooked onto the side ports of the spacer will assist the removal.
7. Next, remove the valve seats, valves, springs and retainers from the discharge chambers.

7.2.2 Reassembly (Discharge)

1. With crankcase side of the discharge manifold facing up, insert the springs into the retainers over the plastic center guide.
2. Place valve spring retainers in deeper valve chambers. They will rest on the machined ridge in each chamber. Examine the valves for wear or pitting and replace if necessary. Install the valves over the springs with recessed (dish) side down.
3. Examine valve seat O-rings for wear and replace if necessary. Lubricate and place O-rings on lip of retainers. Carefully align O-rings in valve chamber to avoid cutting O-ring when the valve seat is installed.
4. Examine valve seats for pitting, scale or ridges and replace if necessary. Install valve seat with grooved side down, so O-ring fits snugly into groove on seat.

5. Examine both O-rings on the discharge valve spacer and replace if necessary. Lubricate O-rings and fit into grooves on outside of spacer.
6. Lubricate spacer and carefully press into valve chambers with small diameter side down until spacer snaps tightly into position.

7.2.3 Reassembly (Inlet)

1. Place valve spring retainers into the shallow valve chambers. They will rest on machine ridge in each chamber.
2. Insert valve springs into retainers over plastic center guide.
3. Inspect the valves for wear, ridges or pitting and replace if necessary. Insert valves over the springs with recessed (dish) side down.
4. Examine valve seat O-rings for wear and lubricate and place O-rings on lip of retainers. Carefully align O-rings in valve chamber to avoid cutting O-ring when valve seat is installed.
5. Examine valve seats for pitting, scale or ridges and replace if necessary. Install valve seat with grooved side down, so O-ring fits snugly into groove on seat.
6. Examine the adapter inner O-rings and replace if worn. Lubricate and install O-rings into inlet valve adapters.
7. Examine the adapter outer O-rings and replace if worn. Lubricate and install O-rings onto inlet valve adapters.
8. Lubricate inlet valve adapter and press into chamber. Carefully align inlet valve adapter into chamber to avoid cutting or extruding O- ring.
9. Replace discharge manifold over plunger ends matching discharge valve spacers with inlet chambers and press into position. Tap with a soft mallet until completely seated in chambers. Replace all 4 washers and socket-head bolts. Hand tighten each. Then torque in accordance with the specifications of Table 7-1.

7.3 SERVICING PUMP SEALS

7.3.1 Disassembly

1. With the discharge manifold removed from the pump, remove the 2 socket-head bolts and spring washers from end of inlet manifold.
2. Rotate crankshaft to loosen inlet manifold.
3. Support inlet manifold from underside and tap with a soft mallet to separate manifold from crankcase.
4. With crankcase side of manifold down, remove high-pressure seals using a reverse pliers.
5. Invert manifold so crankcase side is up, and with reverse pliers, remove low pressure seals.

7.3.2 Reassembly

1. Examine low pressure seal for seal wear or spring failure and replace if necessary. With crankcase side of inlet manifold up, lubricate seal and press into valve chamber with garter spring down. Carefully square seal into position.
2. Examine high-pressure seal for wear and replace if necessary. Invert inlet manifold with crankcase side down. Lubricate seal and press into chamber with v-side up. Carefully square into position.
3. Rotate shaft so the 2 outside plungers are lined up.
4. Lubricate plungers and discharge valve adapter O-rings.
5. Carefully line up and join the inlet and discharge manifolds by pressing the protruding discharge valve adapters into the inlet manifold seal chambers.
6. Carefully slip manifold assembly onto plungers and tap with soft mallet until flush with crankcase.
7. Replace the 2 inlet manifold socket-head bolts and washers and hand tighten. Then torque per Table 7-1.
8. Torque the 4 discharge manifold socket-head bolts in accordance with the specifications of Table 7-1.

7-1. Torque Chart

Pump Part	Thread	Tool Size	Torque
Plunger Retainer	M5	11mm Hex	80 In. lbs.
Inlet Manifold Bolts	M10	17mm Allen	132 In. lbs.
Discharge Manifold Bolts	M10	8 mm Allen	180 In. lbs.

8 DRAWINGS AND PARTS LISTS

8.1 DRAWINGS & PARTS LISTS

The exploded parts views of the various components of the system show the replaceable parts only. The parts lists incorporated with the drawings give the names and numbers to be used when ordering parts.

8.2 ORDERING PARTS

To order replacement parts or accessories, or optional equipment for your system from the factory, contact the HRO Division.

Telephone

(310) 532-5300, extension 286

or

1-800-366-4476

or write to:

Standard Communications
HRO Division
P.O. Box 92151
Los Angeles, California
90009

Replacement parts and accessories are also available from any HRO distributor. When ordering replacement parts, you must give complete information including the part number, description, and serial number.

