GE Power & Water
Water & Process Technologies

OPERATION AND MAINTENANCE MANUAL
OSMO PRO Series

Revision 3

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Prepared For:

Client Name

Plant Location

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1 GENERAL INFORMATION

1.1 The Manual

This manual has been prepared to provide the operator with information on the installation, operation, maintenance, and troubleshooting of PRO Series Reverse Osmosis machines.

The manual may be supplemented with drawings, schematics, and Technotes for clarification.

1.2 Safety Summary

Words in **ENHANCED CAPITAL** letters are used to identify labels on the device and key safety or qualifying statements.

The safety summary does not contain all of the safety statements in the manual. Other safety statements are included within the manual text and are enhanced and defined as follows:

NOTE

Indicates statements that provide further information and clarification.

CAUTION!

Cautions indicate statements that are used to identify conditions or practices that could result in equipment or other property damage.

WARNING!!

Warnings indicate statements that are used to identify conditions or practices that could result in injury or loss of life.

! **Important warnings refer to hazards or unsafe methods or practices that can result in product damage or related equipment damage.**

IMPORTANT!

READ THIS MANUAL: Prior to operating or servicing this device, this manual must be read and understood. Keep this and other associated manuals for future reference and for new operators or qualified service personnel.

USE PROPER POWER CONNECTIONS: Use proper wiring connection methods to satisfy local electrical codes.

DO NOT REMOVE OR OPEN COVERS OR PANELS: To avoid electrical shock hazard, do not remove covers or panels when power is supplied to the device. Do not operate the device when covers or panels are removed. If a panel must be removed for troubleshooting purposes, use extreme caution.

SHOCK HAZARD: Connect this device to a properly grounded connection in accordance with the National Electrical Code and any other local codes or ordinances that apply. **DO NOT,** under any circumstances, remove the ground wires or ground prong from any power plug. Keep the floor surface under the RO free of water.

DEVICE LABELING: Do not, under any circumstances, remove any Caution, Warning, or other descriptive labels from the device until the conditions of warranting the label are eliminated.

DO NOT OPERATE IN FLAMMABLE ATMOSPHERES: To avoid fire or explosion, do not operate this device in an explosive environment.

1.3 Applications

The OSMO PRO Series Reverse Osmosis (RO) System is designed to purify water by forcing water through a semi-permeable RO membrane. Water purified by reverse osmosis has had approximately 97 – 98% of the dissolved ions and approximately 99% of most other contaminants removed. The quality of the purified water, referred to as permeate, depends on many parameters, including the quality of the feedwater and correct operation and maintenance of the equipment.

1.4 Piping Recommendations

Piping materials can significantly contribute to the contamination of water. Most metallic pipes (with the exception of stainless steel) must not be used for transferring high purity permeate water following the RO machine. Schedule 80 PVC pipes, polypropylene, PVDF, and other FDA recommended materials are suitable for most grades of purified water. Care must also be exercised in the choice of a thread sealant. Teflon* tape is suitable for all threaded connections in this system.

WARNING!!

Ordinary pipe dope must be avoided since it may leach objectionable and potentially dangerous impurities into the water.

1.5 Principles of Operation

Your machine is a durable piece of equipment, which with proper care, will last for many years. PRO machines are designed for a wide variety of industrial and commercial applications. Contact the GE Water & Process Technologies sales representative with any questions concerning potential applications.

1.6 Components of the PRO Series System

Automatic Inlet Valve

The automatic inlet valve is actuated with air. A solenoid valve controls the automatic flow of air to this valve. The inlet valve is closed whenever the machine is shut down, which keeps feed water from flowing through the machine at low pressures.

*Teflon is a trademark of E.I. DuPont de Nemours and Company, Inc.

One-Micron Pre-filter

All machines have a depth cartridge pre-filter system located near the feedwater inlet of the machine. The filters are nominally rated at one micron, so all particles larger than one micron will be removed from the inlet stream. The filter system is meant to protect the RO membrane elements from large particles, which could be damaging. The number of filter housings varies with the size of machine. Typically, other forms of filtration precede the cartridge pre-filters.

Membrane Elements

All machines utilize GE Water & Process Technologies' turbulent flow membrane elements to provide high mineral rejection, low-pressure drop, and high flow rates.

Membrane Element Housings

GE Water & Process Technologies four-port side entry stainless steel or Fiberglass Reinforced Plastic housings simplify machine design and membrane element change-out. GE Water & Process Technologies port-to-port dimension allows for a compact machine design providing the most water production in the smallest footprint.

Pumps

All machines are equipped with Tonkaflo® Multi-stage Centrifugal pumps. The pumps are specifically designed to deliver consistent high-pressure flow ideal for membrane system operation. The liquid ends of these pumps are very sophisticated and maintenance should only be performed by authorized Tonkaflo personnel.

1.7 Instrumentation

Conductivity Probe

All machines feature a permeate conductivity probe. Conductivity, measured in microSiemens per centimeter (µS/cm), is a measure of the dissolved minerals (ionic impurities). The cleaner the permeate, the lower the conductivity reading.

High Pressure Switch

All machines feature two high-pressure switches. These switches shut down the machine if permeate or concentrate pressure exceed a preset level. These switches should not have the setpoint values increased to prevent potentially dangerous situations from occurring.

PH Probe

Machines with the Premium electrical package feature a pH probe on the inlet of the RO machine, while it is optional on machines with the Basic electrical package. This probe monitors feed pH to control acid or caustic addition. The machine will shut down if this pH reading exceeds the high or low pH set points. The chemical addition for pH control is controlled through a 4-20 mA Proportional Integral Derivative (PID) control.

Low Inlet Pressure Switch

All machines feature a low inlet pressure switch. This switch shuts the machine down if the feedwater pressure drops below a level that is considered damaging to the pump.

Oxidation Reduction Potential (ORP)

All machines have the option to include an Oxidation Reduction Potential (ORP) probe on the inlet. This probe monitors for the presence of oxidants such as chlorine or chloramines in the feedwater, which are harmful to the membrane elements. The high ORP alarm set point is adjusted at start-up to 10% below a known chlorine-free background, typically 180 – 200mv. A hand-held chlorine monitor should be used to verify chlorine-free operation and ORP settings at start-up and once a week.

Permeate and Concentrate Flow Meters

All machines include flow meters for permeate and concentrate streams. The flow meters are paddle wheel type flow meters. Water flowing through the meter spins the paddle wheel like a pinwheel. The spinning turbine emits a magnetic pulse. The cable carries the signal to the flow monitor where the signal is translated into a digital flow reading.

Pressure Gauges

All machines include stainless steel, glycerin-filled pressure gauges mounted into various locations in the machine's piping to yield pre-filter, post-filter, primary, and final permeate, concentrate, and pump discharge pressure readings.

Instruments Controller

Machines with the Basic electrical package include a Signet 8900 Multiparameter controller. This controller features digital monitoring of the permeate/concentrate flows, conductivity, temperature and optional pH and ORP. The controller has four programmable relays some of which are used for alarms. The 8900 Multiparameter also has configurable analog (4 – 20 mA) outputs that transmit data to the machines PLC or can be used to send data to the user's data acquisition or control system. Machines that have the Premium electrical package do not need the Signet 8900 Multiparameter controller as the sensors transfer the data directly to the machines PLC.

1.8 Electrical Package

Basic Electrical Package

The basic model machine utilizes a GEIP Micro Versamax or Allen-Bradley MicroLogix 1200 Series Programmable Logic Controller (PLC) to control the machine's operation. A GEIP Quick Panel 6.0-inch or an Allen-Bradley PanelView 300 Human Machine Interface (HMI) is used for message display and system control.

Premium Electrical Package

The premium model machine utilizes a GEIP Versamax or Allen-Bradley CompactLogix PLC and a GEIP Quick Panel 12-inch or Allen-Bradley PanelView Plus 700 HMI. The Premium Electrical Package includes a feed conductivity probe and two pressure transmitters for primary and final pressure display.

1.9 Specifications

1.9.1 Flow Specifications

The machine flow specifications listed below are based on a feedwater temperature of 68°F (20°C).

