



GE Osmonics

E4H SERIES

WATER PURIFICATION MACHINES



**OPERATION AND
MAINTENANCE MANUAL**

**OPERATION AND MAINTENANCE MANUAL
FOR GE OSMONICS**

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WATER PURIFICATION MACHINES**

TABLE OF CONTENTS

	<u>Page</u>
1.0 DESCRIPTION	1
1.1 General Information and Principles of Operation	1
1.2 Machine Nomenclature	4
1.3 Machine Permeate Quality	5
1.4 Economy and Deluxe Model Options	5
1.4.1 Economy Model.....	5
1.4.2 Deluxe Model Options.....	6
1.5 Specifications for E-Series Machines.....	7
1.5.1 Feed Water Requirements	7
1.5.2 Permeate (Product Water) Flow Rate	7
1.5.3 Concentrate Flow Rate	8
1.5.4 Typical Pure Water.....	8
1.5.5 Final Operating Pressure.....	8
1.5.6 Pump	8
1.5.7 Reverse Osmosis Membrane Element Rejection	8
2.0 INSTALLATION	10
2.1 Mounting.....	10
2.2 Piping	10
2.2.1 Inlet Piping	10
2.2.2 Valves Required for Clean-In-Place.....	10
2.2.3 Concentrate Outlet Connection	10
2.2.4 Permeate Outlet Connection.....	10
2.3 Electrical	10
2.3.1 Economy Electrical System.....	11
2.3.2 Deluxe Electrical System.....	11

	<u>Page</u>
3.0 PREPARATION AND START-UP	12
3.1 Pretreatment for Water Purification	12
3.2 Start-Up	12
4.0 OPERATION AND MAINTENANCE	18
4.1 Daily Log Sheets	18
4.2 Pre-Filter Cartridge	18
4.3 Flushing	19
4.4 Cleaning	19
4.5 Draining Machine for Shipment	21
4.6 Membrane Element Installation	22
4.7 Membrane Element Replacement	23
5.0 OPTIONAL ACCESSORIES	25
5.1 Level Controls	25
5.2 Filters and Water Softeners	25
5.3 Storage Tanks	25
6.0 TROUBLESHOOTING	26
7.0 RETURN GOODS AUTHORIZATION (RGA) PROCEDURE	31
8.0 WARRANTY	32
9.0 START-UP DATA SHEET	34
10. DAILY LOG SHEET	36

LIST OF FIGURES

1	Normal Versus Cross Flow Filtration	1
2	Membrane Element with Interconnectors.....	2
3	Cross Sectional View of Membrane Element.....	2
4	Principles of Operation	3

LIST OF TABLES

1.1	Feed Water Requirements	7
1.2	Typical Membrane Element Rejections/Passages.....	9
3.3	Machine Recovery	16
4.4	Dry Chemical Cleaners	20

1.0 DESCRIPTION

1.1 General Information and Principles of Operation

Your E-Series reverse osmosis (RO) machine is a durable piece of equipment which, with proper care, will last for many years. These instructions give operating and maintenance details vital to the sustained performance of the machine.

Reverse osmosis is the separation of one component of a solution from another component by means of pressures exerted on a semipermeable membrane element. Removal of ionic, organic and suspended / dissolved impurities occurs during the RO process. Unlike a filter, which separates by “normal” filtration, the General Electric (GE) Osmonics membrane element separates using a process called cross flow filtration. Feed water solution is separated into two streams, permeate and concentrate, and collected from both sides of the membrane element. A semipermeable RO membrane element, under sufficient pressure, allows passage of purified water while rejecting and concentrating dissolved and suspended solids.

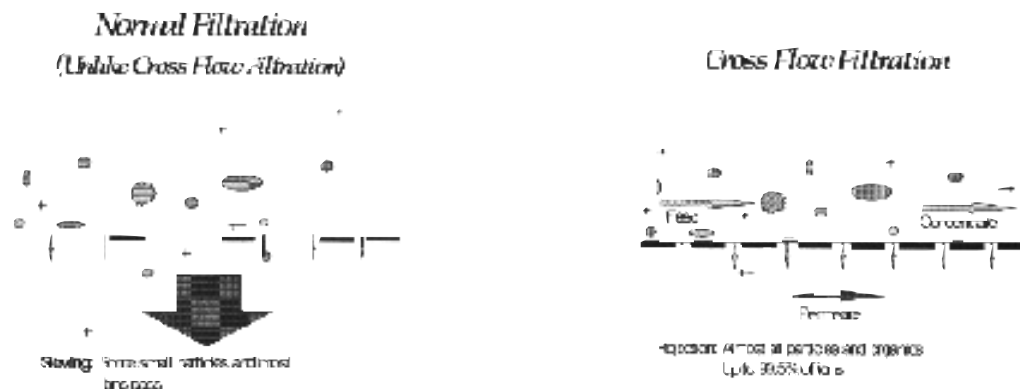


Figure 1.1
Normal Versus
Cross Flow Filtration

GE Osmonics manufactures a patented spiral-wound membrane element package, with a turbulent flow design. This membrane element collects the purified water within a central tube, the permeate tube (Figure 1.2, Membrane Element with Interconnectors and Figure 1.3, Cross Sectional View of Membrane Element).

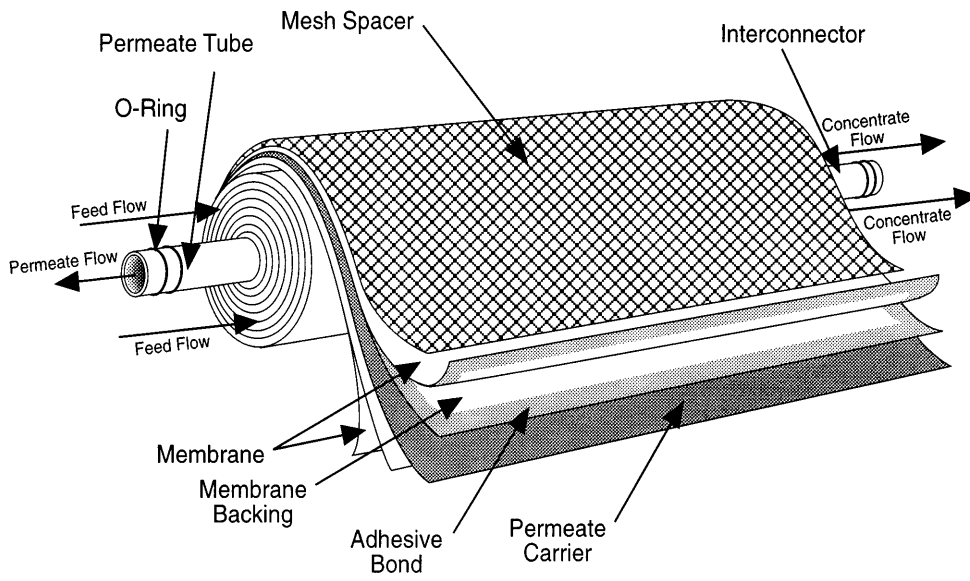
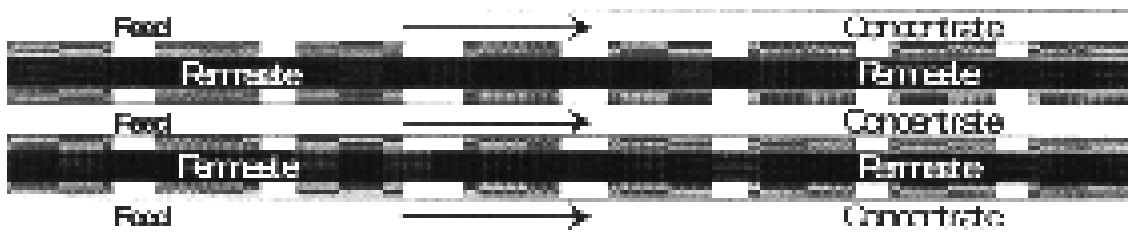


Figure 1.2 - Membrane Element with Interconnectors



**Figure 1.3
Cross Sectional View of
Membrane Element**

Some operating definitions are provided to help you further understand your machine:

Permeate Rate [Product Water Rate (Q_p)] is the flow rate of purified water which has passed through the membrane element and out of the membrane element housing; expressed in gal/min (gpm) or gal/hr (gph) [in metric, liter/min (Lpm) or cubic meters/hour (m^3/h)]. Specified permeate rates are normally at 77°F (25°C).