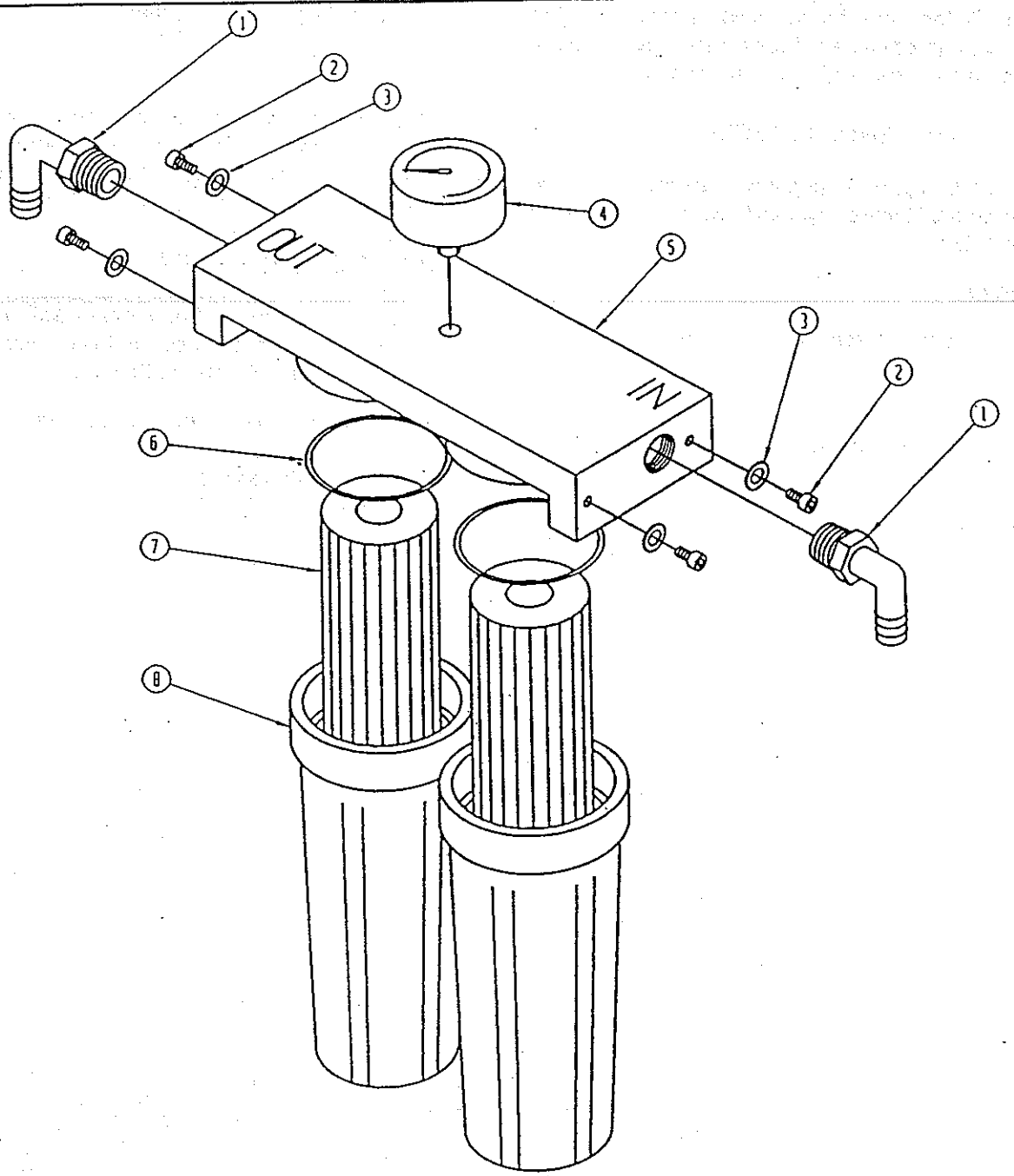
8.3 RETURNING PARTS

If parts are returned to the factory (as with items covered by the Warranty at the front of this manual), send them pre-paid to the following address:

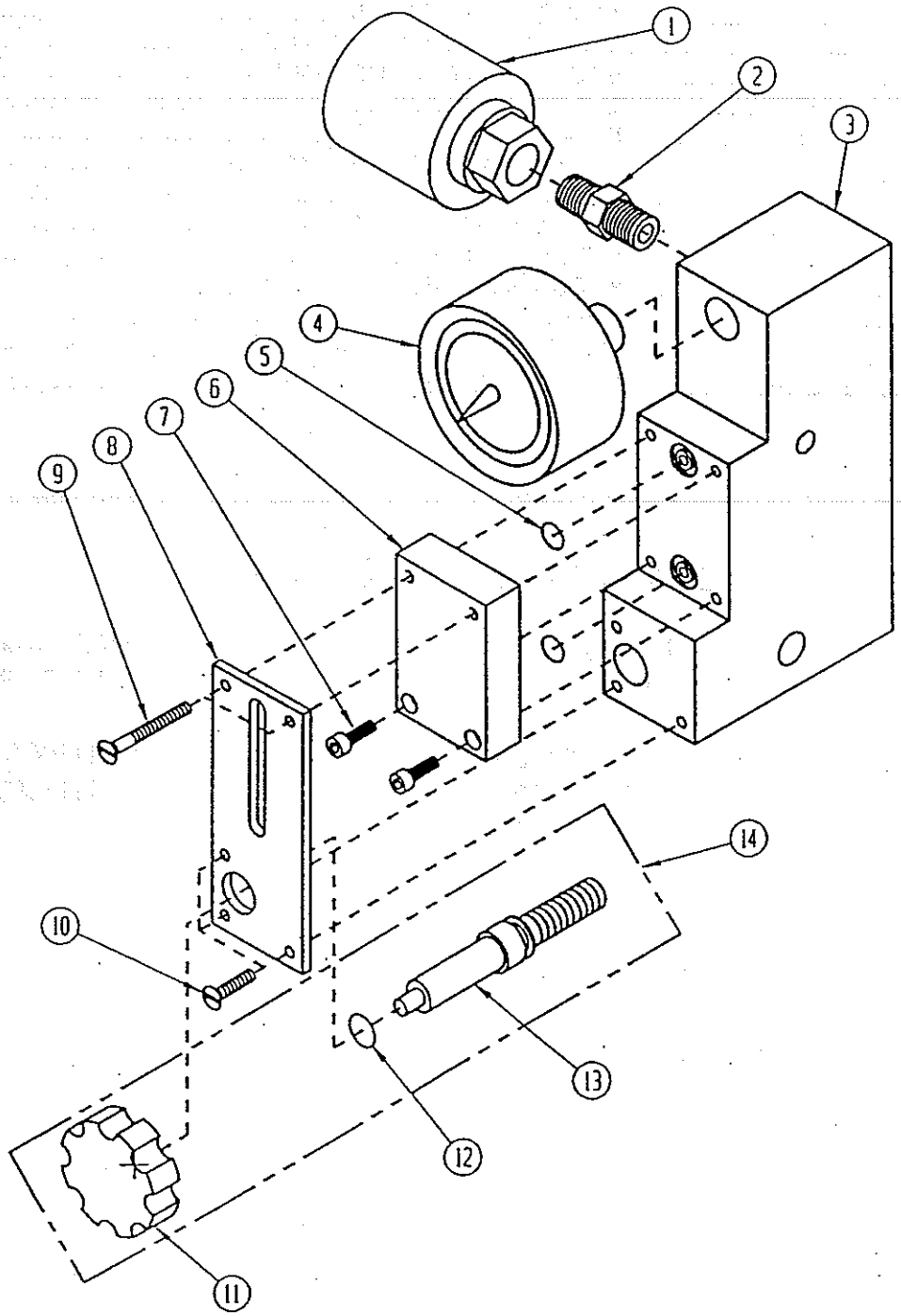
Standard Communications Corp.
HRO Division
108 W. Victoria St.
Carson, California
90746