Table 1-1: Flow Specifications/Range 75% Recovery

	Permeate Rate m3/h	Concentrate Rate m3/h	Recycle Rate gpm m3/h	Feed Rate gpm m3/h
PRO – 11	11	3.7	2.6	14.7
PRO – 23	23	7.5	2.3	30.5
PRO – 34	34	11.4	-	45.4
PRO – 45	45	15.2	4.5	60.2
PRO – 68	68	23	-	91
PRO – 102	102	34	--	136

* Flow rates can vary ±5%.

1.9.2 Pressure Specifications

The machines typically operate at a primary pressure of 200 – 250 psi (13 – 17 bar) with a 50 – 100 psi (3.4 – 6.9 bar) pressure drop across the membrane elements.

1.9.3 Feedwater Requirements

The following feedwater requirements must be met before installing your new machine to ensure quality permeate and extended membrane element life.

Table 1-2: Feedwater Requirements

Temperature	Minimum: 35°F (2°C)* Nominal: 60 – 75°F (16 – 24°C) Maximum: 85°F (29°C)
Inlet Pressure	Minimum: 30 psig (2.1 bar) Maximum: 60 psig (4.1 bar)
Total Dissolved Solids (TDS)	Maximum: 1,500 mg/L
Chloride Ion	Maximum: 350 mg/L (consult with GE Water and Process Technologies if chloride level in feedwater is higher).
Chlorine (continuous feed)	0 ppm

Iron	< 0.1 ppm
LSI	Negative
Operating pH	4 – 9
Silt Density Index (SDI)	< 5

* The system will produce far less permeate at the minimum temperature.

1.9.4 Permeate Flow Rate

Stated in Table 1-1: Flow Specifications/Range 75% Recovery.

Efforts should be taken to limit the permeate flow when operating at higher temperatures. Do not allow the machine to produce more than 20% above the rated permeate flow.

1.9.5 Concentrate Flow Rate

Stated in Table 1-1: Flow Specifications/Range 75% Recovery.

The flow control device can be manually adjusted to maintain between 75-80% recovery.

1.9.6 Pressure Range

To estimate the RO pump boost pressure, use the formula below:

Boost Pressure = (Primary Pressure) – (Post-filter Pressure)

The machine's typical primary pressure will need to be adjusted for different water temperatures in a range between 250 – 150 psi (17 – 10 bar).

1.9.7 Membrane Rejection

Your machine uses GE Water & Process Technologies Fiberglass Reinforced Plastic (FRP) covered OSMO PRO 365 membrane elements with Thin Film Composite (TFC) membrane elements. For ordering information refer to the Spare Parts List (Section 4.6).

Table 1-3: OSMO PRO 365 Membrane Element Specifications

Outer Cover Material	FRP

Typical Ionic Rejection (TDS)*	99.0 – 99.5%
Permeate Flow Rate at 225 psi (15.5 bar)	10,000 gpd (37.8 m^3/d)
Typical Feedwater Temperature Range	10 – 30°C
Maximum Temperature Range	0 – 50°C
pH Range	4.0 – 11.0
Chlorine Tolerance	< 0.01 ppm
Active Membrane Area	365 ft^2 (34 m^2)
Average Molecular Weight Cutoff**	150 MW

*Based on 24 hours of operation at 225 psig (15.5 bar), 77°F (25°C), 7 – 8 pH, 2000 ppm NaCl solution.

**The molecular weight cutoff is based on the pore size of the membranes and the nature (size/shape) of the organic molecule.

1.9.8 Environmental Requirements

Ambient Temperature: 5 - 32°C (40-90°F)

CAUTION!

This machine must not be allowed to freeze. Irreparable harm to various components, including RO membranes may occur. See Section 1.11.3.

NOTE

This machine is designed for indoor operation only.

NOTE

If this unit is operating in a humid environment, the user/operator should recognize that moisture can be caused by condensation and is not necessarily an equipment leak.

1.10 Flow Description

1.10.1 Inlet Flow

The feedwater passes through a stainless steel, seven-round cartridge filter housing. These housings are filled with replaceable one-micron cartridge filters, which remove suspended solids (Figure 1-1: PRO Series Machine). The pressure is measured before and after the cartridge filter housings. These readings are the pre- and post- filter pressures, displayed by the gauges on the piping before and after the filter housing(s). Filtered water then flows to the inlet control valve. When the RO is turned ON, the valve opens, allowing water to flow to the pump inlet. When the RO is turned OFF, the valve closes, preventing low velocity, non-turbulent flow through the membrane elements, which would lead to fouling, scaling, and shortened membrane element life. Both pH and ORP measurements, if applicable, are taken prior to the pump inlet.

NOTE

If an external control device is used (level switches, level transmitter, etc.), the on/off switch would always be in the on position. In this case, the external control switch controls the state of the inlet control valve.

1.10.2 High-Pressure Flow

The Tonkaflo centrifugal pump boosts the water pressure and feeds water to the eight-inch diameter membrane element housings. Line pressure is measured between the pump discharge and the inlet of the first housing. This measurement is the **primary pressure**. The membrane element housings are horizontally mounted and arranged in series and parallel combinations. An arrow label on the side of each housing indicates the direction of flow. The membrane element housings separate the water into two streams. Water that passes through the membrane element (which is filtered or purified) leaves the housing as permeate, and water that does not pass through the membrane element leaves the housing as concentrate. Note that the direction of flow indicators refer only to concentrate flow. Permeate will flow out of the open (not-plugged) end of the housing, regardless of concentrate flow direction (Figure 1-3: Membrane Element).