Concentrate Rate [Waste Water Rate (Q_c)] is the flow rate of water containing rejected solids to drain in gpm or gph (Lpm or m^3/h).

Feed Rate (Q_f) is the flow rate of incoming water in gpm or gph (Lpm or m^3/h). Feedwater rate equals permeate rate plus concentrate rate.

Recovery equals permeate rate divided by feed rate and is expressed as a percentage. For example, 33% recovery means that out of a given feed rate, 33% is produced as purified water (permeate).

Concentration equals the Total Dissolved Solids (TDS) concentration of a solution expressed as milligrams per liter (mg/L) or conductivity (microSiemens/cm).

- C_f = Feed Concentration
- C_p = Permeate Concentration
- C_c = Concentrate Concentration
- C_{avg} = Average Concentration in Machine

Salt (Ionic) Rejection equals the percent of dissolved salt rejected by the membrane element, calculated from an average concentration over the membrane.

Salt (Ionic) Passage equals (100% - rejection) or the percent of dissolved salts passed through the membrane element.

An example of how to calculate salt rejection and recovery is given below:

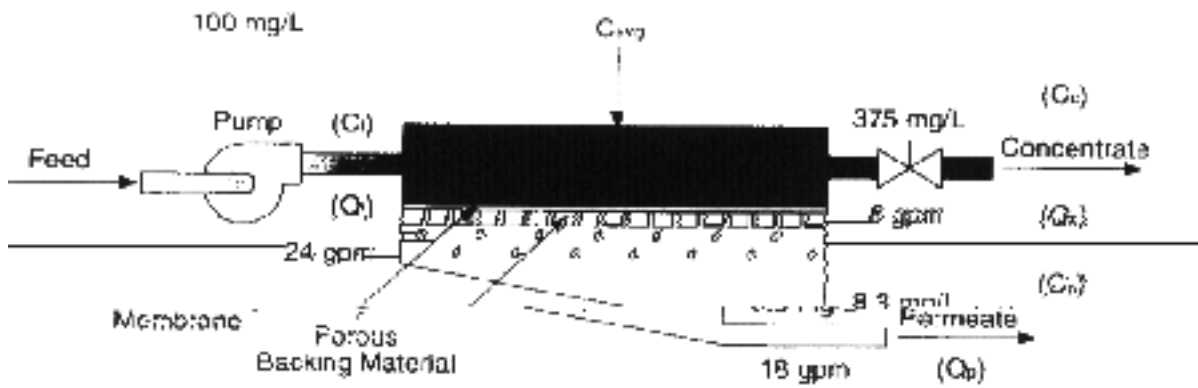


Figure 1.4
Principles of Operation

Given the system case in Figure 1.4 (Principles of Operation):

$$\text{Average Concentration } (C_{\text{avg}}) = \frac{(C_f) 100 \text{ mg/L} + (C_c) 146.9 \text{ mg/L}}{2}$$

$$(C_{\text{avg}}) = 123.5 \text{ mg/L TDS}$$

$$\text{Rejection} = \frac{(C_{\text{avg}}) 123.5 - (C_p) 6.2}{(C_{\text{avg}}) 123.5} \times 100 = 95\%$$

$$\text{Passage} = \frac{(C_p)}{(C_{\text{avg}})} = \frac{6.2}{123.5} \times 100 = 5.0\%$$

$$\text{Recovery} = \frac{(Q_p) 2 \text{ gpm}}{(Q_f) 6 \text{ gpm}} \times 100 = 33\%$$

Flow Description - The feed water passes through a replaceable 5-micron cartridge pre-filter which removes bulk suspended solids. Filtered water then flows to the inlet control valve. This solenoid-controlled diaphragm valve is wired to the ON/OFF switch and opens when the machine is turned ON, allowing water to flow to the pump inlet. When the machine is turned off, the valve closes, preventing non-turbulent flow through the membrane elements, which would lead to shortened membrane element life.

The pump feeds water to the membrane element housings arranged in parallel and serial combinations. The direction of water flow is indicated by an arrow on each membrane element housing. Water is separated by the membrane elements within the membranes and leaves the membrane element housings in two streams: permeate and concentrate.

Permeate from each membrane element housing is collected in a common manifold. The permeate then flows through a flow meter and to the outlet point of the machine.

The concentrate leaves the last membrane element housing and flows to the flow control center (recycle/concentrate manifold). At this point, the recycle valve channels a predetermined amount of concentrate into the pump inlet. Recycle increases recovery while maintaining adequate cross flow through the membrane elements. The other two ports of the flow control center lead to the concentrate valve and final pressure gauge. The concentrate valve has three functions: It controls the amount of concentrate flowing to the drain; it controls the pressure within the machine; and it helps control the system recovery. An Autoflush solenoid is added to the flow control center with an additional tee. The concentrate then flows through a flow meter and to the outlet point of the machine.

1.2 Machine Nomenclature

GE Osmonics E-Series water purification machines are numbered in such a way as to indicate the permeate flow and quality you can expect from the machine.

Example: E4H-21K/ECN, 230, 6, 50-75

- E4H indicates the machine series
- H indicates horizontal membrane element housing configuration
- 21K indicates the rated permeate flow in thousands of gallons per day @ 77°F (25°C), (i.e., 21K = 21,000 gallons per day)
- ECN indicates Economy Model and DLX indicates the Deluxe Model
- 230 indicates 230 VAC, three-phase voltage to starter
- 6 indicates 60 Hz operation, whereas 5 indicates 50 Hz operation
- 50 - 75 indicates 50% to 75% recovery

1.3 Machine Permeate Quality

The permeate rejection performances are as follows:

E4H machines use high rejection Osmo 415 - HR(PA) membrane elements, providing the ultimate in high purity water.

1.4 Economy and Deluxe Model Options

1.4.1 Economy Model

E-Series Economy (ECN) model water purification machines have all the features necessary for safe, continuous production of high purity water. This assumes good quality feed water, adequate pretreatment and regular operator maintenance, each shift or daily, to the operation of the system.

- 50% to 75% recovery
- Multi-stage centrifugal pump, SS construction (stainless steel castings with Noryl stages)
- Base model electrical package includes NEMA-1 enclosure with a 110 VAC, 60 Hz or 220 VAC, 50 Hz single-phase control circuit; applies to all ECN models
- Automatic inlet shutoff valve
- Pre-filter housing and 5-micron cartridge pre-filter
- Pre-filter, post-filter, primary and final pressure gauges

- Digital concentrate and permeate flow meters
- Digital conductivity monitor, panel-mounted, for permeate quality monitoring
- Autoflush System - programmable, automated high-velocity membrane element flushing for the longest membrane element life; set at the factory and adjustable in the field
- Gauges, valves and rigid piping of stainless steel or plastic
- Membrane element housings, all 304 stainless steel (SS), with Noryl end caps
- 316 SS concentrate and recycle valves
- All components in contact with the purified water (permeate) are either FDA-acceptable plastic [nylon, Noryl, polypropylene, polyvinyl chloride (PVC)] or stainless steel materials.
- All high pressure fittings are 304 SS.
- Alarms included: low inlet pressure and high amp draw.