PRE-FILTER ASSEMBLY

REF. DES.	QTY	DESCRIPTION	PART NO.
1	2	ELBOW, 3/4" HOSE BARB X 3/4" MNPT, S/S	590030122A
2	4	SCREW, SOCKET HD CAP, M6 X 12, S/S	569001010A
3	4	WASHER, INTERNAL TOOTH, M6	581001018A
4	1	VAC. GAUGE, -30/+30, BOTTOM MT	601002006A
5	1	PRE-FILTER MAINFOLD	H19851701A
6	2	SEAL, PRE-FILTER	108001005A
7	2	FILER ELEMENT, 20 MICRON	593001006A
8	2	FILTER HOUSING	592002008A



PRE-FILTER ASSY



CONTROL MANIFOLD ASSY

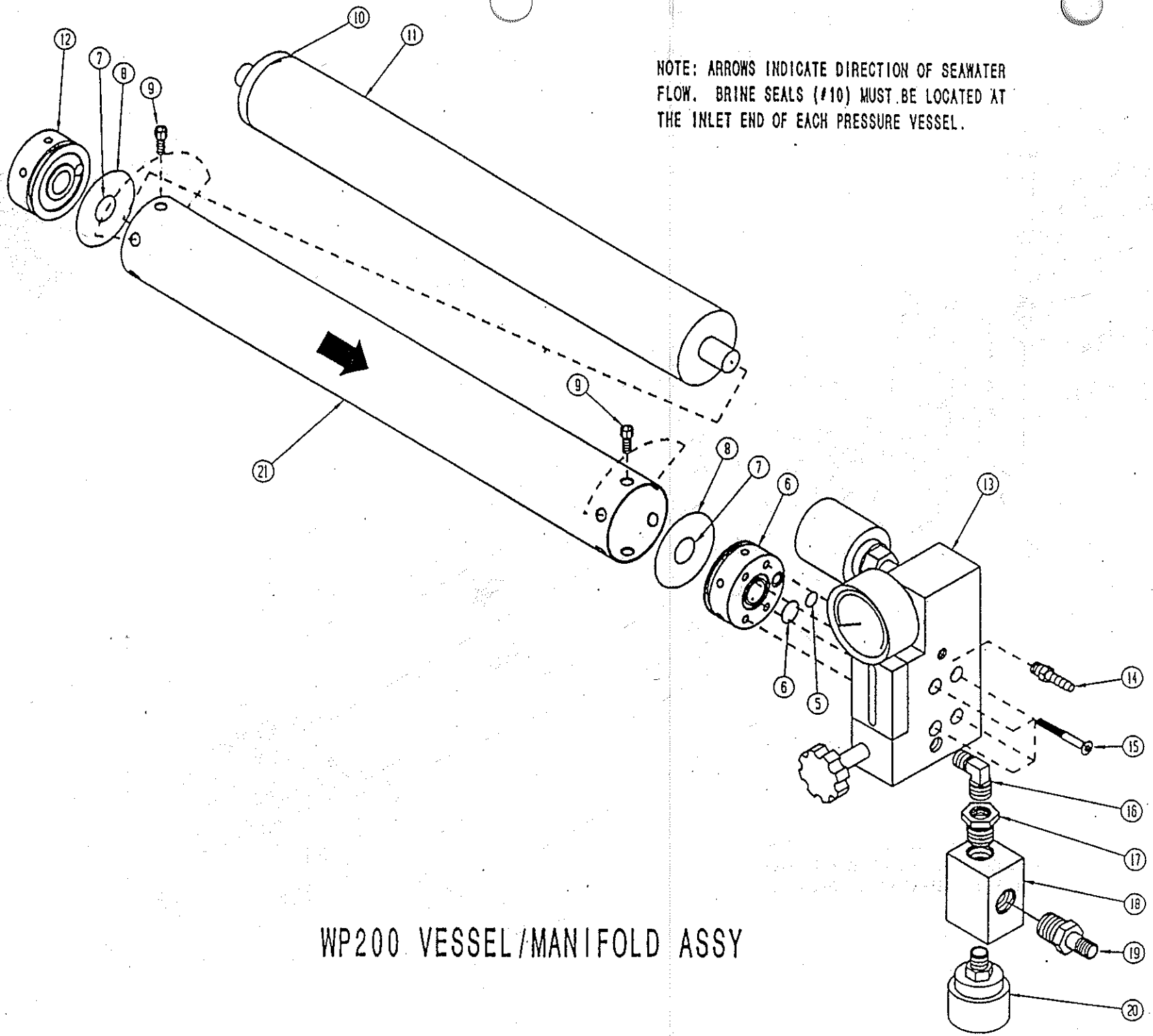
CONTROL MANIFOLD ASSEMBLY

REF. DES.	QTY	DESCRIPTION	PART NO.
1	1	HIGH PRESSURE SWITCH, N/O	SC0008016A
2	1	NIPPLE, 1/4" MNPT, S/S	590051001A
3	1	MANUAL CONTROL MANIFOLD	H21451701A
4	1	GAUGE, 0-1500 PSI, CTR BACK MT	601002009A