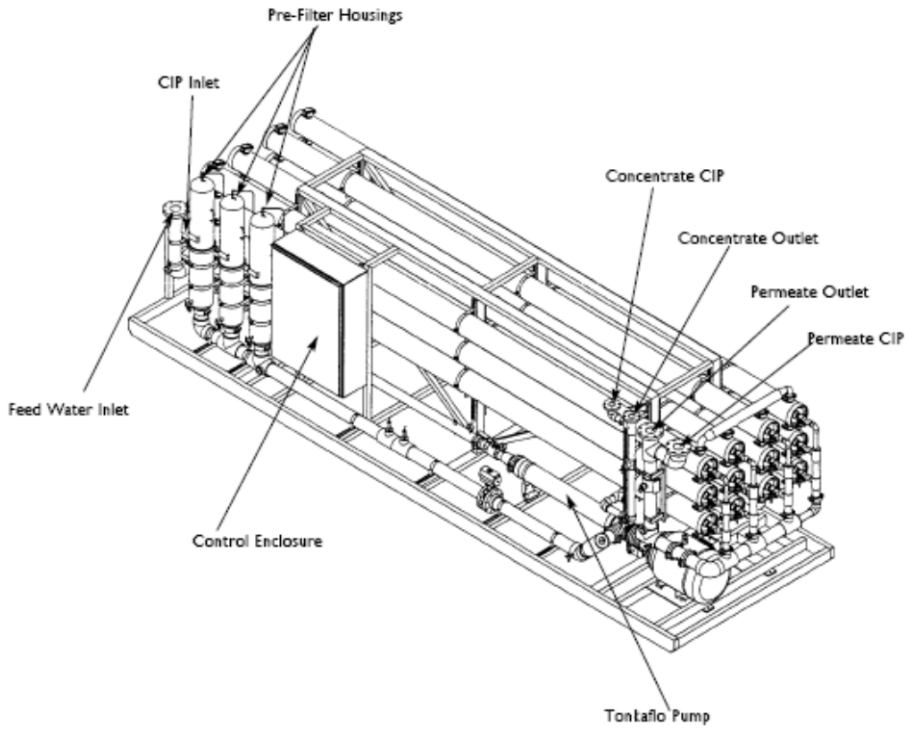

Figure 1-1: PRO Series Machine

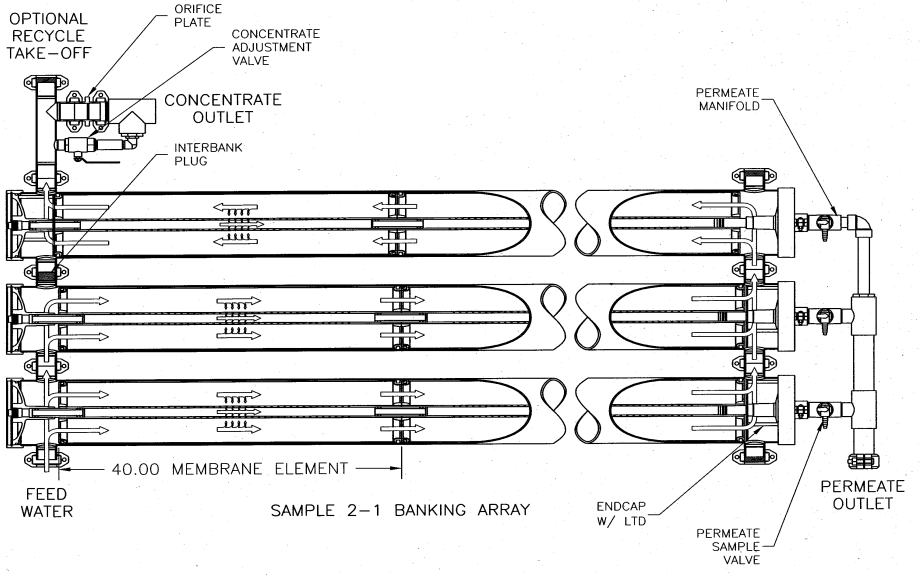

Figure 1-2: Banking Array

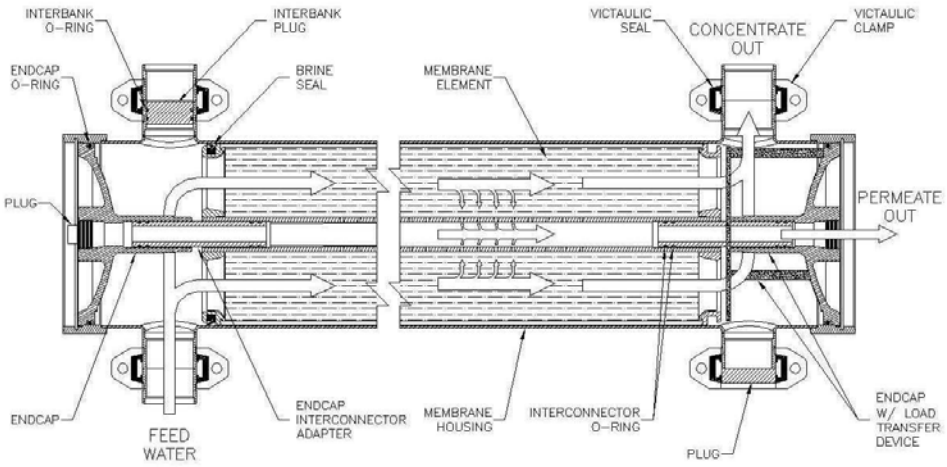

Figure 1-3 :

Membrane Element

1.10.3 Permeate Flow

The permeate leaves each housing and is collected into a common manifold. This stream flows through the permeate flow meter to the permeate outlet of the machine. The conductivity of the stream is measured before the permeate exits the machine. This measurement is the **permeate conductivity.** Both the permeate flow and conductivity readings are displayed on the instrument center or HMI. It is important to not have excessive permeate back pressure. A check valve is present in the permeate piping to prevent backflow of permeate through the membrane elements.

1.10.4 Concentrate Flow

The concentrate leaves the last membrane element housing and flows to the concentrate outlet. Line pressure is measured between the outlet of the last housing and the concentrate orifice. This measurement is the **final applied membrane pressure.** Both the recycle and concentrate orifices or control valves are integral in controlling the operating pressure and recovery of the machine. The recycle flow diverts a fraction of the concentrate back to the pump inlet. Recycling a portion of the concentrate allows the system to achieve a higher volumetric recovery. It also ensures that enough water is fed to the membrane elements to provide adequate crossflow. Some units do not require this. Concentrate passes through the concentrate flow control valve to the

concentrate flow meter and on to the concentrate outlet. The instrument center or HMI displays the concentrate flow. The concentrate valve controls the amount of concentrate that leaves the machine. At the same time, it provides the restriction necessary to control the operating pressure of the machine.

1.11 Storing and Shipping Your Machine

If your machine is to be shutdown for extended periods of time, special steps must be taken to properly protect it from bacteriological contamination.

When an RO machine is shut down, careful consideration must be paid to storage procedures in order to minimize the potential for microbiological growth in the system. Stagnant, untreated conditions create a thriving environment for microbiological organisms. Over time, a biofilm will form and it can be very difficult to remove.

1.11.1 Short term shutdowns

Short term shut down of an RO system (24-48 hours) generally does not require special membrane storage procedures. The RO should be cycled (run in operational mode) for at least 15 minutes every 24-48 hours to reduce the potential for bio-growth and stagnation within the system. Some systems use a permeate flush during shutdown. This type of cycling will allow the system to remain “operationally” ready, and it will allow for a slightly longer time between flush cycles.

1.11.2 Long term shutdowns

For prolonged storage (i.e. several days to several months), the following procedures are recommended. These procedures will help protect and preserve the elements from bacterial growth. The elements can be left in their housings or unloaded and stored separately.

Typically, one of the following lay-up solutions is used depending upon application, regulatory limitations, preference, and chemical availability:

1. 0.5 to 1.0% sodium bisulfite or 3.0% BetzDearborn DCL30

2. Isothiazoline-based non-oxidizing biocide such as Biomate MBC781 according to EPA use-limitations.

3. 1.0 to 2.0% citric acid or 4% Betz MPH5000; 2% Kleen MCT442; 10% Kleen MCT882.

NOTE

DBNPA-based biocides such as Biomate MBC2881 have been successfully used for membrane lay-up, however some membrane manufacturers do not recommend using this chemistry due to the potential by-products formed by a long-term hydrolysis mechanism.

The following procedure is recommended for RO storage in sodium bisulfite or biocide solution.

1. Clean the membrane elements via standard clean-in-place procedures, and thoroughly rinse the RO system.

2. Prepare the appropriate strength sodium bisulfite or biocide solution in the CIP tank by diluting with permeate water.

3. Circulate the solution through the RO system for 15 to 20 minutes.

4. When the RO system is filled with this solution, close the valves to retain the solution in the RO.

5. Repeat Steps 2 and 3 with fresh solution every thirty days if the temperature is below 80°F (27°C), or every fifteen days if the temperature is above 80°F (27°C).

6. When the RO system is ready to be returned to service, flush the system to drain until the permeate water meets quality specifications, then return the machine to service.

NOTE

Over time, sodium bisulfite will become oxidized and form sulfuric acid, lowering the pH. The pH of the lay-up solution should be monitored monthly and fresh solution added if the pH drops to pH=3 or lower, in order to safeguard the membranes.

An alternate procedure that requires less maintenance specifies the use of citric acid or a low pH cleaning solution to “Pickle” the system. The following procedure is recommended:

1. Clean the membrane elements via standard clean-in-place procedures, and thoroughly rinse the RO system.

2. Prepare the appropriate strength citric acid solution in the CIP tank by diluting with permeate water.

3. Circulate the solution through the RO system for 15 to 20 minutes.

4. Shut the RO system down.

5. Valve off CIP tank and drain tank.

6. Leave the acid solution in the RO machine.

The elements can remain in the housings for over a year without any change in element performance, provided the storage temperature is below the maximum element operating temperature.

BE SURE TO THE FOLLOW START-UP PROCEDURE (Section 3.1.2) before putting the machine back in service.

1.11.3 Preventing Freezing

If your machine is to be shipped or stored under circumstances that might cause freezing, completely drain the machine of all remaining water. Failure to do so may result in damaged piping. Do not the restart machine until it has been thawed for at least 24 hours.

1.11.4 Draining Machine

Prior to shipping or outside storage the system should be cleaned with the appropriate cleaner, flushed with water, and protected from biological attack with an appropriate solution. The membrane housings and piping lines of the machine must be completely

drained. Any water remaining in the plumbing of a machine may freeze, causing damage to the piping, pump, membranes, etc.