1.4.2 Deluxe Model Options

The Deluxe (DLX) package contains all of the above Economy (ECN) standard features along with a PROGRAMMABLE LOGIC CONTROLLER (PLC) control system.

- Multi-stage centrifugal pump, stainless steel construction (316 stainless steel end castings and other wetted parts, Noryl internals)
- Autoflush System - programmable, automated high-velocity membrane element flushing for the longest membrane life; set at the factory and adjustable in the field
- All high-pressure fittings are 304 stainless steel.
- Special electrical upgrade package includes PROGRAMMABLE LOGIC CONTROLLER (PLC) controller with alarm delay shutdown for low inlet pressure condition to prevent pump damage should pressure fall below 15 psig (1 barg)
- Clean-In-Place (CIP) system
- Digital flow meter and conductivity controller
- Digital pH controller

- Alarms included: low inlet pressure, high amp draw, high / low pH

1.5 Specifications for E-Series Machines

1.5.1 Feed Water Requirements

Table 1.1
Feed Water Requirements

Temperature	35° - 77°F (2° - 25°C) Not to exceed 85°F (29°C) unless specifically designed for higher temperatures
Inlet Pressure	Minimum: 30 psig (2.1 barg) Maximum: 60 psig (4.1 barg)
Chlorine (continuous feed)	For Osmo HR(PA) membrane elements: 0 ppm
Operating pH	Soft water [less than 1 grain per gallon: 3.0 - 10.0 (gpg) or 17 mg/L hardness], acceptable pH: 5.5 - 6.0
Pre-filter	5 micron HYTREX cartridge (part number on machine label)
Inlet Connections	1.5-inch FNPT*

1.5.2 Permeate (Product Water) Flow Rate

Stated on the serial number label (assumes no permeate back pressure, 2000 mg/L TDS maximum feed concentration, and rated temperature).

To estimate permeate output with back pressure, use the formula below:

$$(\text{Permeate Flow on Label}) \times \frac{[(\text{Operating Pressure}) - (\text{Permeate Back Pressure})]}{\text{Operating Pressure}}$$

Permeate Back Pressure: Maximum: 80 psig (5.5 barg)

Permeate Outlet: 1-inch FNPT

* FNPT: Female National Pipe Thread

1.5.3 Concentrate Flow Rate

Factory set as stated on serial number label

Concentrate Outlet: 1-inch FNPT

1.5.4 Typical Pure Water

Recovery: 50 - 75%

1.5.5 Final Operating Pressure

Minimum: 200 psig (13.8 barg)

Maximum: 235 psig (16.2 barg)

1.5.6 Pump

Multi-stage centrifugal, approximate primary operating pressure of 190 psig (13.1 barg), excluding line pressure.

1.5.7 Reverse Osmosis Membrane Element Rejection

Osmo HR(PA)

Typical Ionic Rejection (TDS) 95 - 98%

Average Molecular Weight Cutoff* 150 MW*

* The Molecular Weight cutoff is based on the pore size of the membrane elements and the nature (size/shape) of the organic molecule.

Figure 1.2
Typical Membrane Element
Rejections/Passages

SALTS

CATIONS

Name	Symbol	Percent Rejection	Percent Passage (Avg)	Maximum Concentration Percent
Sodium	Na ⁺	94-96	5	5-10
Calcium	Ca ⁺	96-98	3	*
Magnesium	Mg ⁺	96-98	3	*
Potassium	K ⁺	94-96	5	5-10
Iron	Fe ⁺	98-99	2	*
Manganese	Mn ⁺	98-99	2	*
Aluminum	Al ⁺	99+	1	10-20
Ammonium	NH ₄ ⁺	88-95	8	3-8
Copper	Cu ⁺	98-99	1	10-20
Nickel	Ni ⁺	98-99	1	10-20
Zinc	Zn ⁺	98-99	1	10-20
Strontium	Sr ⁺	96-99	3	-
Hardness	Ca & Mg	96-98	3	*
Cadmium	Cd ⁺	96-98	3	10-20
Silver	Ag ⁺	94-96	5	*
Mercury	Hg ⁺	96-98	3	-

ANIONS

Chloride	Cl ⁻	94-95	4	5-8
Bicarbonate	HCO ₃ ⁻	95-96	4	5-10
Sulfate	SO ₄ ⁻	99+	1	5-15
Nitrate	NO ₃ ⁻	85-95	10	3-6
Fluoride	F ⁻	94-96	5	5-8
Silicate	SiO ₂ ⁻	80-95	10	-
Phosphate	PO ₄ ⁻	99+	1	10-20
Bromide	Br ⁻	94-96	5	5-8
Borate	B ₂ O ₇ ⁻	35-70**	-	-
Chromate	CrO ₄ ⁻	90-98	6	8-12
Cyanide	CN ⁻	90-95**	-	4-12
Sulfite	SO ₃ ⁻	98-99	1	5-15
Thiosulfate	S ₂ O ₃ ⁻	99+	1	10-20

* Must watch for precipitation; other ion controls maximum concentration

** Extremely dependent on pH; tends to be an exception to the rule

The following are typical rejections and passages for various salts and organics using the SEPA^{fi}-HR membrane at 400 psig (27.6 bar) operating pressure. Modules made with this membrane, such as the OSMP^{fi}-HR, can be expected to give these same passages. As can be seen, multivalent ions tend to have less passage than do monovalent ions. If monovalent ions are combined with multivalent ions to form a salt, the passage will be controlled by the multivalent ion. In RO all ions must be combined as the salt form before passages can be considered.

For estimating purposes, to obtain the expected permeate quality when handling a solution of salts, take a simple average of the feed concentration and the concentrate concentration and multiply this figure by the average percent passage to calculate the average concentration of the permeate. Salts or organics that are complexed with organics of large molecular weights will tend to act like the organics with which they are complexed.

NOTE: The actual permeate water quality will vary with the inlet water quality and can only be verified by actual analysis of the permeate stream.

To estimate passage of salts for membrane elements other than SEPA-HR, take the passage for the SEPA-HR and multiply by the factor for the passage for the particular membrane element. The factors are:

SEPA-SR is 1.6 times SEPA-HR passage
SEPA-PR is 2.5 times SEPA-HR passage

Operation of the SEPA-HR membrane element at pressures over 400 psig (27.6 barg) will reduce salt passage slightly. Operation at 200 psig (13.8 bar) will increase the passage of monovalent ions by approximately 2.0 times and the passage of multivalent ions will increase by 1.5 times the 400 psig (27.6 barg) passage.

For SEPA membrane elements with larger pores than the SEPA-HR it is recommended that actual tests be run prior to estimating the permeate quality.

The maximum concentrations given in the table are the approximate concentrations resulting in an osmotic pressure of 500 psi (34.5 barg) for the solution.