5	2	O-RING, 2-012	353014002A
6	1	FLOW METER ASSEMBLY	SEE CHART
7	2	CAP SCREW, SOCKET HD, M4 X 20	569005010A
8	1	ESCUTCHEON	SEE CHART
9	2	SCREW, FLAT HEAD, M4 X 25	569006010A
10	2	SCREW, FLAT HEAD, M4 X 16	569007010A
11	1	KNOB, PRESSURE REGULATOR	154003003A
12	1	O-RING, 2-111	353020002A
13	1	SHAFT, PRESSURE REGULATOR	H17811202A
14	1	PRESSRE REGULATOR ASSEMBLY	H17849006A

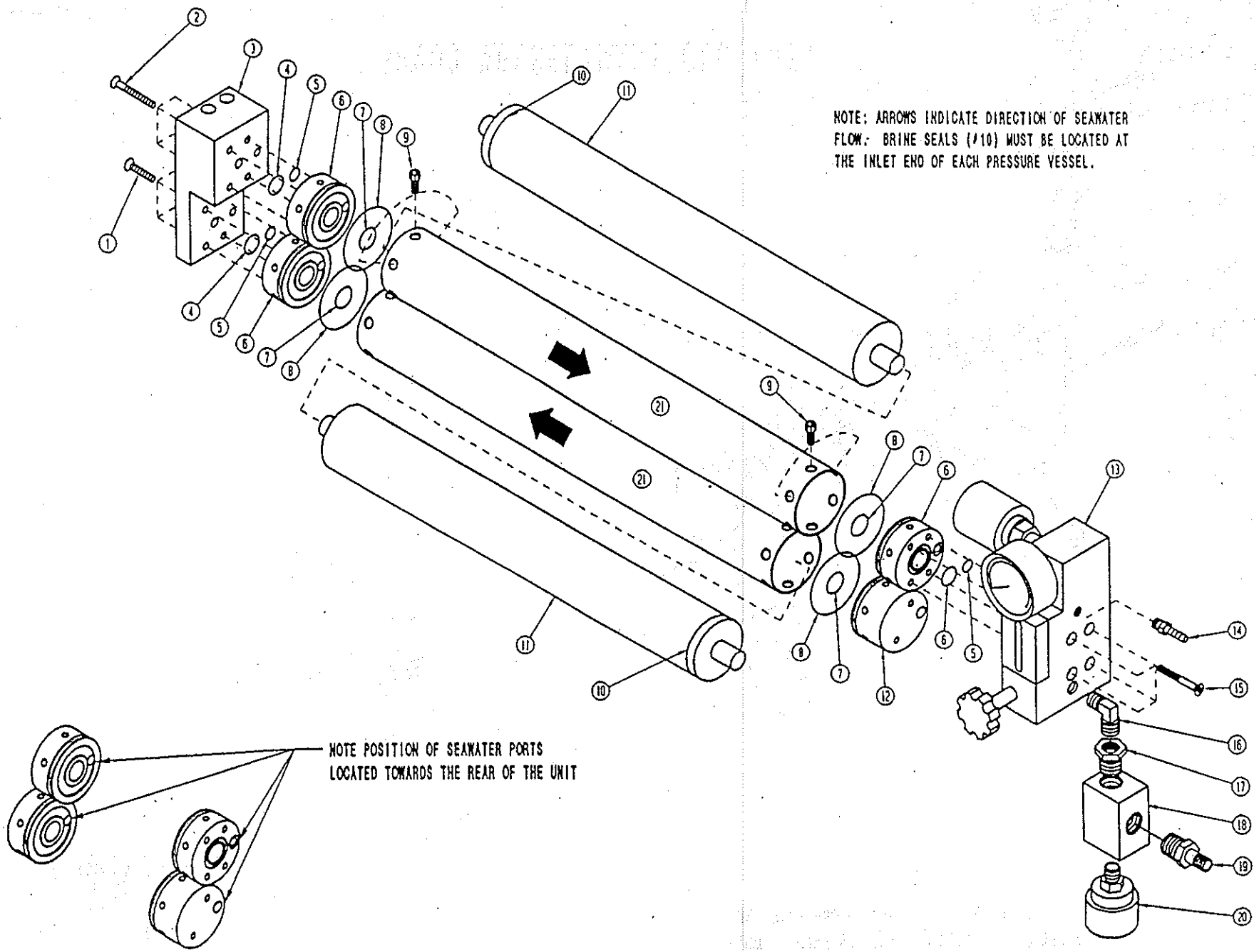
MODEL REFERENCE CHART

REFERENCE DESIGNATOR	PART NUMBER FOR WATERPAK 200	PART NUMBER FOR WATERPAK 400
6	H17849007A	H18649005A
8	H17906301A	H18606301A

NOTE: ARROWS INDICATE DIRECTION OF SEAWATER FLOW. BRINE SEALS (#10) MUST BE LOCATED AT THE INLET END OF EACH PRESSURE VESSEL.