1. Disconnect the inlet, concentrate, and permeate outlets.

2. Drain all water from the pre-filter housing(s).

3. Open the vent valves on top of the pre-filter housing(s).

4. Remove the piping connections on the outlets of the membrane housings.

5. Open the concentrate valve.

6. Open all sample and drain valves.

7. Remove the drain plug from pump discharge and inlet plumbing and remove the Victaulic clamp and gasket on the pump discharge.

8. Allow the machine to drain for a minimum of eight hours or until the opened ports quit dripping.

9. Reconnect all of the plumbing.

1.12 Service Assistance

If service assistance is required, take the following steps:

1. Consult the TROUBLESHOOTING Section of this manual (Section 5). If the problem cannot be identified and corrected by any of the procedures found in that section, then:

2. **Call the GE Water & Process Technologies Field Service Group at (866) GEWATER**

Prior to making the call, have the following information available:

- RO model you have.
- The serial number of your PRO (on the nameplate attached to the face panel).

- Detailed description of the problem.
- Operation and Maintenance Logs. Current operating parameters (i.e. flow, operating pressures, pH, etc.).
- Last time cleaned.

2 INSTALLATION

2.1 Rigging Instructions

All equipment skids will be delivered in a covered van or flatbed truck.

2.1.1 Covered Van Delivery

The machine will not be crated, but will be secured inside the van with wood blocks, straps, etc. All pieces of equipment that are wet tested at GE Water & Process Technologies factory are completely drained to prevent ice damage.

Remove the equipment from the van at a loading dock using forklifts, pallet jacks, and moving carts. All equipment frames are designed to allow lifting devices easy access at the narrow ends.

2.1.2 Flatbed Truck Delivery

The machine will be shrink wrapped with plastic. The machine is secured to the flatbed with chains/straps and may be completely covered in shipping tarps for protection. Miscellaneous instruments and manifold pieces may have been removed from the RO for shipping purposes. In these cases, the loose parts will be put into a box and strapped to the internal frame of the RO machine.

The skids should be picked from the flatbed by placing lifting straps under the bottom section of the frame. Spreader bars must be used to prevent the lifting straps from damaging the internal structure of the equipment (pipe, instruments, enclosure, etc.).

Inspect each piece of equipment as it is received making note of any physical damage to piping, pneumatic lines, instruments, gauges, or the frame. Notify the carrier immediately if there is damage to the equipment that may have occurred during shipment. Inspect each piece of equipment to verify all pieces listed on the packing sheets are accounted for. Notify GE Water & Process Technologies immediately if there are any missing pieces.

After each piece of equipment is removed from the flatbed truck, it should be placed in its position in the water treatment room or stored indoors. Any loose items should be kept together attached to their respective equipment skids or in boxes, pallets or crates

as appropriate. If the equipment cannot be stored indoors, all pieces must be kept under a heavy-duty tarp or other material to protect from the elements.

2.2 Installation Considerations

2.2.1 Location

Select a location for your machine that is flat, near the required electrical and water supply, provides adequate drainage and clearance for membrane element replacement (Mounting Requirements, Section 2.2.2). GE Water & Process Technologies recommends the machine be used indoors and sheltered from direct sunlight.

2.2.2 Mounting Requirements

Machines are equipped with a stand-alone frame, which supports the machine. When setting up your machine, GE Water & Process Technologies recommends you take into consideration the space needed to remove cartridge pre-filters from filter housings and membrane elements from membrane element housings. The filter housings require room above the housings and the membrane elements require room on the ends of the machine. The membrane element housings require 5-feet (1.5 m) of clearance on both ends of the machine. If adequate spacing is not available, the entire membrane element housing may have to be removed for membrane element changes. The machine should be leveled and evenly supported under the skid. GE Water & Process Technologies recommends that the machine be anchored and/or grouted to a housekeeping pad, depending on the local seismic codes and vibration requirements.

2.2.3 Feedwater Requirements

See Section 1.9.2: Pressure Specifications and

Table 1-3: OSMO PRO 365 Membrane Element Specifications for feedwater requirements.

2.2.4 Temperature

The performance specifications of the RO machine are based on a feedwater temperature of 68°F (20°C). For each degree Fahrenheit the feedwater temperature falls, the RO product flow decreases approximately 1.5%, and for each degree Celsius drop, the product flow is reduced by 3% (refer to Temperature Correction Factors, Technote 113). The operator has the ability to make some adjustments to the operating pressure with the pump discharge throttle valve. In climates where winter water temperature drops significantly below 60°F (16°C) it may be necessary to heat the water or consider an alternative machine configuration.

WARNING!!

The temperature of the tempered water should be monitored closely with a thermometer as high temperatures can damage the RO membranes. Refer to the Feedwater Requirements (Section 1.9.3) for the maximum operating temperature for the RO machine.

CAUTION!

It is necessary to keep the RO from freezing to prevent serious damage to the machine.

2.2.5 Piping

The piping used to transport the permeate and concentrate from the machine needs to be designed to prevent backflow. The concentrate piping should have an atmospheric break prior to entering the drainage system. If multiple RO machines are used, install check valves into the concentrate piping at each machine prior to connecting the lines into a common manifold. In addition, the drain should be sized to accommodate the backwash of filter if on the same line.

2.2.6 Power and Electrical Requirements

Before opening any electrical enclosure, make sure the main power source to the machine is disconnected.

WARNING!!

The electrical system control circuit is separate from the motor voltage. All field wiring must comply with applicable local and national electric codes. The system requires single-phase source supplied to the control enclosure, and a 3-phase source to the motors (via the motor starter or variable frequency drive).

The RO unit control system requires 240 VAC and 5 amps of current or 120 VAC and 10 amps of current for operation.

Refer to the single line diagram for the machines 3-phase voltage requirements.

2.2.7 Inlet Water Connections

Special connections may be needed to the connect water supply. Connections vary between facilities and local water authority codes.

Certain cities may require: a system shut-off valve, backflow preventer, pressure regulator, surge suppressor, and/or a pressure relief device. Contact your local authority or licensed contractor with any questions.

2.2.8 Connections

Table 2-1: Connections

	PRO-50	PRO-100	PRO-150	PRO-200	PRO-300	PRO-450
Feedwater Inlet	2”	3”	3”	4”	4”	6”
Permeate Outlet	2”	3”	3”	3”	4”	6”
Concentrate Outlet	1.5”	1.5”	1.5”	2”	2”	3”

*All connections are I.P.S. Flanges

3 SYSTEM OPERATION

3.1 Initial Start-up

3.1.1 Pre-Treatment for Water Purification

GE Water & Process Technologies RO systems will operate most efficiently on filtered water with a pH of less than 7.0, negative LSI, and a Silt Density Index (SDI) of three (3) 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 mineral precipitation on the membrane, GE Water & Process Technologies evaluates each application and water condition and makes specific recommendations to assure continuity of the membrane element warranty. Data from the water analysis is processed with a computer program analysis to determine if potential problems may 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 Water & Process Technologies for review and recommendations for operation of the machine. Seasonal water conditions must also be taken into consideration.

Before entering the machine, the feedwater must be filtered to a minimum of 5 microns.

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.

3.1.2 Start-Up

NOTE

If your machine is provided with the membranes installed in the housings, proceed with start-up. If your machine is provided with the membranes in shipping boxes, you must load the membranes in the housings prior to starting the machine. For membrane loading instructions, go to Section 4.5.4. Upon completion of membrane installation, return to this section and continue your start-up procedure.

TFC membrane (only) must not contain the following chemicals or permanent loss of rejection and/or permeate flow may result:

- Free or Total chlorine
- Ozone
- Oils and greases or organic compounds
- Iodine compounds
- Quaternary germicides
- Cationic surfactants
- Detergents containing non-ionic surfactants
- Cleaners other than those approved for use
- Other oxidants

1. Re-check the function and integrity of your pretreatment equipment. Ensure that your water softener, activated carbon filters, and/or multi-media filters (where applicable) have been leak-checked, back washed, and thoroughly rinsed for service before starting up your RO unit. Ensure that the various chemical feed systems are primed with chemicals, tested for leaks, and connected to the feed line of the RO unit.