Compounds such as CaSO₄ which have specific solubility limits can be controlled with proper addition of dispersants. Check with the factory for more information on Omsonics special line of dispersants

ORGANICS

	Molecular Weight	Percent Rejection	Maximum Concentration Percent
Sucrose Sugar	342	99.9	30-35
Lactose Sugar	360	99.9	30-35
Protein	10,000 Up	99.9	50-80
Glucose	180	99.0	15-20
Phenol	94	***	-
Acetic Acid	60	***	-
Formaldehyde	30	***	-
Dyes	400 to 900	99.9	-
Biochemical			
Oxygen Demand (BOD)		90.0-99.9	
Chemical			-
Oxygen Demand (COD)		99.9	
Urea	60	40-60	Reacts similar to a salt
Bacteria & Virus	50,000 to 500,000	99.9+	-
Pyrogen	1,000 to 5,000	99.9+	-

*** Permeate is enriched in material due to preferential passage through the membrane.

GASES, DISSOLVED

Carbon Dioxide	CO ₂	30-50%
Oxygen	O ₂	Enriched in permeate
Chlorine	Cl ₂	30-70%

2.0 INSTALLATION

2.1 Mounting

E4H machines are equipped with a stand alone frame, 61-inch (155-cm) H x 132-inch (335 cm) W x 34-inch (86 cm) D, which supports the machine. At least 45 inches (114 cm) of space should be allowed on each end of the membrane element housings for removal and loading of membrane elements. If 45-inches (114 cm) are not available, the entire membrane element housing may need to be removed for membrane element changes.

2.2 Piping

2.2.1 Inlet Piping

The feed water source is piped to the inlet using 1.5-inch NPT fittings. A CIP system is supplied with the DLX Model E4H. FOR ECN MODEL: To install a CIP system, remove plug and install valves on the E-Series machine as described in Section 2.2.2. If the inlet pressure is in excess of 60 psig (4.1bar) or fluctuates by more than 5 psig (0.4 bar), a pressure regulator should be installed ahead of the CIP tee.

2.2.2 Required Valves for Clean-In-Place

NOTE: Clean-In-Place (CIP) valves are only required for Economy (ECN) Models.

IMPORTANT NOTE: GE Osmonics has installed a plugged pipe tee in the inlet line of the E4H units. This plug, when removed, will facilitate cleaning of the unit. A tee with (two) two-way valves or a single three-way valve should also be installed on the permeate and concentrate outlets to allow flow back to the cleaning tank. Never operate the machine with the concentrate or permeate lines blocked. Severe damage to the unit may result. (Refer to the attached drawing # 1163858 for a system flow schematic.)

2.2.3 Concentrate Outlet Connection

Install the CIP valve on the concentrate outlet tee, connect a 1-inch hose or pipe, and run it to an open drain. To avoid drainage from the machine while not in use, the concentrate outlet piping should be placed at a height at least equal to the height of the machine. A siphon break may also be installed in the concentrate line for added protection. The concentrate outlet hose can be any length, and the diameter should match the outlet on the machine. [Maximum back pressure is 60 psig (4.1 barg).]

2.2.4 Permeate Outlet Connection

Install the CIP valve on the permeate outlet tee. The pure water (permeate) should be transported to the point of use via non-corroding-type tubing, pipe, or hose. Examples are: food-grade flexible nylon tubing, stainless steel tubing, or PVC hose. The permeate outlet is 1-inch FNPT.

2.3 Electrical

The DLX and ECN E-Series models are supplied with a single-phase, 110 VAC 60 Hz or 220 VAC 50 Hz control circuit and 8-foot cord which plugs into a three-prong grounded receptacle. For 220 VAC, 50 Hz units, plug must be customer-supplied. A 20 amp dedicated service circuit is required for proper operation.

For each model, the motor is wired at the factory to an overload protection magnetic motor starter which is controlled by a panel-mounted manual switch.

The electrical system control circuit is separate from the motor voltage. Therefore, electrical wiring required in the field needs two supply voltages, the control circuit voltage and a separate three-phase motor voltage. All field wiring must comply with applicable local and national electric codes.

2.3.1 Economy Electrical System

STEPS

1. Connect the control circuit power cord to 115 VAC, 60 Hz, or 220 VAC, 50 Hz, single-phase power.
2. Connect the magnetic motor starter 230/460 VAC or 220/380 VAC, three-phase power to match the motor voltage and phase. Check the tag (located on the motor starter) that indicates the factory wiring. A separate, fused disconnect for the motor wiring is required, with proper protection for the Hp and amp draw of the motor.

Refer to drawing #1164309 for the ECN electrical diagram. The ECN circuit has a timing relay for delayed machine shutdown.

2.3.2 Deluxe Electrical System

STEPS

1. Connect the control circuit power cord to 115 VAC, 60 Hz, or 230 VAC, 50 Hz, single-phase power.
2. Connect the magnetic motor starter 230/460 VAC or 220/380 VAC, three-phase power to match the motor voltage and phase. Check the tag (located on the motor starter) that indicates the factory wiring. A separate, fused disconnect for the motor wiring is required, with proper protection for the Hp and amp draw of the motor.

3.0 PREPARATION AND START-UP

3.1 Pretreatment for Water Purification

All systems will operate most efficiently on filtered water with a pH of less than 6.5 and a Silt Density Index (SDI) of 5 or below. If the machine is operated on higher pH water, other forms of pretreatment may be necessary. A water analysis prior to start-up of the machine is required. To minimize the chances of calcium carbonate, calcium sulfate, or other salt precipitation on the membrane, GE Osmonics evaluates each application and water condition and makes specific recommendations to ensure continuity of the membrane element warranty. Data from the water analysis is processed with a computer program analysis to determine if potential problems exist. If the machine is to be run at a different location than was originally intended, a new water analysis is required for warranty consideration and should be sent to GE Osmonics for review and recommendations for operation of the machine.

Before entering the machine, the feed water must be filtered to 5 microns.

Thin-layer composite (TLC) membrane element feed water must not contain the following chemicals or permanent loss of rejection and/or permeate flow may result:

- free chlorine
- formalin (until after a membrane elements have been run for 24 hours; thereafter, 0.5% formaldehyde may be used as a biocide)
- iodine compounds
- quaternary germicides
- cationic surfactants
- detergents containing non-ionic surfactants
- cleaners not approved by GE Osmonics

CAUTION: A water softener should not regenerate while the machine is running unless safeguards are used to be sure the machine is operated on softened water during regeneration.

3.2 Start-Up

NOTE: If your machine is provided with the membrane elements installed in the housings, proceed to 3.2.1. If your machine is provided with the membrane elements in shipping boxes, you must load the membrane elements in the housings prior to starting the machine. For membrane element loading instructions, skip to Section 4.6 (Membrane Element Installation). Upon completion of membrane element installation, return to Step 1 to continue your start-up procedure.

STEPS

1. Re-check the function and integrity of your pretreatment equipment. Ensure that your water softener, activated carbon filters and iron filters (where applicable) have been leak-checked, backwashed, and thoroughly rinsed for service before starting up your RO unit.
2. Attach the feed water pipe to the inlet of the machine.
3. Check for leaks at all connection points.
4. Turn ON the feed water gradually and check for leaks in the inlet piping. No flow should go through the machine while the power is OFF and the inlet solenoid is in the closed position.

NOTE: When the machine is OFF, there should never be flow through the machine. Flow through the machine when it is OFF can ruin the membrane elements, and the inlet solenoid must be repaired.

5. Attach tubing from permeate and concentrate outlet points and run the tubing to drain.
6. Ensure that you have made provisions for both voltages required to operate your machine. The machine requires two power sources: (1) the high voltage for the motor operation, and (2) the control circuit power supply. The factory provides the 110 VAC (or 220 VAC 50 Hz) power cord needed for the control circuit. The motor electrical service must be field-wired directly into the motor starter on the machine. Bring your motor service to terminals labeled "T" on the motor starter. Check the voltage label to ensure that you have brought the correct voltage to the starter.
7. Be sure the power to the motor starter is de-energized.
8. With the machine ON/OFF switch in the OFF position, plug in the factory supplied 110 VAC (or 220 VAC 50 Hz) power cord.
9. Open your concentrate and recycle flow control valves two complete turns. These valves are positioned on the flow control center of the machine. This piping is located on the left section of the machine, near the membrane element housings. The flow control center features a concentrate flow control valve, a recycle flow control valve, and a pressure gauge sensor point piped into the panel-mounted pressure gauge.