WP200 VESSEL/MANIFOLD ASSY



WP400 VESSEL/MANIFOLD ASSY

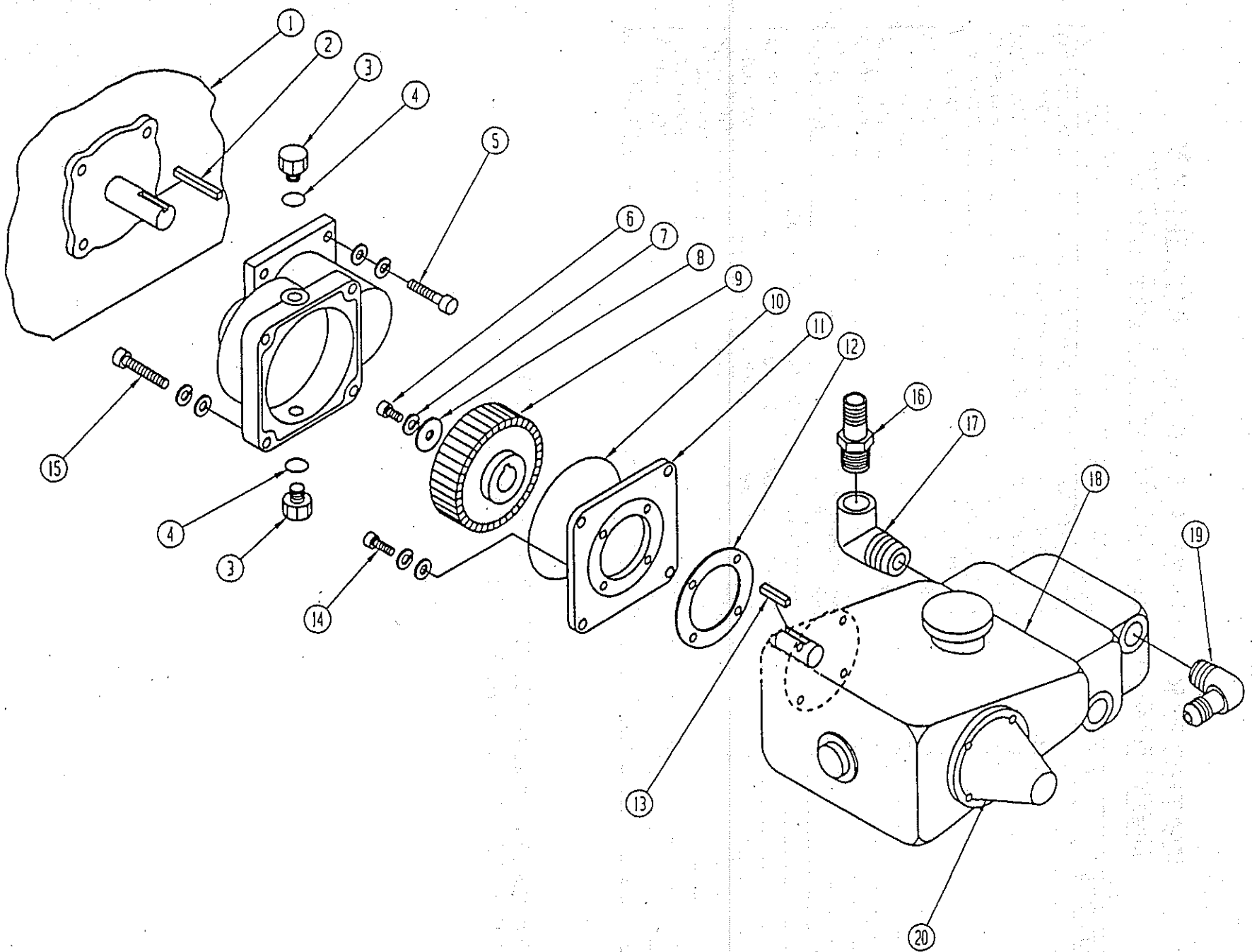
WATERPAK VESSEL/MANIFOLD ASSEMBLY

NUMBERS IN PARENTHESIS INDICATE QUANITIES FOR WATERPAK 200 ONLY

REF. DES.	QTY	DESCRIPTION	PART NO.
1	4 (0)	SCREW, SOCKET FLAT HEAD, M6 X 30	569023010A
2	8 (4)	SCREW, SOCKET FLAT HEAD, M6 X 50	569003010A
3	1 (0)	INTERCONNECT MANIFOLD, WP400	H21551701A
4	3 (1)	O-RING, 2-120	353026002A
5	3 (1)	O-RING, 2-012	353014002A
6	3 (1)	END PLUG, THRU-HOLE	H17835601A
7	4 (2)	O-RING, 2-116	353005002A
8	4 (2)	O-RING, 2-228	353006002A
9	24 (12)	CAP SCREW, SOCKET HD, M6 X 12	569001010A
10	2 (1)	BRINE SEAL, 2-1/2"	108001015A
11	2 (1)	MEMBRANE W/BRINE SEAL	591007003A
12	1	END PLUG, INLET	H17835602A
13	1	CONTROL MANIFOLD ASSEMBLY, WATERPAK	**
14	1	CONNECTOR, 1/4" BARB X 1/8" MNPT	590105101A
15	1	ELBOW, 1/4" MNPT X 1/4" MNPT	590030624A
16	1	BUSHING, 1/2" MNPT X 1/4" FNPT	590090603A
17	1	RESTRICTOR TEE	H14549032A
18	1	CONNECTOR, 1/2" BARB X 1/2" MNPT	590100222A
19	1	LOW FLOW SHUTDOWN SWITCH, N/C	SC0009016A
20	2 (1)	PRESSURE VESSEL, 21"	H17958901A