2. Attach the feedwater piping to the inlet of the machine. Attach the discharge piping to the permeate outlet connection which sends the purified water to the storage tank or other process systems. Attach the discharge piping to the concentrate outlet connection that sends the concentrated, or reject water, to a drain or other process systems. Attach air supply and control voltage. GE Water & Process Technologies recommends installing isolation valves on each of these lines. See the Flow Diagram and Process and Instrumentation Drawing (P&ID). Ensure that cartridge pre-filters are installed.

3. Turn on the feedwater gradually and check for leaks in the inlet plumbing. No flow should go through the machine while the power is off and the automatic inlet valve 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 permanently damage the membrane elements.

4. Attach discharge plumbing or tubing to the Clean-In-Place (CIP) inlet, permeate and concentrate connections, which sends water to and from the CIP tank. Connect piping or tubing to the CIP drain direct. This drain connection will be used to direct permeate water to drain during the start-up flush cycle.

GE Water & Process Technologies recommends installing isolation valves on each of these lines. See the Flow Diagram and P&ID.

5. The machine requires two power supplies, (1) the high voltage for the motor operation and (2) the control circuit power supply. Ensure that you have made provisions for both power supplies required to operate your machine. Check the voltage label to ensure that you have brought the correct voltage to the starter or VFD. Please refer to Electrical Drawings for more details.

!

Motors are dual rated. Appropriate motor starters must be selected depending on full load amp draw for available voltage. The motor must be wired for the appropriate voltage.

IMPORTANT!

6. Be sure the power to the motor starter is de-energized.

7. With the power source to the motor starter or VFD de-energized, using the HMI turn the OFF/AUTO/HAND/FILL/CIP/CIP FLUSH switch to the FILL position. Water will begin to flow through the machine at this point but the pump will NOT start. Open the vent filter valves on the top of the cartridge filter housings and the permeate sample ports on the membrane element housings. This will permit air to exit the machine. Allow the machine to operate in this manner for 10 minutes, to purge the air out of the machine. Close these vent valves once a steady stream of water is expelled from them.

8. As your machine is filling check for leaks and repair as needed.

9. After 10 minutes, turn the OFF/AUTO/HAND/FILL/CIP/CIP FLUSH switch to the OFF position.

10. Energize the power source to the motor starter or VFD. The pump should not operate at this point because the switch is in the OFF position.

11. Check the rotation of the high-pressure pump by briefly turning (e.g., bumping) the OFF/AUTO/HAND/FILL/CIP/CIP FLUSH switch to the HAND position. After five seconds, the high-pressure pump will start. Immediately turn the switch to the OFF position. Watch, or have an assistant watch, the motor or coupling shaft for direction of rotation. The motor should rotate clockwise as you are looking down on to the motor end of the high-pressure pump. If the motor is not rotating clockwise, change any two of the three leads (for 3-phase) in the motor starter or VFD and recheck rotation. **Always turn the power OFF to change any wiring**.

CAUTION!

Operation of the pump backwards for even a short time may cause damage to the pump.

12. Open the concentrate valve slightly and turn the OFF/AUTO/HAND/FILL/CIP/CIP FLUSH switch to the HAND position. After a short delay, the high-pressure pump will start and the machine will begin to build pressure.

Once the pressure has come up, adjust the concentrate valve to the proper flow rate.

13. As the machine is operating, watch the primary and final pressure gauges. Refer to Table 1-1: Flow Specifications/Range 75% Recovery and Section 1.9.2 Pressure Specifications for average operating flows and pressures.

14. As the machine purges the air and fills with water, the pressure will gradually increase. The permeate and concentrate flow meters should begin to detect flow, displayed on the operation screen of the HMI. If you do not see flow after 30 seconds, turn the machine OFF and refer to TROUBLESHOOTING (Section 5).

CAUTION!!

Never allow the machine to operate without adequate water pressure. This can cause severe damage to the high-pressure pump.

15. If necessary, gradually adjust the concentrate valvesAs you adjust the valve, watch the final pressure gauge (P_{final}) and your concentrate flow meter. Opening the concentrate valve will decrease operating pressure and closing the concentrate valve will increase operating pressure. Adjust the valve until your concentrate flow meter displays your design flow.

Your machine will generally operate at a recovery rate of 70 – 80%. (Refer to Table 1-1: Flow Specifications/Range 75% Recovery for Flow Specifications and Rates.) To adjust the recovery rate, contact the GE Water & Process Technologies Field Service Group.

16. Typically, once the desired flow rate is achieved, no further valve adjustment is needed unless temperature and/or pressure conditions change.

NOTE

Permeate flow rates are dependent upon temperature and conditions at your site. Contact the GE Water & Process Technologies Field Service Group if you have any questions.

17. 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 biocide has been removed from the membranes.

NOTE

The membranes in your machine are rated for certain flow rates at 68°F (20°C). Maximum flow rates are achieved when the membranes have been completely rinsed and on-line for at least 24 hours.

18. Record start-up performance data on the Start-Up Data (Section 6.4).

NOTE

A Daily Log Sheet (Section 6.5) that includes general operating conditions (pressures, flows, concentrations, pH, and pretreatment conditions), and routine or special maintenance (cleaning as needed) must be kept. GE Water & Process Technologies will require this log sheet if a warranty question arises.

3.2 Control Narrative

See the Control Section of the water treatment system manual for control narrative.

3.3 Daily Start-Up Procedure

Check the machine to insure inlet, permeate, and concentrate valves are in the proper positions for operation.

To turn the RO on, press the OFF/AUTO/HAND/FILL/CIP/CIP FLUSH switch to the AUTO position if a remote start signal or tank level controls the RO machine or HAND to operate manually. If the alarm light is lit, push the “alarm reset” switch. If the alarm light

stays lit, check the RO for an alarm condition. If no alarm conditions exist, the main inlet valve will open, and the high-pressure pump will turn on after a short delay. The RO machine will shutdown in an alarm after 10-15 seconds if there is insufficient inlet pressure [<12 psig (0.83 bar)].

Daily performance data must be recorded on the Daily Log Sheet (Section 6.5).

3.4 Shut Down Procedure

Prior to shutting machine down, ensure that the Daily Log Sheet (Section 6.5) has been completed. If not, complete before shutting the machine down.

NOTE

1. Turn the RO control OFF/AUTO/HAND/FILL/CIP/CIP FLUSH switch to FILL.

2. The high-pressure pump will shut-off and the machine will perform a fresh water flush (2-5 minutes of fresh water flush is recommended).

3. Turn the RO control OFF/AUTO/HAND/FILL/CIP/CIP FLUSH switch to OFF.

4. The inlet valve will close all flow of water.

If the machine is in AUTO mode and controlled by an outside signal or tank level, it will not be necessary to turn the machine off at the control screen unless it needs to be taken out of service.

In AUTO mode a basic control system will automatically perform a fresh water flush under low pressure for 5 minutes prior to shutting down. If the machine has the premium electrical package when enabled the permeate will be diverted to the CIP tank and then to the inlet of the machine for 5 minutes prior to shutting down the high-pressure pump, otherwise a fresh water flush under low pressure will be conducted. Both methods ensure that concentrated feedwater is flushed from the system before shut down.

4 MAINTENANCE

The operation and maintenance of your machine is relatively simple but requires regular data recordings and routine preventative maintenance. GE Water & Process Technologies cannot emphasize too strongly the importance of filling out the Daily Log Sheet during each operating shift. You should have filled out a data sheet upon start-up containing pertinent facts on the operation of your machine. These two records are invaluable in diagnosing the performance of the equipment, or warranty issues, 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 Water & Process Technologies Field Service Group.

The five preventative maintenance procedures that must be done on a regular basis are as followed:

1. Maintain Daily Log Sheet (Section 6.4).
2. Change the pre-filter cartridges (Section 4.2.1).
3. Run the machine for at least 3 hours of operation every 72 hours.
4. Clean the machine as necessary (Section 4). GE Water & Process Technologies recommends cleaning the machine monthly, or at a minimum once per quarter.
5. Change the oil in the Tonkaflo pump as described in the pump's operation and maintenance manual.

Operator maintenance on a GE Water & Process Technologies RO system is limited to maintaining performance logs, cleaning, calibration of instruments, and replacement of damaged or failed parts. The maintenance procedures have been categorized by their frequency and are as follows: (specific instructions follow the maintenance schedule).