NOTE: The Autoflush valve is positioned in this flow control center.

The proper adjustment of these valves is critical to the operation of the RO machine. The concentrate valve determines the amount of rejected water leaving the machine, and creates the operating pressure shown on the pressure gauge. The recycle valve returns unused reject flow back into the

inlet stream to the RO pump. It is important to balance the operating pressure and the respective flows of these valves to ensure that your machine is operating correctly. It is also important to understand the relationship of these two valves, the pressure gauge, and your RO pump. The pump has a fixed amount of flow produced, and the valves are the control devices to distribute this fixed flow amount. The pressure gauge is an indicator of applied membrane element pressure, at the flows set by the valves.

10. Turn the ON/OFF switch to the ON position. Water will begin to flow through the machine at this point but the pump will not start. Allow the machine to operate in this manner for 10 minutes, to purge the air out of the machine. Verify alarm set points in the Lakewood 2450 Reverse Osmosis controller.

Consult the Lakewood Model 2450 Installation and Operation Manual (P/N 1109695) for operating instructions. The factory alarm set points are as follows:

Low Inlet Pressure	12 psig (0.83 barg)
Low pH	2.0
High pH	8.0
pH Control	5.6 - 6.2
High Temperature	120°F (49°C)

NOTE: The high-pressure pump should not be operating at this time.

11. As your machine is filling check for leaks and repair as needed.
12. Turn the ON/OFF switch to the OFF position.
13. Energize the power source to the motor starter. The pump should not operate at this point.
14. Check the rotation of the high-pressure pump by briefly turning the ON/OFF switch to the ON position. Watch the motor, or coupling shaft, for direction of rotation. The motor should rotate clockwise as one looks at the motor end of the high-pressure pump. If the motor is not rotating clockwise, change any two of the three leads (for three-phase) in the motor starter and recheck rotation. Always turn the power off to change any wiring.

WARNING: OPERATION OF THE PUMP BACKWARDS, EVEN FOR A SHORT TIME, CAN CAUSE DAMAGE TO THE PUMP.

15. Turn the ON/OFF switch to the ON position. The high-pressure pump will operate and the machine will begin to build pressure. As you are operating, be sure to watch the pressure gauge on the instrument panel. The machine is designed to operate at 220 psi (15.2 bar).

NOTE: Do not allow the pressure to exceed 250 psi (17.2 bar). If the pressure exceeds 250 psi (17.2 bar), open the concentrate flow control valve until the pressure gauge shows 250 psi (17.2 bar) or less.

As the machine purges the air and fills with water, the pressure will gradually increase. You should see water flowing through the permeate and concentrate flow meters. If you do not see flow, turn the machine OFF and return to Step 1.

WARNING: NEVER ALLOW THE MACHINE TO OPERATE WITHOUT ADEQUATE WATER PRESSURE. THIS CAN CAUSE SEVERE DAMAGE TO THE HIGH-PRESSURE PUMP.

16. Gradually close the concentrate flow control valve. As you close the valve, watch the pressure gauge and your concentrate flow meter. Close the valve until your concentrate flow meter displays your design flow, and you do not exceed 250 psi (17.2 bar). If you reach 250 psi (17.2 bar) before the valve is completely closed, open the recycle flow control valve one full turn, then continue to close the concentrate flow control valve. Continue to close the concentrate flow control valve until it is completely closed and your pressure is below 250 psi (17.2 bar).

The concentrate flow control valve has a drilled orifice to ensure a predetermined amount of flow and pressure in the closed position. This orifice is sized to operate the machine at 75% recovery.

17. With the concentrate flow control valve fully closed and the pressure below 250 psi (17.2 bar), gradually close the recycle flow control valve until the pressure reaches 250 psi (17.2 bar).

Your machine is now operating at the design pressure and flow rates, in a 75% recovery configuration. Your specific needs or conditions may dictate the need to operate the machine at a lower recovery. If you wish to operate in a recovery configuration lower than 75%, Step 18 (below) will explain the necessary steps.

18. Your machine is equipped with flow meters and a pressure gauge that will assist you in setting alternate flow rates for variable recoveries. If you wish to operate at a recovery lower than 75% you must ensure that the flow rates for the permeate and concentrate are at desired levels. Some minor adjustments in the concentrate and recycle flow control valves may be necessary.

See Table 3.1 (Machine Recovery) below for specified flow rates for various machine recoveries. When you have selected your desired flow rate, gradually adjust the concentrate flow control valve to achieve desired flow and use the recycle valve to bring the operating pressure up to 250 psi (17.2 bar).

Once the desired flow rate is achieved [250 psi (17.2 bar) operating pressure] no further valve adjustment is needed.

The table below shows flow rates at 50%, 66% and 75% recovery for the E4H models. Use this table in adjusting flow rates.

NOTE: Permeate flow rates are dependent upon temperature and conditions at your site. Contact your dealer if you have any questions.

**Table 3.3
Machine Recovery**

	Permeate Flow [gpm (m ³ /h)]	Concentrate Flow [gpm (m ³ /h)]		
		at 50%, 60%, and 75% Recovery	at 50% Recovery	at 66% Recovery
E4H-16K	11.2 (2.6)	11.25 (2.6)	5.80 (1.3)	3.75 (0.9)
E4H-21K	15.0 (3.4)	15.00 (3.4)	7.73 (1.8)	5.00 (1.1)
E4H-27K	18.8 (4.3)	18.75 (4.3)	9.66 (2.2)	6.25 (1.4)
E4H-38K	26.2 (6.0)	26.25 (6.0)	13.52 (3.1)	8.75 (2.0)
E4H-43K	30.0 (6.8)	30.00 (6.8)	15.45 (3.5)	10.00 (2.3)

19. The system is now operational.
20. Before putting the machine into final operation, continue to run the permeate and concentrate streams to drain for at least 30 minutes. This is done to ensure that all of the bactericide has been removed from the membrane elements.
21. Connect the permeate line to the point of use of the permeate. Check for leaks and ensure that you have no kinks in hoses, or blockage of any piping on the permeate and concentrate outlet lines.
22. Make any necessary final adjustments to flows and pressure according to Step 18.

NOTE: The membrane elements in your machine are rated for certain flow rates at 77°F (25°C). Maximum flow rates are achieved when the membrane elements have been completely rinsed and on-line for at least 24 hours.

23. A Daily Log Sheet (Section 10.0) which includes general operating conditions (pressures, flows, concentrations, pH, and pretreatment conditions), and routine or special maintenance (flushing or cleaning as needed) must be kept. This Daily Log Sheet will be required by GE Osmonics if a warranty question arises.

4.0 OPERATION AND MAINTENANCE

The operation and maintenance of your GE Osmonics E4H Machine is relatively simple but requires regular data recording and routine preventative maintenance. We cannot emphasize too strongly the importance of filling out the daily log sheet during each operating shift. A data sheet was filled out upon start-up containing pertinent facts on the operation of your machine. These two records are invaluable in diagnosing the performance of the equipment and must be kept for reference. If you have questions concerning the operation of your machine or the method of data recording, contact the GE Osmonics Application Engineering Department.

The three preventative maintenance procedures which must be done on a regular basis are as follows:

1. Change the pre-filter cartridge.
2. Flush the machine daily.
3. Clean the machine with approved GE Osmonics cleaners.

See the following sections for specific maintenance procedures.