** FOR WATERPAK 200 - ORDER PART NUMBER H21449004A

** FOR WATERPAK 400 - ORDER PART NUMBER H21549003A



PUMP/GEARBOX/ENGINE ASSY

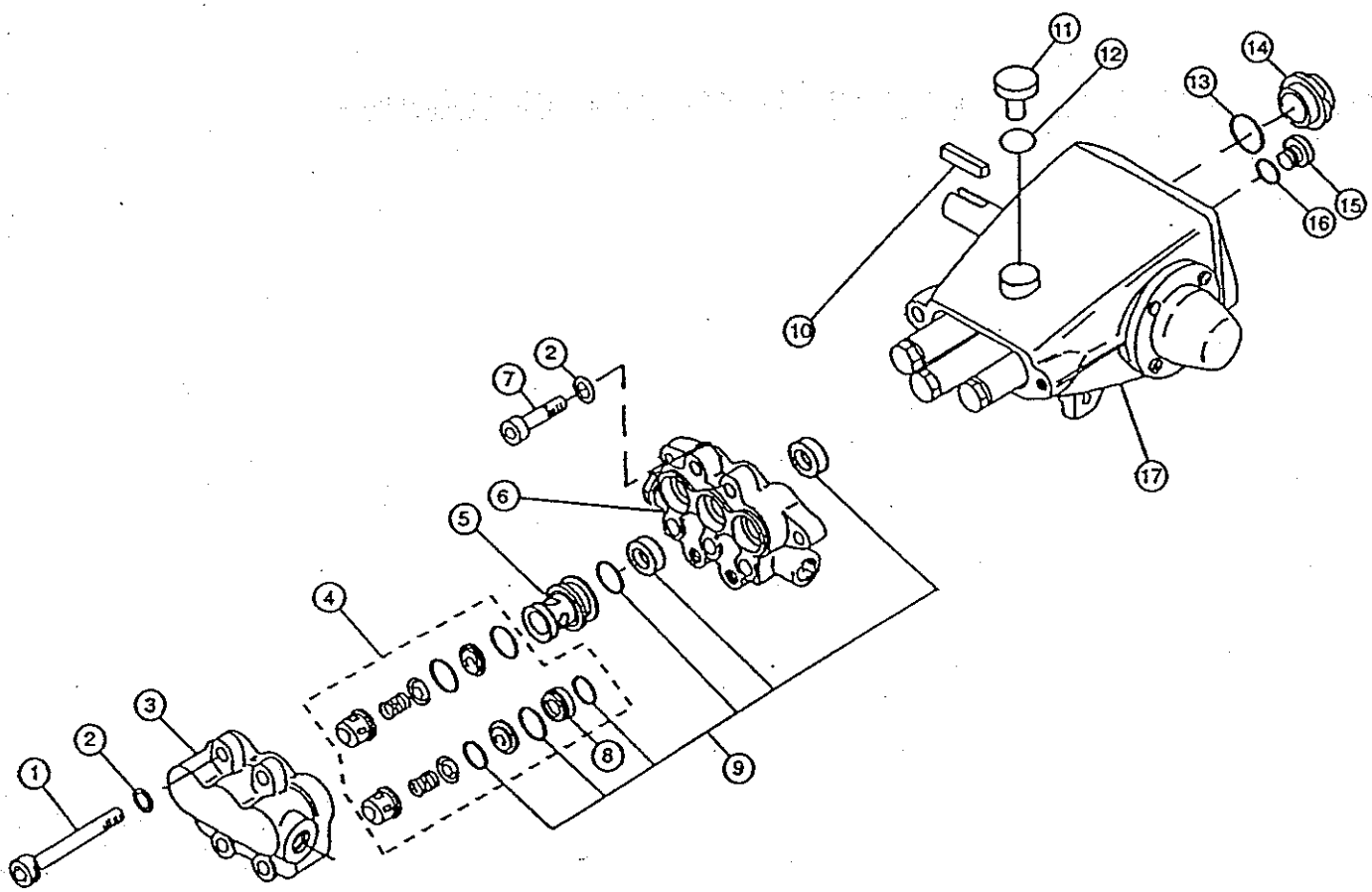
ENGINE/PUMP ASSEMBLY

REF. DES.	QTY	DESCRIPTION	PART NO.
1	1	GAS ENGINE, 5 HP	403001011A
2	1	ENGINE KEY, 3/16 X 3/16 X 1-3/4	070007016A
3	2	FILL/DRAIN PLUG	356004005A
4	2	FILL/DRAIN O-RING	353006015A
5	4	HEX HEAD BOLT, 5/16-24 X 1"	
6	1	HEX HEAD BOLT, M8 X 20	
7	1	LOCK WASHER, M8	
8	1	GEAR RETAINING WASHER, M8	
9	1	SPUR GEAR	
10	1	CASE FLANGE O-RING	353015015A
11	1	CASE FLANGE	
12	1	FLANGE SEAL	108012012A
13	1	PUMP KEY, 5 X 5 X 21	070006001A
14	4	HEX HEAD BOLT, M6 X 20	
15	4	HEX HEAD BOLT, M8 X 25	
16	1	CONNECTOR, 3/4 BARB X 1/2 MNPT	590105201A
17	1	ELBOW, 1/2 MNPT X 1/2 FNPT	590140222A
18	1	PUMP, 4 GPM	599008003A
19	1	ELBOW, 3/8 MNPT X 9/16-18-37, S/S	590030324A
20	1	SHAFT PROTECTOR	053002016A

NOTE: ITEMS 2 THRU 15- GEAR BOX ASSEMBLY, ORDER PART NO. 058001003A.