4.1 Daily Maintenance Requirements

4.1.1 Daily Log Sheet

A Daily Log Sheet, which includes general operating conditions [pressure, flows, instrument readings (pH, conductivity, etc.)] and routine or special maintenance (pre-filter changes, cleaning, etc.), must be kept. Copies of the log can be made from the template (Section 6.5). **GE Water & Process Technologies will require a copy of this log sheet if a warranty question arises.**

4.1.2 Record Pressure Gauge Readings

Observe and record the pre-filter, post filter, primary, and final pressure gauges on the Daily Log Sheet.

4.2 Weekly Maintenance Requirements

The actions below should be performed in addition to the daily requirements.

4.2.1 Replace Pre-Filter

Cartridge filters were once considered only as a point-of-use water treatment method for removal of larger particles. However, breakthroughs in filter design, such as the controlled use of blown microfiber filters (as opposed to wrapped fabric or yarn-wound filters), have tremendously broadened cartridge filter utilization.

Best Practice

A 1-micron pre-filter is factory-installed to protect the membranes and valves from particles, which may be in the feedwater. The filter cartridges must be replaced after a pressure drop of 8 – 10 psig (0.55 – 0.69 bar) across the filter during operation or, at least, once a month.

Filters can be changed based on scheduled time frequency. This can be dictated by the type of application or the end user requirement.

Use only GE Water & Process Technologies approved pre-filters rated for 5 microns or less. Do not attempt to clean used filters. Discard and install new filters. To order replacements, see the Spare Parts List (Section 4.6).

Failure to change the filter according to these requirements will void the warranty.

NOTE

4.2.2 Record RO Temperature

Observe or measure and record the RO temperature. This information is available from the instrument display center. The RO temperature has a significant effect in the permeate flow rate of the RO membrane elements.

4.3 Monthly or Quarterly Maintenance Requirements

The actions below should be performed in addition to the weekly requirements.

4.3.1 Membrane Element Cleaning

Read and understand all cleaning instructions before beginning process.

NOTE

Cleaning your machine on a regular basis is vital. Over time, contaminants buildup 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 damage and reduce the membrane element life. A decrease in permeate flow and/or rejection of salts, or an increased pressure drop across the membrane elements (the difference between the primary and final pressures) 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. Refer to the Membrane Cleaning Procedure (Section 4.5.2).

GE Water & Process Technologies offers a full line of chemical cleaners for specific cleaning needs. See the Spare Parts List (Section 4.6).

4.3.2 Review Operating Data

Review operating data for any trends that might be cause for concern or additional maintenance. For example, check operating data for a 5% or more change in flow, rejection, or pressure differential. If any of these changes occur review the TROUBLESHOOTING Section (Section 5).

4.4 Annual Maintenance Requirements

The actions below should be performed in addition to the monthly requirements.

1. Check the instrument display monitor for accuracy.

2. Check the instruments for correct functioning. Check the pH and ORP probes every six months. Replace or calibrate if necessary.

3. Check the tubing, gaskets, and fittings for leaks and wear. Replace if necessary.

4. Check the switches and lights for correct operation. Replace or repair if necessary.

5. Check all pre-RO devices for correct operation. Replace if necessary.

6. Lubricate the motor. Refer to the pump's operation and maintenance manual.

7. Check membrane element performance. The normal life span of a well-maintained membrane is 2 – 3 years.

4.5 Maintenance Procedures

4.5.1 Pre-Filter Replacement Procedure

One-micron pre-filters are factory-installed to protect the high-pressure pump, membranes, and valves from particles in the feedwater.

The pre-filter cartridges should be replaced regularly to minimize pressure drop and help minimize biological growth. Weekly or biweekly replacement is typical. Use only GE Water & Process Technologies approved filters rated for 5 microns or less. Do not attempt to clean used pre-filters.

The pre-filters should be replaced before and after cleaning of the membranes elements.

1. To change the pre-filter, turn the RO machine OFF, turn the feed water supply off.

2. Close the manual inlet valve upstream of the high pressure pump inlet to prevent water from draining out of the RO machine.

3. Open the pre-filter vent tops and make sure no feedwater pressure exists.

4. Open the pre-filter drain valves.

5. Remove the pre-filter housing tops by loosening the V-band clamps.

6. Remove the old filters.

7. Install the new filters. Assure proper compression of the pre-filter springs, indicated by a 2/3's compression of the uncompressed spring length.

8. Re-install the pre-filter tops, close the pre-filter drain valves, and tighten the V-band clamps.

9. Open the feedwater supply, allow air to purge through the vents.

10. Close vents after a steady stream of water is produced.

11. Open the manual inlet valve upstream of the high pressure pump inlet.

Failure to change pre-filters may void the machine warranty.

NOTE

4.5.2 Membrane Cleaning Procedure

Refer to the Pro RO CIP Operation and Maintenance manual for membrane cleaning procedures.

4.5.3 Membrane Removal Procedure

As time progresses, the effectiveness of the membrane elements will be reduced. Symptoms of reduced membrane element effectiveness include reduced rejection and permeate flow rate drift. Membrane element life can be extended with diligent cleaning of the machine. Precipitation of minerals 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. Reference Figure 1-2: Banking *Array* and Figure 1-3: Membrane Element

1. Remove the setscrews on the end caps and remove the snap rings from the end caps. Remove end caps from all of the membrane element housings.

2. Remove all of the membrane elements from the membrane element housings in the direction of flow (where possible). A heavy-duty pliers or channel lock pliers may be necessary to pull the old membrane element out of the membrane element housing. A long pole, pipe, pieces of 4 x 4, etc., may be used to push the old membrane elements out of the housings.

4.5.4 Membrane Installation Procedure

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

CAUTION!

The membrane element may be packaged in a small amount of bactericide solution to prevent biological growth; provide adequate ventilation when handling.

NOTE

Take the necessary precautions when handling membrane elements.

1. Remove the membrane 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. If you ordered the parts kit, inspect for damage. 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. If you are replacing existing membrane elements, set the membrane element aside in a clean space, and remove membrane elements (Membrane Removal Procedure Section 4.5.3).

5. Inspect the membrane element housing and clean as necessary to remove any contaminants, obstructions, etc.

6. Apply O-ring lubricant to all O-rings on the end caps, and the brine seal on the membrane element. Typically, glycerin is used. Using very little lubricant or no lubricant can make the installation process very difficult and can cause damage to the O-rings and seals.

7. 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).

8. 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 rotate the membrane to ensure the brine seal enters the housing without coming out of the brine seal groove. Install the interconnectors in between each membrane element, as well as between each membrane element and the endcaps at both ends.

9. Re-install the end caps by gently twisting the end cap while pushing it onto the interconnector and verifying the interconnector is sealed well with the element's 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 just past the snap ring groove. Re-install the snap rings.

10. Re-connect any fittings that were removed when disassembling the membrane housings.

If at initial start-up, return to Section 3.1.

11. Run the permeate and concentrate streams to drain for at least 30 minutes. This is done to ensure that all of the biocide has been removed from the membrane elements.

4.5.5 Pump Bearing Frame Lubrication

Refer to your pump's operation and maintenance manual.

4.6 Spare Parts List

For additional spare part details refer to your Process and Instrumentation Diagram (P&ID). Items described below are used on all models. Contact the GE Water & Process Technologies Customer Support Center to order parts.