4.1 Daily Log Sheets

A Daily Log Sheet (Section 10.0) which includes general operating conditions (pressures, flows and concentrations) and routine or special maintenance (pre-filter changes, flushing, cleaning, etc.) must be kept. Copies of the log can be made from the template. A copy of this log sheet will be required by GE Osmonics if a warranty question arises.

4.2 Pre-Filter Cartridge

A 5-micron pre-filter is factory-installed to protect the membrane elements and valves from particles which may be in the feed water. The pre-filter uses two 20-inch (50.8-cm) diameter, 5-micron nominal rated cartridges. To order replacements, contact your distributor.

The pre-filter cartridges must be replaced, at a minimum, once per week or after every 100 hours of operation, whichever comes first. A pressure drop of 8 psig (0.6 bar) across the filter or more during operation indicates one or more cartridges need changing. Use only Osmonics approved filters rated for 5 microns or less. Do not attempt to clean used filters - install new replacements.

IMPORTANT NOTE: Failure to change the pre-filter according to these requirements will void the warranty.

4.3 Flushing

The machine should be flushed at least daily to remove sediment from membrane element surfaces. To flush the unit:

STEPS

1. Open the concentrate valve until the pressure gauge indicates the minimum pressure designated on the nameplate. This increases the flushing action on the membrane element.

NOTE: If pressure will not decrease to designated pressure, or if the concentrate rate does not increase when the valve is opened, the valve may be plugged.

2. Operate the machine at the designated minimum pressure for 10 to 20 minutes.

CAUTION: **Do not operate the machine below the designated pressure without approval from GE Osmonics. Operation below the stated pressure may be detrimental to the pump.**

3. Close the concentrate valve and ensure that the proper concentrate flow rate is going to the drain (see the nameplate on the panel).

NOTE: The Autoflush (AUF) system, available in DLX packages, automatically flushes the machine and eliminates the need for frequent manual flushing.

4.4 Cleaning

Cleaning the E4H-Series machine on a regular basis is vital. Over time, contaminants build up to form a layer on membrane element surfaces, reducing the permeate flow and quality. If this build-up is not removed from the membrane element, it may cause permanent chemical damage and reduce membrane element life. A decrease in permeate flow and/or rejection of salts, or an increased pressure drop across the machine will indicate when cleaning is required. Cleaning may be required as often as once every week or as infrequently as every two months, depending upon the local water supply conditions. GE Osmonics recommends cleaning at least every month to ensure good membrane element performance and long membrane element life.

GE Osmonics offers a full line of chemical cleaners for specific cleaning needs. See Table 4.4 (Dry Chemical Cleaners).

**Table 4.4
Dry Chemical Cleaners**

Cleaner	Description	Part Number	Quantity
Osmo AD-20	Dry acid-surfactant for cleaning TLC, PA and CA membrane elements.	1155420 1155421 1155422 1155423	8 x 4 lb. pkgs/case 45 lb. pail 100 lb. key 300 lb. drum
Osmo AK-110	High pH alkaline cleaner for PA membrane elements. Recommended for situations where microbial fouling is a problem. <u>DO NOT</u> use on CA membrane elements.	1155416 1155417 1155418 1155419	8 x 4 lb. pkgs/case 45 lb. pail 100 lb. key 300 lb. drum
Osmo ET-70	Cleaner intended to deal with sulfate or iron precipitation fouling. Recommended for CA and PA membrane elements.	1155424 1155425 1155426 1155427	8 x 4 lb. pkgs/case 45 lb. pail 100 lb. key 300 lb. drum

CLEANING PROCEDURE

STEPS

1. With the RO machine running, open the Clean-In-Place (CIP) permeate valve. After this valve has been opened, close the permeate service valve. Permeate water will flow into the CIP tank. Allow the water to run through the CIP tank and the CIP tank drain valve for a few minutes to ensure the tank is rinsed thoroughly. After a minute or so, close the CIP tank drain valve. The CIP tank should begin to fill with RO permeate. When the CIP tank has filled to the indicated full line, turn the ON/OFF switch on the RO machine to the OFF position.
2. While the machine is OFF, open the CIP inlet valve. Divert the permeate and concentrate streams to the cleaning container for recirculation. Ensure that the pre-filter is clean. A CIP pump (supplied with DLX models only) is recommended to supply feed pressure into the machine.
3. To circulate the cleaning solution through the machine with suction, remove the CIP plug. Use a non-collapsible suction hose or pipe to feed the machine.

NOTE: Do not allow the machine pump to operate without concentrate flow. If pump prime is lost while cleaning on suction, positive inlet pressure is required to reprime. No air should be sucked into the inlet line during suction cleaning.

4. Turn the CIP ON/OFF switch to the ON position and recirculate the cleaning solution through the machine. The cleaning solution should be recycled for approximately 15 minutes or until the solution temperature reaches 85°F (29°C). If heat rise occurs too quickly, larger volumes of cleaning solution or the use of a heat exchanger will slow the temperature rise. Turn the CIP OFF and allow it to soak for 10 minutes.

TLC MEMBRANE NOTE: It is best to clean at temperatures of 100°F - 110°F (38°C to 43°C), but lower temperatures will suffice. Do not allow the cleaning temperature to exceed 110°F (43°C). Allow the cleaning solution to recirculate for 10 minutes. Turn the machine off and allow the membrane elements to soak in the solution for approximately 20 minutes.

WARNING: **DO NOT LEAVE THE CLEANING STRENGTH SOLUTION IN THE MACHINE FOR A PERIOD LONGER THAN ONE HOUR. THE CLEANING SOLUTION MAY DAMAGE THE MEMBRANE ELEMENTS AND/OR THE MACHINE DURING AN EXTENDED PERIOD OF CONTACT.**

5. To flush the detergent from the machine, close the CIP inlet valve and divert the permeate and concentrate to drain by opening the CIP drain valve. Operate the machine as described in the flushing section (Section 4.3, Flushing) for at least one hour. The detergent is sufficiently flushed when the permeate conductivity is restored to nearly its previous level.
6. To return the RO to service, open the permeate, concentrate valves so that flow is routed as intended in the service mode. Close the CIP permeate, CIP concentrate valves. The RO is now ready for operation.

4.5 Draining Machine for Shipment

Prior to shipping or outside storage of a GE Osmonics E4H Machine, the system should be cleaned with the appropriate cleaner, flushed with water, and protected from biological attack with the appropriate solution for TLC membrane. The membrane element housings and piping lines of the machine must be completely drained. Any water remaining in the piping of a machine may freeze, causing damage to the piping, pump, membrane elements, etc. The party shipping or storing the machine is responsible for any damage resulting from freezing.

STEPS

1. Disconnect the inlet, concentrate and permeate outlets.
2. Drain all water from the cartridge filter housing.

3. Remove the tubing connections on the inlets and outlets of the membrane element housings.
4. Open the concentrate valve.
5. Remove the drain plugs from all PVC manifolds.
6. Be sure the flow meters are drained by disconnecting the bottom fitting of each flow meter.
7. Allow the machine to drain for a minimum of eight hours or until the opened ports quit dripping.
8. After draining is complete, reconnect all of the piping.

4.6 Membrane Element Installation

NOTE: For machines with membrane elements not loaded at the factory, the following steps are to be used for installation.

CAUTION: The membrane element is packaged in a small amount of bactericide solution to prevent biological growth; provide adequate ventilation when handling. The membrane element must be kept moist at all times in order to prevent possible damage to the membrane element material.