WATERPAK HIGH PRESSURE PUMP ASSEMBLY

REF. DES.	QTY	DESCRIPTION	PART NO.
1	4	Bolt, Socket Head, M10 x 55	231003003A
2	6	Lock Washer, M10	
3	1	Manifold, Outlet	517004003A
4	1	Valve Kit	602008004A
5	3	Spacer, Discharge Valve	118003011A
6	1	Manifold, Inlet	517003003A
7	2	Bolt, Socket Head, M10 x 35	231002003A
8	3	Adapter, Inlet Valve	121001002A
9	1	Seal Kit	602009004A
10	1	Pump Key, 5mm x 5mm x 21mm	070006001A
11	1	Oil Filler Cap	067001006A
12	1	O-Ring, Oil Filler Cap	353005015A
13	1	Gasket, Oil Gauge	108006012A
14	1	Oil Gauge	601002004A
15	1	Drain Plug	356002005A
16	1	O-Ring, Drain Plug	353006015A
17	1	Pump, 4 GPM, Fully Assembled (No Engine)	599008003A



HRO Systems™

Horizon Reverse Osmosis Desalination Systems

HRO CFK-1 & 2
CHARCOAL FILTER

The HRO Systems Model CFK-1 and CFK-2 charcoal filters are designed to be installed in either the product water output line of the HRO System or, mounted under a sink directly to a drinking water faucet.

Installed in the product water output line of the watermaker, the charcoal filter will remove foul odors that may still be present in the product water.

Installed directly in line on a drinking water faucet the charcoal filter will remove bad taste, odor and trace chlorine from the fresh water holding tank

INSTALLATION

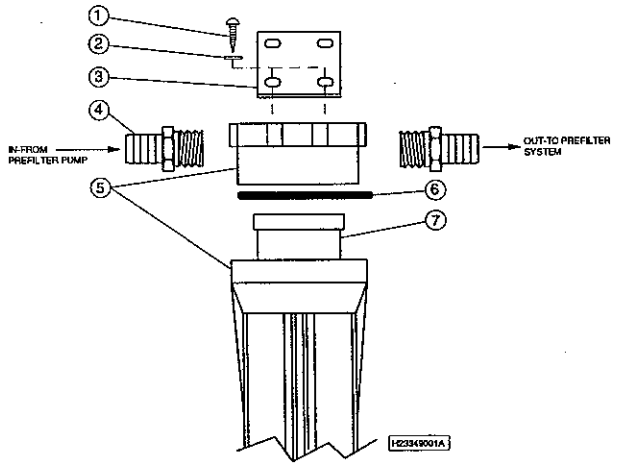
Install the charcoal filter where ever it is convenient and can be easily serviced. Follow the "IN" and "OUT" labels on the top of the filter for correct flow.

Model CFK-1 is rated for 1 GPM (gallon per minute) of flow and is designed for installation on the product water line of all HRO Systems with outputs not exceeding 1300 gallons per day (55 GPH). It is also adequate for most under sink installations. If your sink faucet flows more than 1 GPM the CFK-2 should be used.

Model CFK-2 is rated for 2 GPM of flow and is designed for installation on the product water line of all HRO Systems with outputs not exceeding 2600 GPD (110 GPH). The CFK-2 can also be used for under sink applications. The maximum flow rate of 2 GPM should not be exceeded.

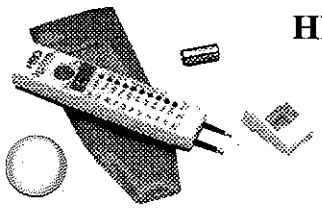
MAINTENANCE

With regular use the charcoal filter element should be changed about every 3 months. With irregular or seasonal usage the element should be changed at the start of each season or whenever you notice a change in the smell or taste of the water.