Description	Part Number
Pre-Filters/Membrane Elements	
1-micron, RO.Save 01-40-XK (20/ctn)	1236278
Membrane Element: OSMO PRO 365 WT	1240538
Membrane Element: OSMO PRO 400 WT	1240678
PVC Interconnector, for 8-inch membrane elements	1115808
O-ring for interconnector	1142599
Blank permeate tube, PRO Series membrane, PVC	1118744
Concentrate seal, U-cup for PRO and AG	1118749
Filter Housing V-Band Clamp	1142468
Filter Housing O-Ring, BUNA-N,70DUR	1143060
Filter Housing Brass,.31-24 UNF,0.63L	1152873
Filter Housing Wing Nut, Internal, 316,0.38	1143002
Filter Housing Tie Rod,316,47.50	1140866
Instruments	
Pressure gauge, SS, 0 – 600 psig (0 – 41.4 bar) 2.5-inch diameter with 1/4-inch mount	1118569

Pressure gauge, SS, 0 – 100 psig (0 – 6.9 bar) 2.5-inch diameter with 1/4-inch back mount	1118571
Pressure switch, 0 – 160 psig (0 – 11.0 bar)	1227357
Pressure switch, 0 – 600 psig (0 – 41.4 bar)	1227356
Pressure Transmitter, 0 – 500 psig (0 – 34.4 bar) PRE models	3013257
Flow sensor, paddle wheel type for Basic Models	1117652
Flow sensor, paddle wheel type PRE models	3037469
Conductivity sensor PRE models	3037467
Conductivity sensor PRE models	3037468
Temperature sensor PRE models	3029708
pH sensor PRE models	3034593
ORP sensor PRE models	3034594
Conductivity sensor for Signet 8900	3017445
pH sensor for Signet 8900	3049035
ORP sensor for Signet 8900	3049036

Valves

PVC sample valve, 1/4-inch	1156744
SS sample valve, 1/4-inch	1226020
PVC sample valve, 3/8-inch	1201698
PVC sample valve, 1/2-inch	1115307
Solenoid valve	1112563

RO Pumps/Motors

Pump, liquid end, Tonkaflo SS8512KZB (PRO-11)	1123885
Pump, liquid end, Tonkaflo SS12509KZC (PRO-23)	1123895
Pump, liquid end, Tonkaflo SS24008KZE (PRO-34)	1123237
Pump, liquid end, Tonkaflo AS40406KZE (PRO-45)	1225626
Pump, liquid end, Tonkaflo AS40407KZE (PRO-68)	1225628
Pump, liquid end, Tonkaflo AS40407KZE (PRO-102)	1225628
Pump, mechanical seal kit, 1-inch Type 21 for all std. Pumps with “E” or “K” bearing frames	1121177
Bearing frame grease, 2 Lithium (14.5 oz.)	1113767
Oil, Tonkaflo, Heavy duty (1 qt.)	1120693
Pump discharge screen, 3-inch victaulic	1120501
Pump discharge screen, 4-inch victaulic	1125379

8-inch Housing Parts

O-ring, 815-series end cap, Buna-N	1156580
Retaining ring, 815-series end cap	1156483
Retainer screw, 815-series end cap	1156877
PVC Interconnector, for 8-inch membrane elements	1115808
O-ring for interconnector	1142599
Blank permeate tube, 815 series PVC	1118744
Concentrate seal, U-cup for 815 series membrane elements	1118749

Cleaning Chemicals

Kleen MCT 103
Kleen MCT 511

Literature

Operation and Maintenance Manual
Pure Water Handbook 1154273

4.7 Level Switch, Level Transmitter or Other External Controls

It is possible to control your PRO machine externally.

The external control options include:

- 4-20 mA transmitter signal (tank level)
- Discrete ON/OFF signal (plant DCS system)
- Discrete pretreatment lock-out signal

See Control Narrative for details.

4.8 Chemical Pump

GE Water & Process Technologies has available multiple chemical injection systems with control factory configured for pH control, antiscalant, or sodium sulfite addition. See the Chemical Feed Systems Section of the water treatment system manual.

5 TROUBLESHOOTING

This troubleshooting guide can assist you in identifying common operating problems you may experience with your machine. The operator can easily correct many of these problems; however, for those that persist or are not understood, you should contact the GE Water & Process Technologies Field Service Group. Have the following information available when calling the GE Water & Process Technologies Field Service Group:

- Machine installation date.
- Model number (found on right-hand side of front panel).
- Serial number (found on right-hand side of front panel).
- Daily Log Sheets.
- Detailed description of problem.

Table 5-1: Troubleshooting Guide

TROUBLESHOOTING GUIDE		
Symptom (Alarm)	**Possible Cause**	**Remedies**
Low inlet pressure (low inlet alarm)	Insufficient feedwater pressure	Increase the feed pressure, open the inlet/feed valve, check for restrictions, and consider installing a feedwater boost pump.
	Clogged pre-filter	Replace the pre-filters.
	Solenoid valve not opening	Clean or replace the solenoid valve. Clean air line for adequate pressure. Check regulator for correct operation and setting.
Low operating pressure	High flow rates	Close the orifice bypass valve, check the permeate and concentrate flow rates and adjust if necessary. Excessive permeate flow may indicate improper interconnector installation.
	Pump discharge screen (low primary pressure)	Inspect and clean.

	Dirty or fouled membranes (low final pressure)	Clean the membranes.
	Warm operating conditions	Correct temperature.
	Pump rotating backwards (3-phase power only)	Switch any two 3-phase leads to the motor starter.
	Pump not operating correctly	See pump instructions.
High temperature (High temp alarm)	Temperature too high	Shut-off machine and let it cool down. Lower feedwater temperature. If recirculating water, install cooling heat exchanger to prevent water heat up.
	Switch set too low	Follow procedure in instrument instruction manual to change switch setting.
	Faulty temperature instruments	Check instruments against reference standards and replace as necessary.
High/low inlet pH (alarm)	pH out of range	If pH is too low, the acid feed system may be over-injecting. Reset to maintain pH in middle of alarm setting or refer to machine specifications. Refer to chemical feed manual.
		If pH is too high, check operation of acid feed system for proper operation. Refer to chemical feed manual.
	Faulty pH probe	Calibrate and check with reference standard. Clean or replace as necessary. Refer to pH meter manufacturer's manual.
High ORP (alarm)	Chlorine breakthrough	Check setting and operation of sodium bisulfite system. Check for presence of chlorine. If using activated carbon upstream, check the condition of the carbon media.

	Faulty ORP probe	Recalibrate or replace ORP probe.
	Alarm set too low	Verify chlorine-free water and raise alarm setpoint. See instrument instruction manual.
Low permeate flow rate	Low operating pressure	See the possible causes for low operating pressure.
	Dirty or fouled membranes	Clean the membranes.
	Operating on cold water less than 55 - 60°F (13 - 16°C)	Install a hot/cold feedwater tempering valve if more permeate flow is needed. Operate with a feedwater temperature of 55 - 65°F (13 - 18°C).
	Membranes installed backwards or damaged concentrate seal	Install membranes in the direction of fluid flow. Clean the machine immediately. Membranes with damaged concentrate seals should be cleaned.
	Flow meter inaccurate	Check the flow rate manually with a stopwatch and calibrated container (such as CIP tank).
Low permeate flow rate (continued)	Valve position	Check CIP and outlet valve positions for correct orientation.
Low concentrate flow rate, normal or higher than normal pressure	Concentrate orifice plugged	Remove the concentrate orifice and/or disassemble the plumbing. Clean the orifice.
	Concentrate outlet line restricted	Examine the concentrate line for obstructions or a closed valve.
	Flow meter inaccurate	Check the flow rate manually with a stopwatch and calibrated container. Note: CIP tank can be used for this purpose.
High operating pressure (high perm. Or conc. Alarm)	Recycle or concentrate lines plugged	Disassemble the plumbing to the recycle orifice and remove foreign particles.
	Inaccurate pressure switch setting	Replace or calibrate the switch as required.

	Service and CIP valves closed at the same time	Verify water path to both is open.
	Restricted or reduced permeate flow rate	See the possible causes for low permeate flow rate.
Excessive pressure drop [exceeding max ΔP] (high primary pressure – low final pressure)	Restricted flow after pump outlet	Check for blockage of the concentrate flow at the inlets and outlets of the membrane housings. Check for blockage at the pump discharge screen.
	Telescoped membrane covering membrane housing outlet port	Ensure that the anti-telescoping device (ATD) is located properly on the membrane.
Excessive pressure drop [exceeding max ΔP] (high primary pressure – low final pressure)	Severely fouled or dirty membranes	Clean the membranes.
Water flowing when machine is turned off	Inlet control valve not closing or seating properly.	Clean or replace the solenoid valve. Clean the membranes immediately. Water must not pass through the inlet when the machine is off. Repair or replace valve components as necessary.
Declining rejection (high permeate conductivity)	Dirty or fouled membranes	Clean the membranes.
	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. NOTE: This typically only happens immediately after membrane installation.
	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 Water & Process Technologies for review.