STEPS

1. Remove the membrane element bag containing the membrane element from the shipping tube.
2. Cut the bag open as close as possible to the seal at the end of the bag, so that the bag may be re-used if necessary.
3. Remove the membrane element from the bag and remove the foam protectors from each end of the membrane element.
4. Remove the parts from the parts container (if included) and inspect. Make sure that all parts are clean and free from dirt. Examine the O-rings, brine seal, and permeate tube for nicks or cuts. Replace the O-rings or brine seal if damaged. Set the membrane element aside in a clean space and continue on to Step 5.
5. Remove the end caps from both ends of all membrane element housings on your machine. This is done by loosening the clamp bolts at each end cap closure assembly.
6. Determine the direction of fluid flow in the membrane element housing. (Be certain to look at the “Direction of Flow” arrow for each membrane element housing. Direction of flow may vary within a given machine.)

7. Inspect the membrane element housing and clean as necessary to remove any contaminants, obstructions, etc.
8. Apply a small amount of O-ring lubricant to all O-rings on the end caps, and the brine seal on the membrane element.
9. Insert the downstream end of the membrane element in the upstream end of the membrane element housing (i.e., load in the direction of flow; the brine seal is on the end of the membrane element that goes in last. For membrane element housings with the flow arrow pointing up refer to Step 10.
10. Insert the membrane element in the membrane element housing with a smooth and constant motion. When you reach the point where the brine seal is about to enter the housing, gently turn the membrane element to ensure the brine seal enters the housing without coming out of the brine seal groove.
11. When all of your membrane elements are installed, you must close the membrane element housing by reinstalling the end caps and clamps. It is preferred to install the bottom end cap first, and tighten the clamp completely, before installing the top end cap.
12. Reinstall the end caps by gently twisting the end cap while pushing it on to the permeate tube. Ensure that you do not pinch or fatigue any O-rings while pushing the end cap on. Push the end cap on until the outer diameter of the cap is flush with the outer diameter of the membrane element housing. Install the clamp halves, and tighten the bolts until the clamp halves meet.
13. Reconnect any fittings that were removed when disassembling the membrane element housings.
14. Return to Section 3.2 (Start-Up, Step 1).

4.7 Membrane Element Replacement

As time progresses, the efficiency of the membrane element will be reduced. In general, the salt rejection does not change much until two-three years after installation, when operated on properly pretreated feed water and when routine maintenance is performed. The permeate flow rate will begin to decline slightly after one year of operation but can be extended with diligent flushing and cleaning of the machine. High pH feed water and/or precipitation of hardness can cause premature loss in rejection and even flow rate. The following procedure is to be followed to replace existing membrane elements in the machine.

STEPS

1. Remove the end caps and clamps from all of the membrane element housings.

2. Remove all the membrane elements from the membrane element housings in the direction of flow, where possible. If necessary, a membrane element can be removed against the direction of flow. A heavy duty pliers or channel lock pliers may be necessary to pull the old membrane element out of the membrane element housing.
3. To reinstall replacement membrane elements, follow Steps 4 -14 (Section 4.6, Membrane Element Installation).

NOTE: Do not operate the machine on water over 85°F (29°C).

NOTE: Do not allow the machine to freeze unless it is totally drained. The machine must thaw a minimum of 24 hours before starting.

5.0 OPTIONAL ACCESSORIES

5.1 Level Controls

Float switches, pressurized storage switches or other level controls should be wired into the control circuit line prior to the switch on the unit. The following ensures that the inlet valve, instruments, and pump are not powered when storage tanks are full: float switch assembly with cord, counterweight, and plastic float (used with an atmospheric storage tank).

5.2 Filters and Water Softeners

Backwashable filters and softeners should be installed such that unfiltered or unsoftened water will not be fed to the machine while the RO unit is operating. Failure to do this may cause fouling or precipitation of calcium carbonate or other materials onto the membrane elements.

5.3 Storage Tanks

Fiberglass, polyethylene, and stainless steel storage tanks are available. All tanks are available with fittings installed at the factory. These tanks must be installed with even support along the bottom.

6.0 TROUBLESHOOTING

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REMEDIES
Low operating pressure	Insufficient feed water pressure or flow	Open the feed pressure, open the feed water valve, check for restrictions.
	Clogged pre-filter cartridge	Replace the pre-filter cartridge.
	High flow rates	Close the concentrate valve, check the permeate and concentrate flow rates and adjust if necessary. Excessive permeate flow may indicate a damaged O-ring.
	Dirty or fouled membrane elements	Flush and clean the membrane elements.
	Solenoid valve not opening	Clean or replace the solenoid valve.
	Pump rotating backwards (three-phase power only)	Switch any two of the three-phase leads to the motor starter.
	Insufficient electrical power	Check the fuses or circuit breaker, measure the voltage.
	Pump not operating correctly	See the pump instructions.
	Low permeate flow rate	Low operating pressure

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REMEDIES
Low permeate flow rate (continued)	Dirty or fouled membrane elements	Flush and clean the membrane elements.
	Operating on cold water less than 55°F (13°C)	Install a hot/cold feed water tempering valve if more permeate flow is needed. Operate with a feed water temperature of 72° - 77°F (22° - 25°C).
	Membrane elements installed backwards or damaged concentrate seal	Install membrane elements in the direction of fluid flow. Flush and clean the machine <u>immediately</u> . Membrane elements with damaged concentrate seals should be cleaned and may be returned for repair.
	Flow meter inaccurate	Check the flow rate manually with a stopwatch and calibrated container.
Low concentrate flow rate, normal or higher than normal pressure	Concentrate valve plugged	Remove the concentrate valve stem and/or disassemble the plumbing. Clean the valve.
	Concentrate outlet line restricted	Examine the concentrate line for obstructions or kinks, repair or replace the tubing.
	Flow meter inaccurate	Check the flow rate manually with a calibrated container.
Pressure does not drop when concentrate valve opened	Dirty concentrate valve	Disassemble and clean the plumbing to the valve.

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REMEDIES
High operating pressure	Recycle or concentrate valve plugged	Disassemble the plumbing to the recycle valve and remove foreign particles. Check the concentrate valve stem.
	Inaccurate pressure gauge	Replace or calibrate the gauge as required.
	Restricted or reduced permeate flow rate	See possible causes for low permeate rate.
Excessive pressure drop [over 50 psig (3.4 barg)] (high primary pressure - low final pressure)	Restricted flow after pump outlet	Check for blockage of the concentrate flow at the inlets and outlets of membrane element housings.
	Telescoped membrane element covering membrane element housing outlet port	Ensure that the anti-telescoping (ATD) is located properly on the membrane element.
	Severely fouled or dirty membrane elements	Flush the machine, then clean it with detergent.
Water flowing when machine is turned OFF	Inlet solenoid valve not closing or seating properly	Clean or replace the valve. Clean the membrane elements with detergent <u>immediately</u> . Water must not pass through the inlet when the machine is OFF.
Declining rejection (high permeate conductivity)	Dirty or fouled membrane elements	Flush and clean the membrane elements.

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REMEDIES
Declining rejection (high permeate conductivity) (continued)	O-ring seal broken or damaged	Replace the O-ring, check the sealing surfaces on the O-ring groove, interconnectors, and end caps. Replace damaged parts.
	Change in incoming water quality	Open the concentrate valve and flush. Test the water for pH, hardness, TDS, and iron content. A water analysis should be sent to GE Osmonics.
	Inaccurate conductivity monitor or fouled probe	Calibrate the monitor with a solution of known conductivity or check the readings with another conductivity meter. Replace or clean the probe. Check the connections between the probe and monitor.
Switch ON, unit not operating	Pressurized storage switch or float switch has cut power to machine	Check the permeate back pressure or position of float in the storage tank.
	Thermal overload in motor has tripped	Allow the machine to cool; check the feed water supply and/or AMP draw to the motor.
	No power to machine	Check the fuses or circuit breakers, measure the voltage.
	Motor and/or pump not operating properly	See pump instructions. Contact GE Osmonics for possible repair or replacement.