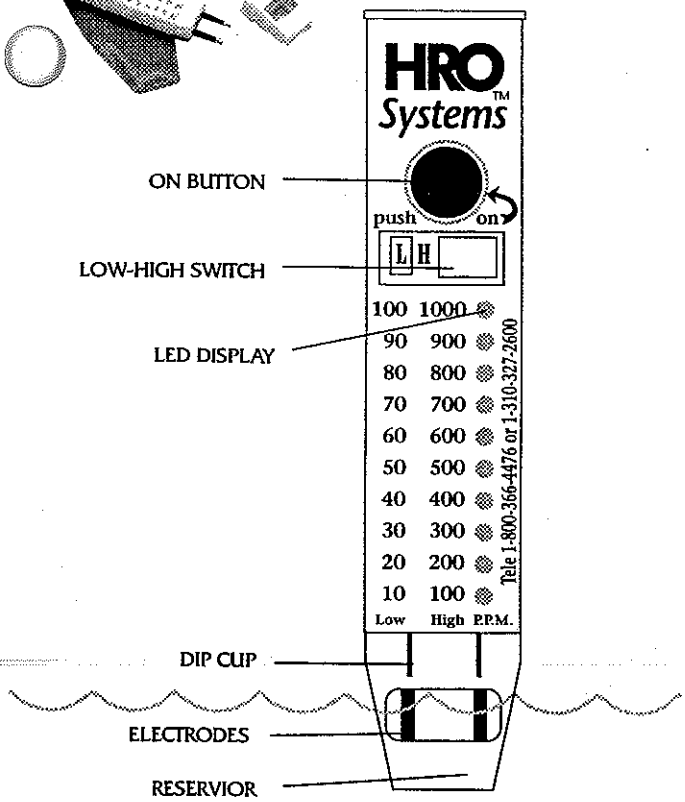


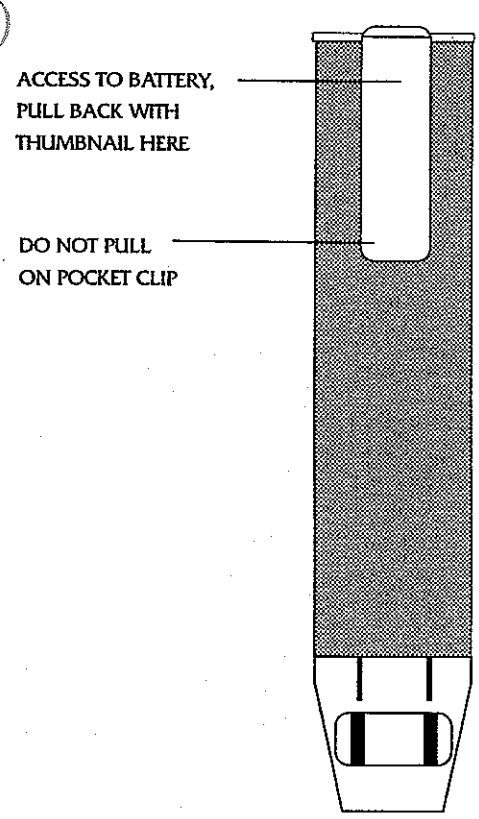
ITEM	QTY	DESCRIPTION	PART NO.
1	4	SCREW, #10 X 1"	569006012A
2	4	WASHER, #10	581009020A
3	1	BRACKET, CFK-1	160001016S
		BRACKET, CFK-2	160002002A
4	2	CONNECTOR,, 1/4" HOSE BARB X 3/8 MNPT	590105801A
5	1	FILTER HOUSING/LID, #10 X 3/8 (CFK-1)	592001008A
		FILTER HOUSING/LID, "BIG BLUE" (CFK-2)	592001010A
6	1	O-RING, #10 FILTER	353001030S
		O-RING, "BIG BLUE" HOUSING	108003005A
7	1	CHARCOAL FILTER ELEMENT, CFK-1	593001004A
		CHARCOAL FILTER ELEMENT, CFK-2	593003004A

HRO Systems Inc.
PO BOX 2560 GARDENA, CALIFORNIA 90247-0560
PHONE: 310327-2600 FAX: 310-769-5917 TELEX: 182598
MADE IN U.S.A.



HRO Systems HRO TDSM Hand Held Tester





HRO Systems™
Horizon Reverse Osmosis Desalination Systems

HRO Systems Inc., 13650 Cimarron Avenue, Gardena, California 90249 U.S.A.
Tele: 1-310-327-2600 - Fax: 1-310-769-5917

HRO Systems HRO TDSM Hand Held Tester

This instrument is designed to measure the mineral content of water by determining the electrical current that the water will pass between the two probe sensors; the greater the minerals, the greater the current flow. A small battery provides the electrical current source. The Tester is accurate between 50° and 104°F. The scale readings are in equivalent sodium chloride strength in PPM (parts per million). The highest red LED lit corresponds to the salinity content of the water tested. This meter is designed to register minimum 10 PPM and maximum 1000 PPM which are the typical variances of drinking water. It will not measure distilled water, brackish water or sea water.

TO USE:

1. Select H (High) or L (Low) range by moving the slide switch right or left to expose either H or L. Tap water and HRO Systems product water will usually be in the High range and product water from secondary purifying sources will be in the Low range.

2. Hold the Meter vertical, with dip cup attached, and dip only the lower portion of the dip cup into the water to fill the dip cup reservoir.

3. Press the "Push ON" button to energize and observe lights.

NOTE: If you have selected Low range and the 100 light is lit, switch to High range to verify if reading is only 100.

CAUTIONS DURING USE:

Keep probes clean. Keep dip cup on while using. Do not submerge the meter body in water. This DS Meter is not water tight. If water enters the body disassemble and dry thoroughly for several hours before reassembly.

CAUTIONS AFTER USE:

Remove the dip cup from meter body. Clean and dry probes and dip cup with a tissue or soft cloth. Replace the dip cup onto the meter body. Store in a cool dry place when not in use.

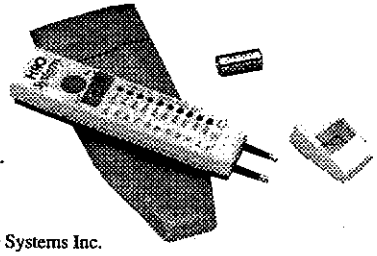
TO REPLACE BATTERY:

1. Grasp the top of the pocket clip with your thumbnail and pull to the rear. This may take some moderate force in order to free the two lock tabs allowing the top of the clip to pull away from and to the rear of the meter body. Do not pull on the lower portion of the pocket clip tab as it is fragile and not designed for pulling.

The battery life is estimated at approximately 1500 tests. The battery, 4LR-44, is available at camera stores and electronic stores.

WARRANTY:

HRO Systems Inc. warrants that the HRO Systems Hand Held DS Meter (product) shall be free of defects and will perform according to specifications for a period of 90 days from the date of shipment. HRO Systems liability under this warranty shall be limited to repair or replacement of the product at HRO Systems option, and under no circumstances shall HRO Systems be liable for consequential damages arising out of or in any way connected with the failure of the product to perform as set forth herein. This limited warranty is in lieu of all other expressed or implied warranties, including those of merchantability and fitness for a particular purpose. To obtain warranty service, the defective product must be returned with a letter of explanation of failure to HRO Systems freight prepaid. The repaired product will be returned by UPS ground service within the Continental U.S.A. or by U.S. Air Parcel Post outside the U.S.A. The letter must include a return shipping address and telephone number. No warranty will be honored if the serial number is missing or altered.
The battery is a consumable and not a warranted item.



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