Declining rejection (high permeate conductivity) (continued)	Inaccurate conductivity monitor or fouled probe	Calibrate the monitor with a conductivity standard solution or check the readings with another conductivity meter. Replace or clean the probe. Check the connections between the probe and monitor.
	Low recycle flow	Adjust recycle flow (if applicable).

6 MISCELLANEOUS

6.1 Return Goods Authorization (RGA) Procedure

If you wish to return goods for repair, warranty evaluation and/or credit, please have your original sales order or invoice available when you call GE Water & Process Technologies. Call the GE Water & Process Technologies Field Service Group at (866) GEWATER. An GE Water & Process Technologies Field 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 Water & Process Technologies with the freight prepaid by the customer. Call our Customer Support Center with any questions or issues concerning freight claims and a representative will discuss your situation.

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

6.2 Machine Warranty/Guarantee

Seller warrants its products to be free from defects in material or workmanship for a period of 15 months from receipt or 12 months from start-up/first use of the product, whichever occurs first, but only when said products are operated at all times in accordance with Seller's written instructions. This warranty does not apply to replaceable parts or components normally subject to wear and replacement.

Unless stated specifically on a form, official "Performance Warranty Document" signed by an officer or director level employee of the Seller and an employee of the Buyer who is authorized to make such representations, there is no performance warranty on products or warranty on process results.

Seller expressly disclaims liability for incidental and/or consequential damages including, without limitation, lost profits. This warranty is made expressly in lieu of all other warranties, express or implied, including all implied warranties of merchantability or fitness for any particular purpose. Buyer assumes all liabilities for use and misuse by buyer, its agents or assignees.

Buyer shall give immediate notice in writing to Seller if products or components thereof or performance (where applicable) appear defective, and shall provide Seller with reasonable opportunity to make inspections, tests, and repairs using the most efficient and cost effective methods available for such products or components. If Seller is not responsible under the terms of this document and/or any formal performance warranty, Buyer shall pay Seller the costs and expenses of such inspections, tests, and repairs.

Seller's obligation under this warranty is limited to repair or replacement at its factory, for the original user, of any product or component part thereof, which shall prove to have been defective. No allowance will be made for repairs or alterations made by the Buyer without the Seller's written consent or approval. In no event shall Seller be liable to Buyer for any amount, including costs incurred or expended by Seller in attempting to correct any product deficiency, relating to any claim by Buyer against Seller in excess of the aggregate total purchase price under this contract. No charges or expenses incident to any claim will be allowed. The remedies provided herein are exclusive, and Seller shall incur no liability other than that stated herein.

Goods may not be returned to Seller without Seller's written permission. Seller will provide Buyer with a RGA number to use for returned goods. All returns shall have freight and related costs prepaid by Buyer from point of origin. Seller is not responsible for meeting state and local codes or ordinances, or other special codes not specifically stated in writing on the purchase document or contract.

TECHNICAL ADVICE - Seller may, at Buyer's request, furnish technical assistance, advice and information with respect to the products supplied under this contract, if and to the extent that such advice, assistance, and information are conveniently available. Seller has no obligation to provide such information, which is provided without charge at the Buyer's risk, and which is provided subject to the limited warranty above.

6.3 Membrane Element Warranty/Guarantee

GE Water & Process Technologies, Inc. guarantees the proposed product to be free from defects in material or workmanship when operated in accordance with written instructions for a period of one year from start-up or fifteen months from receipt, whichever is shorter. Parts not manufactured by GE Water & Process Technologies are covered by their manufacturer's warranties that are normally for one year.

GE Water & Process Technologies' spiral-wound membrane elements are guaranteed to operate within specifications when used for general water treatment for a period of 24 months from receipt providing the membrane elements have not been abused by operating at high temperatures, high or low pH, on undisinfected water, or on solutions which tend to precipitate.

For applications or water conditions other than those specified in the original purchase order for the reverse osmosis or ultrafiltration machine, the User should consult GE Water & Process Technologies' Engineering Department as to the suitability of the solution to be run in the membrane membranes.

Limitations on pH and temperature can vary with membrane type and the application of the equipment. For general water treatment, pH should be kept between 3.0 and 7.0 with a temperature below 85°F (29°C) unless specifically designed for higher temperatures.

For special applications or for pH or temperature ranges outside the stated limits, GE Water & Process Technologies may reduce the warranty period.

A membrane element which fails to perform satisfactorily within the first 90 days after receipt, has not been mishandled, and is returned to the factory, will be replaced free of charge except for freight and local labor. If a membrane element fails to perform satisfactorily during the balance of the warranty period and with the return of the membrane element to the factory, GE Water & Process Technologies will replace the membrane element with a new membrane element and will charge the User for the portion of the 24 months that the membrane element was used plus incoming freight and local labor. Such pro rata charges will be based on the list price prevailing at the time of warranty consideration. A new membrane element supplied under warranty terms will carry the standard 24-month new membrane element warranty.

If a membrane element is to be returned for warranty inspection, the User must obtain a Return Goods Authorization (RGA) number from GE Water & Process Technologies before returning the membrane element. Membrane elements are to be returned freight prepaid to GE Water & Process Technologies, and GE Water & Process Technologies will return any warranty replacement membrane elements to the customer prepaid. Membrane elements must be kept damp at all times and must be clean and bagged in a watertight bag before returning. Only GE Water & Process

Technologies' approved cleaners, biocides, dispersants or other chemicals may be used with the membrane elements. Use of other chemicals may void the warranty. The User is responsible for knowing the membrane material and for ensuring that chemicals harmful to the membrane are never in contact with the membrane elements.

It is the obligation of the User to maintain frequent operating data records. GE Water & Process Technologies may request these records in the warranty evaluation. User must notify GE Water & Process Technologies at the very first sign of changes in operation of the GE Water & Process Technologies machine or membrane elements. Such notification should be in writing and should include all data requested on the operating log sheets.

6.4 Start-Up Data

Customer: Date:
Model No: Tested By:
Pump Model No: Serial No:

	Units (Circle One)		Data	Data	Remarks
Temperature	°F	°C			
Permeate Rate	gpm	lpm	/	/	
Concentrate Rate	gpm	lpm	/	/	
Total Flow Rate	gpm	lpm	/	/	
% Recovery	%				
Pre-Filter Pressure	psi	bar			
Post-Filter Pressure	psi	bar			
Primary Pressure	psi	bar			
Final Pressure	psi	bar			
Feed Conductivity	µS/cm				
Concentrate Conductivity	µS/cm				
Average Conductivity	µS/cm				
Permeate Conductivity (manual)	µS/cm				
Permeate Conductivity (meter)	µS/cm				
% Passage (Perm TDS/Avg TDS)	%				
Chlorine in Concentrate	Ppm				

Low Pressure Switch Setting	psi bar			

6.5 Daily Log Sheet

NOMENCLATURE:
PRESS = PRESSURE
CONC = CONCENTRATE, Q_C
PERMEATE = PERMEATE, Q_P
TEMP = TEMPERATURE
COND = CONDUCTIVITY

MACHINE MODEL NO:

SERIAL NO:

NAME OF COMPANY:

PERIOD OF THIS SHEET:

NOTE: Please record all calibrations of instruments or other occurrences related to this system.

DATE AND TIME										
PRE-FILTER PRESSURE *(psi or bar)*										
POST-FILTER PRESSURE *(psi or bar)*										
PRIMARY PRESSURE *(psi or bar)*										
FINAL PRESSURE *(psi or bar)*										
FEEDWATER TEMP (°F or °C)										
PERM FLOW *(gpm or lpm)*										
CONCENTRATE FLOW *(gpm or lpm)*										
RECOVERY, Q_P / (Q_P+Q_C)										
FEED COND (µS)										
CONC COND (µS)										
PERM COND (µS)										
AVERAGE COND (µS), (C_F+C_C)/2										
FILTER CHANGE (✓)										
CLEAN (✓)										
FEED CHLORINE *(ppm)*										
FEEDWATER HARDNESS *(ppm)*										
OPERATORS INITIALS										
Reference the Troubleshooting Guide where trends or differences are noted. This is a template; make copies as necessary.										