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REMEDIES
Electrical machine shutdown	Alarm condition has turned machine OFF	Restart the machine by pushing the alarm bypass. Check all possible alarm conditions: inlet pressure or motor starter overload.
	Motor starter overloaded, heater tripped	Turn the switch OFF; rest the heater(s). Check the motor AMP draw and the line voltage.
	Timing relay defective/burned out	Replace the relay.

7.0 RETURN GOODS AUTHORIZATION (RGA) PROCEDURE

If you wish to return good for repair, warranty evaluation and/or credit, please have your original sales order or invoice available when you call GE Osmonics. Call (800) 848-1750 and ask to speak with Customer Service. A GE Osmonics Customer Service representative will provide instructions and a return authorization number which needs to be clearly written on the outside of the box used to ship your materials. All equipment must be shipped to GE Osmonics with the freight prepaid by the customer. Call our Customer Service Center with any questions or issues concerning freight claims and a representative will discuss your situation.

All materials to be returned must be rendered in a non-hazardous condition prior to shipping.

IMPORTANT NOTE: Machines must never be shipped with water in them; this will void the warranty. Drain the machine completely before shipping and avoid freezing before draining. The machine should be sanitized (Section 4.4, Cleaning) prior to draining (Section 4.5, Draining Machine for Shipment).

8.0 WARRANTY

Warranty Terms

Subject to the terms and conditions set forth hereinafter, Seller (GE Osmonics, Inc. or any of its authorized subsidiaries) warrants to the original purchaser (hereafter the "Buyer") that the products manufactured by Seller are free from defects in material and in workmanship for twelve (12) months from the Warranty Commencement Date (as defined below) only when used strictly in accordance with the applicable operating instructions and within the range of the operating conditions specified by Seller for each such product. This Warranty does not extend to equipment or components manufactured by others into which a Seller product has been incorporated or to equipment or components which have been incorporated into a Seller product but, if allowable, Seller hereby assigns, without warranty, to the Buyer its interest, if any, under any warranty made by the manufacturer of such equipment or component. This Warranty does not cover disposable items such as fuses, lamps, filters, cartridges, or other such disposable items, which must be replaced periodically under the normal and foreseeable operating conditions of the goods warranted hereby.

Warranty Commencement Date

The Warranty Commencement Date for each Seller product shall be the later of the date of: (1) receipt by the Buyer, or (2) the date of installation at the Buyer's premises provided that such installation must occur within three (3) months of shipment from the Seller's manufacturing facility in Minnetonka, Minnesota. In no event shall the Warranty Commencement Date exceed three (3) months from the shipment from the Seller's manufacturing facility. The Buyer shall provide proof of purchase in order to exercise rights granted under this Warranty. If requested by GE Osmonics, the Buyer must also provide proof of the installation date. Proof of installation shall be returned by Buyer to Seller within thirty (30) days after installation by virtue of supplying a Warranty Validation Card supplied with each Seller product fully completed and signed in ink by Buyer and the authorized installer of the product.

Warranty Service

SELLER'S OBLIGATION UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT (AT SELLER'S SOLE OPTION) OF ANY PRODUCT, OR COMPONENT THEREOF, PROVED TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP WITHIN THE COVERED WARRANTY PERIOD. The Buyer, at the Buyer's risk and expense, shall be responsible for returning such product or component, upon obtaining a Return Goods Authorization (RGA) number from the Seller, freight prepaid, and in conformance with any special packaging and shipping instructions set forth on the operation documentation or RGA instructions, or as otherwise reasonably required, to the Seller's address set forth below, together with (1) RGA number issued by Seller at Buyer's request; (2) proof of purchase and, if necessary, proof of installation date; (3) a description of the suspected defects; (4) the serial number of the Seller product alleged to be defective; and (5) a description of the type of water pretreatment equipment which has been utilized in connection with the product, if any. Seller shall, in Seller's reasonable discretion, be the sole judge of whether a returned product or component is defective in material or

workmanship. Required or replaced products or components shall be returned to the Buyer by the Seller, freight prepaid by Seller, via UPS ground or best way surface freight. In genuine emergency situation, Seller will (at Seller's sole option) forward replacement parts to Buyer without waiting for authorized return of the questionable part(s). In such cases, Buyer will issue a purchase order or other payment guarantee prior to shipment. If the returned part is found to have been misused or abused, the defective part is not received by Seller within thirty (30) days, the Buyer will be invoiced for replacement part(s) provided. This Warranty does not cover or include labor and/or travel to the Buyer's premise or location or any other location. Charges will be made for the usual and customary Seller costs and associated expenses incurred by Seller in providing Warranty Service at any location other than Seller's factory at the address set forth below, and Seller reserves the right to precondition such travel to Buyer's premises upon prepayment of Seller's anticipated costs of attending such premises.

Voidability of Warranty

This Warranty shall be void and unenforceable as to any Seller product which has been damaged by accident, mishandling, abuse or has been repaired, modified, altered, disassembled or otherwise tampered with by anyone other than Seller or an authorized Seller service representative; or, if any replacement parts are not authorized by Seller have been used, or, the product has not been installed, operated and maintained in strict accordance and adherence with the operating documentation and manuals for such product. Any express warranty, or similar representation of performance set forth in the operation documentation for a reverse osmosis or ultrafiltration membrane incorporated into a Seller product shall be void and unenforceable unless the feed water requirements set forth in the operating documentation for such product are unequivocally and strictly adhered to.

Limitations and Exclusions

THIS WARRANTY AND REMEDIES DESCRIBED HEREIN AND HEREIN ABOVE ARE EXCLUSIVE AND IN LIEU OF ANY AND ALL OTHER WARRANTY OR REMEDIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL THE SELLER BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL OR OTHER SIMILAR TYPES OF DAMAGES, OR FOR DAMAGES FOR THE LOSS OF PRODUCTION OR PROFITS, OR INJURY TO PERSON OR PROPERTY. NO PERSON HAS ANY AUTHORITY TO BIND SELLER TO OTHER THAN WHAT IS SET FORTH ABOVE.

THIS WARRANTY GIVES THE BUYER SPECIFIC LEGAL RIGHTS AND THE BUYER MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM JURISDICTION TO JURISDICTION. THE PARTIES RECOGNIZE AND AGREE, THAT IN ALL RESPECTS THE LAWS OF THE STATE OF MINNESOTA SHALL APPLY TO AND SHALL GOVERN ANY INTERPRETATION OR LEGAL SIGNIFICANCE OF THIS DOCUMENT.

9.0 START-UP DATA

Customer: _____

Model Number: _____

Date: _____

Serial Number: _____

Tested By: _____

	Units (Circle One)				Data	Data	Remarks
Temperature	°F		°C				
Permeate Rate	gpm	gph	Lpm	Lph	/	/	
Concentrate Rate	gpm	gph	Lpm	Lph	/	/	
Total Flow Rate	gpm	gph	Lpm	Lph	/	/	
Recovery			%				
Pre-Filter Pressure	bar		psi				
Post-Filter Pressure	bar		psi				
Primary Pressure	bar		psi				
Final Pressure	bar		psi				
Feed TDS			µS				
Concentrate TDS			µS				
Average TDS			µS				
Permeate TDS (manual)			µS				
Permeate TDS (meter µS)			µS				
% Passage (Perm TDS / Avg TDS)							
Chlorine in Concentrate			ppm				
Low Pressure Switch Setting	bar		psi				
Pump Model Number							
Pump Serial Number							

For more information:

Call (952) 933 - 2277 for additional information (800) 848 - 1750 in the U.S., or visit www.gewater.com.

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